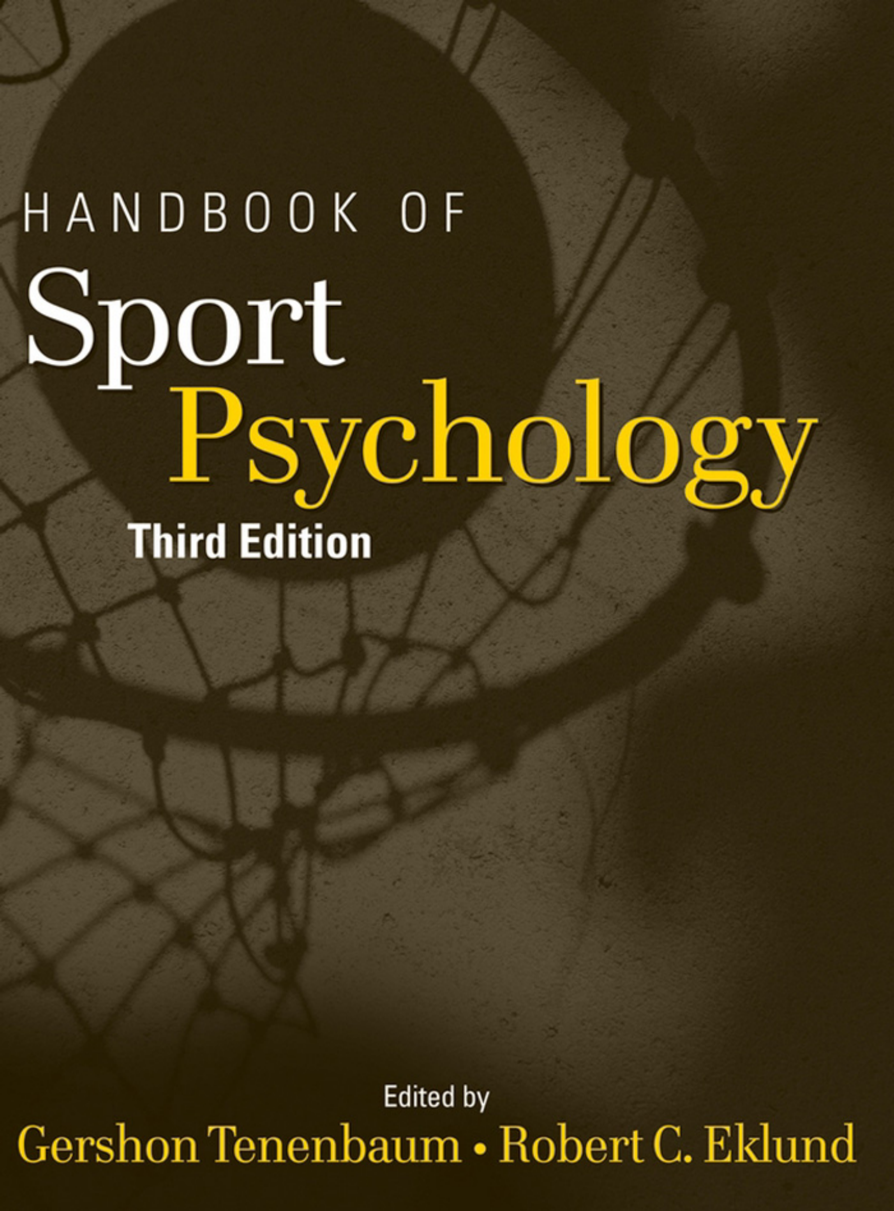


HANDBOOK OF

Sport Psychology

Third Edition

Edited by

Gershon Tenenbaum • Robert C. Eklund

HANDBOOK OF
SPORT PSYCHOLOGY

HANDBOOK OF SPORT PSYCHOLOGY

THIRD EDITION

Edited by

GERSHON TENENBAUM AND ROBERT C. EKLUND

John Wiley & Sons, Inc.

This book is printed on acid-free paper. ♾

Published by John Wiley & Sons, Inc., Hoboken, New Jersey.
Published simultaneously in Canada.

Library of Congress Cataloging-in-Publication Data:

Handbook of sport psychology.—3rd ed. / Gershon Tenenbaum and Robert C. Eklund, eds.
p. cm.
Includes bibliographical references and index.
ISBN-13: 978-0-471-73811-4 (cloth)
ISBN-10: 0-471-73811-5 (cloth)
1. Sports—Psychological aspects. 2. Sports—Research. I. Tenenbaum, Gershon. II. Eklund, Robert C. (Robert Charles), 1958–
GV706.4.H37 2007
796.01—dc22

2006008113

Printed in the United States of America.

10 9 8 7 6 5 4 3 2 1

To Hony, my wife, the best partner
I could have wished to share my life with, and to
Ravid, Noam, and Sharon, my children, who bring me pride and joy.

—GERSHON TENENBAUM

To my sons, Garth (5 years) and Kieran (3 years), who generously volunteered to
write chapters so that we'd be able to go play sooner, and
my wife, Colleen, who nurtures and supports "play" for the whole Eklund family.

—ROBERT C. EKLUND

In memory of
Hony M. Tenenbaum
September 26, 1954 – July 25, 2006

Contents

PART VIII SPECIAL TOPICS

Foreword

ROBERT SINGER

It certainly is gratifying and exciting for me, as coeditor of the two previous editions of this *Handbook* (i.e., Singer, Murphy, & Tennant, 1993; Singer, Hausenblas, & Janelle, 2001), to realize the impact this type of resource book has had on the field of sport psychology in general, and on so many individuals around the world. These include students, educators, and psychologists, oriented primarily as scholars or as practitioners. Because of this enormous success, the *Handbook* is now being updated and published in the third edition. The two previous editions were successful, and no doubt the present edition will be of even greater significance.

Such expectations can be attributed to a variety of factors. Editors Gershon Tenenbaum and Bob Eklund are very experienced and well-known internationally among sport psychologists for their scientific and professional contributions, and both are highly motivated and organized in their work. They possess a comprehensive understanding of the vast subject matter and recognize the variety of topics and themes associated with the area. The magnitude of the coverage of issues of topical interest in sport psychology, as well as the reputations of the authors contributing to this compendium, reflect the effort made by these editors to produce an outstanding volume. A tremendous increase in research and scholarly activities has been seen in recent decades. Likewise, more students are studying sport psychology to become counselors, clinicians, or sport scientists who work directly with athletes to aid them in the learning mastery of skills and performance enhancement. Then there are also those who will become educators and teach the subject matter of sport psychology. All of these observations generate a need to update the *Handbook* more frequently. The *Handbook* serves not only as a timely overview of recent developments, but also as a stimulus for further scholarly productivity and improved teaching and clinical applications. Better coaching and athletic performance should also occur.

Previous editions of the *Handbook* have tended to continue certain topics, omit others, and include new ones. Editors have a difficult role to play in the decision process on this account. In my opinion, Tenenbaum and Eklund have made wise decisions in their choices for inclusion in this edition—and ones that, I believe, reflect their understanding of and sensitivity to trends in scholarly interests in and impact on sport psychology. A very broad interpretation of the dimensions of sport psychology could lead to a gigantic book. Fortunately, the present editors have shown restraint and good judgment while providing a great variety of diversified contemporary topics. The authors have done an outstanding job in their coverage of assigned topics as well as presentation style. Much research is synthesized, organized, and presented in an excellent manner to challenge and inform and yet hold the reader's interest.

This book cannot be digested by merely scanning the pages. It is meant for the person who is serious about becoming more informed on many selected topics related to sport psychology and who wants to be challenged and stimulated by the scholarly and scientific nature of the field. Every theme may not interest the reader, at least in a first glance at the table of contents. Sometimes, however, following up on themes of less initial interest can be transformative in terms of expanded knowledge and appreciation of contributions in the area. In fact, further research may, serendipitously, be the result of these forays. With all my travels to other countries, I have been continually amazed to see copies of the previous *Handbooks* in the offices of dedicated sport psychologists. No doubt, the same will be true about this edition.

Finally, I appreciate the opportunity to write the Foreword for a book that means so much to me. The *Handbook of Sport Psychology* has been, and will continue to be, a gold standard resource book due to its intellectual content, breadth of topics, excellence of contributors, timeliness of topic coverage, and contributions to sport psychology and sport psychologists. I felt very challenged in attempting to design the framework of the first two *Handbooks.* I am very grateful to my coeditors and the many authors (good friends of mine) who made those volumes a success. No doubt, current editors Tenenbaum and Eklund feel equally proud, and rightfully so, of being able to put everything together in expert fashion to realize the production of a very significant publication that will touch the professional lives of many individuals in the future.

Contributors

Bruce Abernethy
Institute of Human Performance
University of Hong Kong
Hong Kong, China

School of Human Movement Studies
University of Queensland, Australia
Brisbane, Australia

Dorothee Alfermann
Faculty of Sport Science
University of Leipzig
Leipzig, Germany

Mark B. Andersen
School of Human Movement Recreation
and Performance
Victoria University
Melbourne, Australia

Duarte Araújo
Faculty of Human Kinetics
Technical University of Lisbon
Lisbon, Portugal

Shawn M. Arent
Department of Exercise Science and Sport Studies
Rutgers University
New Brunswick, New Jersey

Joseph Baker
School of Kinesiology and Health Science
York University
Toronto, Ontario, Canada

Sian L. Beilock
Department of Psychology
University of Chicago
Chicago, Illinois

Bonnie G. Berger
School of Human Movement, Sport, and Leisure Studies
Bowling Green State University
Bowling Green, Ohio

Stuart J. H. Biddle
School of Sport and Exercise Sciences
Loughborough University
Loughborough, England

Brenda Light Bredemeier
College of Education
University of Missouri
St. Louis, Missouri

Britton W. Brewer
Department of Psychology
Springfield College
Springfield, Massachusetts

Janet Buckworth
Physical Activity and Education Services
Ohio State University
Columbus, Ohio

Dirk Büsch
Institut für Angewandte Trainingswissenschaft
Leipzig, Germany

Chris Button
School of Physical Education
University of Otago
Dunedin, New Zealand

Nikos L. D. Chatzisarantis
School of Sport and Health Sciences
University of Exeter
Exeter, England

Packianathan Chelladurai
School of Physical Activity and Educational Services
Ohio State University
Columbus, Ohio

David E. Conroy
Department of Kinesiology
Pennsylvania State University
University Park, Pennsylvania

Jean Côté
School of Physical and Health Education
Queen's University
Kingston, Ontario, Canada

Kerry S. Courneya
Department of Physical Education
University of Alberta
Edmonton, Alberta, Canada

Scott L. Cresswell
Department of Human Movement and Exercise Science
University of Western Australia
Crawley, Western Australia, Australia

Kristen Dams-O'Connor
Department of Educational and Counseling Psychology
University at Albany–State University of New York
Albany, New York

Keith Davids
School of Human Movement Studies
Queensland University of Technology
Brisbane, Queensland, Australia

Rodney K. Dishman
Department of Kinesiology
University of Georgia
Athens, Georgia

David W. Eccles
Department of Educational Psychology and Learning Systems
Florida State University
Tallahassee, Florida

Robert C. Eklund
Department of Educational Psychology and Learning Systems
Florida State University
Tallahassee, Florida

Deborah L. Feltz
Department of Kinesiology
Michigan State University
East Lansing, Michigan

Diane L. Gill
Department of Exercise and Sport Science
University of North Carolina
Greensboro, North Carolina

Rob Gray
Department of Applied Psychology
Arizona State University
Mesa, Arizona

Christy A. Greenleaf
Department of Kinesiology, Health Promotion, and Recreation
University of North Texas
Denton, Texas

Dieter Hackfort
ASPIRE Academy for Sports Excellence
Department of Quality Management, Education, and Social Affairs
Doha, Qatar

Martin S. Hagger
School of Psychology
University of Nottingham
University Park, Nottingham, United Kingdom

Yuri L. Hanin
KIHU-Research Institute for Olympic Sports
Jväskylä, Finland

Stephanie J. Hanrahan
Schools of Human Movement Studies and Psychology
University of Queensland
Brisbane, Queensland, Australia

Bradley D. Hatfield
Department of Kinesiology
University of Maryland
College Park, Maryland

Kentaro Hayashi
Department of Psychology
University of Hawaii–Minoa
Honolulu, Hawaii

Nicola J. Hodges
School of Human Kinetics
University of British Columbia
Vancouver, British Columbia, Canada

Jocelyn L. Horn
Department of Educational Psychology
Ball State University
Muncie, Indiana

Thelma S. Horn
Department of Physical Education, Health, and Sport Studies
Miami University
Oxford, Ohio

Jasmin C. Hutchinson
Department of Physical Education and Dance
Oxford College of Emory University
Oxford, Georgia

Raoul Huys
Laboratoire Mouvement and Perception
CNRS and Université de la Méditerranée
Marseilles, France

Robin C. Jackson
Institute of Human Performance
University of Hong Kong
Hong Kong, China

Akihito Kamata
Department of Educational Psychology and Learning Systems
Florida State University
Tallahassee, Florida

Scott E. Kerick
Human Research and Engineering Directorate
Army Research Laboratory
Aberdeen, Maryland

Jason R. Kilmer
Adjunct Faculty
Evergreen State College
Substance Abuse Prevention Program
St. Martin's University
Lacey, Washington

Daniel M. Landers
Department of Kinesiology
Arizona State University
Tempe, Arizona

Ronnie Lidor
Zinman College of Physical Education and Sport Sciences
Wingate Institute
Netanya, Israel

Faculty of Education
University of Haifa
Haifa, Israel

Magnus Lindwall
School of Health and Social Sciences
Halmstad University
Halmstad, Sweden

Sonia Lippke
Department of Health Psychology
Free University Berlin
Berlin, Germany

Herbert W. Marsh
Educational Studies
Oxford University
Oxford, England
and
University of Western Sydney
SELF Research Centre
Sydney, Australia

Matthew P. Martens
Department of Educational and Counseling Psychology
University at Albany–State University of New York
Albany, New York

Kathleen A. Martin Ginis
Department of Kinesiology
McMaster University
Hamilton, Ontario, Canada

Richard S. W. Masters
Institute of Human Performance
University of Hong Kong
Hong Kong, China

Jonathon P. Maxwell
Institute of Human Performance
University of Hong Kong
Hong Kong, China

James C. Moncier III
School of Medicine
University of Alabama
Huntsville, Alabama

Nicholas D. Myers
Department of Educational and Psychological Studies
School of Education
University of Miami
Coral Gables, Florida

Yael Netz
Zinman College of Physical Education and Sport Sciences
Wingate Institute
Netanya, Israel

Trent A. Petrie
Department of Psychology
Center for Sport Psychology and Performance Excellence
University of North Texas
Denton, Texas

Harry Prapavessis
School of Kinesiology
University of Western Ontario
London, Ontario, Canada

Ian Renshaw
Division of Sport and Recreation
Faculty of Health
Auckland University of Technology
Auckland, New Zealand

Glyn C. Roberts
Department of Psychology
Norwegian University of Sport Science
Oslo, Norway

Thomas Schack
Department of Neurocognition and Action
University of Bielefeld
Bielefeld, Germany

David Light Shields
Division of Teaching and Learning
University of Missouri
St. Louis, Missouri

Robert D. Stainback
Department of Psychology
University of Alabama at Birmingham
Birmingham, Alabama

Natalia Stambulova
School of Social and Health Sciences
Halmstad University
Halmstad, Sweden

Janet L. Starkes
Department of Kinesiology
McMaster University
Hamilton, Ontario, Canada

Clare Stevinson
Department of Physical Education
University of Alberta
Edmonton, Alberta, Canada

Bernd Strauss
Department of of Sport Psychology
University of Müenster
Müenster, Germany

Robert E. Taylor
Department of Psychology
University of Alabama at Birmingham
Birmingham, Alabama

Gershon Tenenbaum
Department of Educational Psychology and Learning Systems
Florida State University
Tallahassee, Florida

David A. Tobar
School of Human Movement, Sport, and Leisure Studies
Bowling Green State University
Bowling Green, Ohio

Darren C. Treasure
Competitive Advantage International Performance Systems
Scottsdale, Arizona

Jeffrey K. H. Vallance
Department of Physical Education
University of Alberta
Edmonton, Alberta, Canada

Robert J. Vallerand
Department of Psychology
University of Quebec
Montreal, Quebec, Canada

John van der Kamp
Institute of Human Performance
University of Hong Kong
Hong Kong, China

Robin S. Vealey
Department of Physican Education, Health, and Sport Studies
Miami University
Oxford, Ohio

Paul Ward
Learning Systems Institute
Florida State University
Tallahassee, Florida

Diane E. Whaley
Department of Leadership, Foundations, and Policy
University of Virginia
Charlottesville, Virginia

A. Mark Williams
Research Institute for Sport and Exercise Sciences
Liverpool John Moores University
Liverpool, England

Jean M. Williams
Department of Psychology
University of Arizona
Tuscon, Arizona

Reviewers

Note: Reviewers with asterisks are not authors of chapters. They were invited to review chapters with the understanding that their contribution to the *Handbook* as reviewers would be acknowledged. The remainder of the reviewers are contributors who reviewed chapters other than their own for the *Handbook*.

Bruce Abernethy
Institute of Human Performance
University of Hong Kong
Hong Kong, China

School of Human Movement Studies
University of Queensland, Australia
Brisbane, Australia

Mark B. Andersen
School of Human Movement Recreation and Performance
Victoria University
Melbourne, Australia

Shawn M. Arent
Department of Exercise Science and Sport Studies
Rutgers University
New Brunswick, New Jersey

Stuart J. H. Biddle
School of Sport and Exercise Sciences
Loughborough University
Loughborough, England

Brenda Light Bredemeier
College of Education
University of Missouri
St. Louis, Missouri

Janet Buckworth
Physical Activity and Education Services
Ohio State University
Columbus, Ohio

***Luis Calmeiro**
Department of Educational Psychology and Learning Systems
Florida State University
Tallahassee, Florida

Nikos L. D. Chatzisarantis
School of Sport and Health Sciences
University of Exeter
Exeter, England

David E. Conroy
Department of Kinesiology
Pennsylvania State University
University Park, Pennsylvania

Jean Côté
School of Physical and Health Education
Queen's University
Kingston, Ontario, Canada

***Sean Cumming**
School of Health
University of Bath
Bath, England

Keith Davids
School of Human Movement Studies
Queensland University of Technology
Brisbane, Queensland, Australia

Rodney K. Dishman
Department of Kinesiology
University of Georgia
Athens, Georgia

David W. Eccles
Department of Educational Psychology and Learning Systems
Florida State University
Tallahassee, Florida

Robert C. Eklund
Department of Educational Psychology and Learning Systems
Florida State University
Tallahassee, Florida

Deborah L. Feltz
Department of Kinesiology
Michigan State University
East Lansing, Michigan

Christy A. Greenleaf
Department of Kinesiology, Health Promotion, and Recreation
University of North Texas
Denton, Texas

Dieter Hackfort
ASPIRE Academy for Sports Excellence
Department of Quality Management, Education, and Social Affairs
Doha, Qatar

Nicola J. Hodges
School of Human Kinetics
University of British Columbia
Vancouver, British Columbia, Canada

***Maria Kavussanu**
School of Sport and Exercise Sciences
University of Birmingham
Birmingham, England

***Vikki Krane**
Human Movement, Sport, and Leisure Studies
Bowling Green State University
Bowling Green, Ohio

***David Lavallee**
School of Sport and Exercise Sciences
Loughborough University, England
Loughborough, England

James C. Moncier III
School of Medicine
University of Alabama
Huntsville, Alabama

***Chris Lonsdale**
Department of Sports Science and Physical Education
Chinese University of Hong Kong
Hong Kong, China

***Jeff Martin**
Kinesiology, Health, and Sport Studies
Wayne State University
Detroit, Michigan

***Cameron McIntosh**
Health Analysis and Measurement Group
Statistics Canada
Ottawa, Ontario, Canada

Yael Netz
Zinman College of Physical Education and Sport Sciences
Wingate Institute
Netanya, Israel

Trent A. Petrie
Department of Psychology
Center for Sport Psychology and Performance Excellence
University of North Texas
Denton, Texas

***Steve Petruzzello**
Department of Kinesiology
University of Illinois
Urbana-Champaign, Illinois

Glyn C. Roberts
Department of Psychology
Norwegian University of Sport Science
Oslo, Norway

***Alan Smith**
Department of Health and Kinesiology
Purdue University
West Lafayette, Indiana

Robert D. Stainback
Department of Psychology
University of Alabama at Birmingham
Birmingham, Alabama

Bernd Strauss
Department of of Sport Psychology
University of Müenster
Müenster, Germany

Robert E. Taylor
Department of Psychology
University of Alabama at Birmingham
Birmingham, Alabama

Gershon Tenenbaum
Department of Educational Psychology and Learning Systems
Florida State University
Tallahassee, Florida

Robert J. Vallerand
Department of Psychology
University of Quebec
Montreal, Quebec, Canada

Paul Ward
Learning Systems Institute
Florida State University
Tallahassee, Florida

A. Mark Williams
Research Institute for Sport and Exercise Sciences
Liverpool John Moores University
Liverpool, England

Jean M. Williams
Department of Psychology
University of Arizona
Tuscon, Arizona

Diane E. Whaley
Department of Leadership, Foundations, and Policy
University of Virginia
Charlottesville, Virginia

***Phillip Wilson**
Department of Physical Education and Kinesiology
Brock University
St. Catharines, Ontario, Canada

PART I

Motivation, Emotion, and Psychophysiology

CHAPTER 1

Understanding the Dynamics of Motivation in Sport and Physical Activity

An Achievement Goal Interpretation

GLYN C. ROBERTS, DARREN C. TREASURE, and DAVID E. CONROY

Understanding and enhancing motivation is one of the most popular areas of research in psychology, as well as sport and exercise psychology. In psychology and sport psychology, this research has primarily addressed the role of motivation in individual lives, especially when addressing motivation in achievement contexts. Motivation has usually taken the form of managing the motivation of others, which is often the concern of the parent, the teacher, or the coach, or of managing one's own motivation.

It has been argued (e.g., Roberts, 2001) that the term *motivation* is overused and vague. There are at least 32 theories of motivation that have their own definition of the construct (Ford, 1992), and there are almost as many definitions as there are theorists (Pinder, 1984). It is defined so broadly by some as to incorporate the whole field of psychology, and so narrowly by others as to be almost useless as an organizing construct. The solution for most has been to abandon the term and use descriptions of cognitive processes, such as self-regulation and self-systems, processes such as personal goals and goal setting, or emotional processes. However, most contemporary theorists agree on the important assumption that motivation is not an entity, but a process (e.g., Maehr & Braskamp, 1986). To understand motivation, we must make an attempt to understand the process of motivation and the constructs that drive the process.

UNDERSTANDING MOTIVATION AND ACHIEVEMENT BEHAVIOR

Motivational processes can be defined by the psychological constructs that *energize, direct, and regulate* achievement behavior. Motivation theories may be viewed as being on a continuum ranging from deterministic to mechanistic to organismic to cognitive (for a more extensive treatment of motivation theories, see Ford, 1992; Weiner, 1972). Deterministic and mechanistic theories view humans as passive and driven by psychological needs or drives. Organismic theories acknowledge innate needs but also recognize that a dialectic occurs between the organism and the social context. Cognitive theories view humans as active and initiating action through subjective interpretation of the achievement context. Contemporary theories tend to be organismic or social-cognitive and are based on more dynamic and sophisticated conceptions that assume the human is an active participant in decision making and in planning achievement behavior (e.g., Bandura, 1986; Deci & Ryan, 1985; Dweck & Leggett, 1988; Kuhl, 1986; Maehr & Nicholls, 1980; Nicholls, 1989). Although organismic approaches are experiencing a resurgence in the literature (Hagger & Chatzisarantis, in press), the majority of motivation research in physical activity contexts over the past 30 years has adopted a social-cognitive approach (e.g., Duda, 1992, 2001; Duda & Hall, 2001; Duda & Whitehead, 1998; Roberts, 1984, 1992, 2001; Roberts, Treasure, & Kavussanu, 1997). Specifically, the motivation theory that has emerged as the most popular in sport and physical activity contexts is achievement goal theory. In 1998, Duda and Whitehead identified 135 research studies reported in the 1990s, yet just 2 years later Brunel (2000) identified 160 studies. As we go to press, the number stands at over 200!

Accordingly, in this chapter we take a generally social-cognitive perspective, where achievement may be defined as *the attainment of a personally or socially valued achievement goal that has meaning for the person in a physical* *activity context* (e.g., losing weight, improving a skill, defeating an opponent). Achievement is subjectively defined, and success or failure in obtaining the goal is a subjective state based on the participant's assessment of the outcome of the achievement behavior (e.g., Maehr & Nicholls, 1980; Spink & Roberts, 1981).

ACHIEVEMENT GOAL THEORY IN SPORT AND PHYSICAL ACTIVITY

The history of achievement goal theory (in general and in sport) has been reviewed in several other publications (e.g., Duda, 2005; Duda & Hall, 2001; Roberts, 2001; Roberts et al., 1997), so the present chapter focuses on identifying key constructs, tenets, and limitations of the theory, reviewing empirical support, and presenting recent proposals for expanding or restructuring the approach.

Achievement goal theory assumes that the individual is an intentional, goal-directed organism who operates in a rational manner, and that achievement goals govern achievement beliefs and guide subsequent decision making and behavior in achievement contexts. It is argued that to understand the motivation of individuals, the function and meaning of the achievement behavior to the individual must be taken into account and the goal of action understood. Individuals give meaning to their achievement behavior through the goals they adopt. It is these goals that reflect the purposes of achievement striving. Once adopted, the achievement goal determines the integrated pattern of beliefs that undergird approach and avoidance strategies, the differing engagement levels, and the differing responses to achievement outcomes. By so recognizing the importance of the meaning of behavior, it becomes clear that there may be multiple goals of action, not one (Maehr & Braskamp, 1986). Thus, variation of achievement behavior may not be the manifestation of high or low motivation per se, or the satisfaction of needs, but the expression of different perceptions of appropriate goals with their attendant constellation of cognitions. An individual's investment of personal resources, such as effort, talent, and time, in an activity is dependent on the achievement goal of the individual.

The overall goal of action in achievement goal theory, thereby becoming the conceptual energizing force, is assumed to be the desire to develop and demonstrate competence and to avoid demonstrating incompetence. The demonstration and development of competence is the energizing construct of the motivational processes of achievement goal theory. But competence has more than one meaning. One of Nicholls's (1984) conceptual contributions was to argue that more than one conception of ability exists, and that achievement goals and behavior may differ depending on the conception of ability held by the person. Nicholls argued that two conceptions of ability (at least) are manifest in achievement contexts, namely, an *undifferentiated concept of ability,* where ability and effort are not differentiated by the individual, either because he or she is not capable of differentiating, as is the case with young children, or because the individual chooses not to differentiate; and a *differentiated concept of ability,* where ability and effort are differentiated (Nicholls, 1984, 1989).

Nicholls (1976, 1978, 1980) argued that children originally possess an undifferentiated conception of ability in which they are not able to differentiate the concepts of luck, task difficulty, and effort from ability. From this undifferentiated perspective, children associate ability with learning through effort, so that the more effort one puts forth, the more learning (and ability) one achieves. Following a series of experiments, Nicholls (1978; Nicholls & Miller, 1983, 1984a, 1984b) determined that by the age of 12 children are able to differentiate luck, task difficulty, and effort from ability, enabling a differentiated perspective. When utilizing this differentiated perspective, children begin to see ability as capacity and that the demonstration of competence involves outperforming others. In terms of effort, high ability is inferred when outperforming others while expending equal or less effort or performing equal to others while expending less effort.

Individuals will approach a task or activity with certain goals of action reflecting their personal perceptions and beliefs about the particular achievement activity in which they are engaged and the form of ability they wish to demonstrate (Dennett, 1978; Nicholls, 1984, 1989). The conception of ability they employ and the ways they interpret their performance can be understood in terms of these perceptions and beliefs. These perceptions and beliefs form a *personal theory of achievement* at the activity (Nicholls, 1989; Roberts, 2001; Roberts et al., 1997), which reflects the individual's perception of how things work in achievement situations. The adopted personal theory of achievement affects one's beliefs about how to achieve success and avoid failure at the activity. Therefore, people will differ in which of the conceptions of ability and criteria of success and failure they use, and in how they use them, based on their personal theory of achievement.

The two conceptions of ability thereby become the source of the criteria by which individuals assess success and failure. The goals of action are to meet the criteria by which success and failure are assessed. Nicholls (1989) identifies achievement behavior utilizing the undifferentiated conception of ability as *task involvement* and achievement behavior utilizing the differentiated conception of ability as *ego involvement*. When the individual is task-involved, the goal of action is to develop mastery, improvement, or learning, and the demonstration of ability is self-referenced. Success is realized when mastery or improvement has been attained. The goal of action for an ego-involved individual, on the other hand, is to demonstrate ability relative to others or to outperform others, making ability other-referenced. Success is realized when the performance of others is exceeded, especially when expending less effort than others (Nicholls, 1984, 1989).

In this chapter, when we refer to the motivated state of involvement of the individual, we use the terms ego involvement and task involvement to be consistent with Nicholls's use of the terms. In addition, when we refer to individual differences (e.g., self-schemas, personal theories of achievement, dispositions), we use the terms *task orientation* and *ego orientation*. Other motivation theorists (e.g., Dweck, 1986; Dweck & Legget, 1988; Elliot, 1997; Maehr & Braskamp, 1986) have used different terms to describe the same phenomena. When we refer to the situational determinants of motivation, the achievement cues inherent in the context, and the schemas emerging from achievement situations, we are consistent with Ames (1984a, 1992a, 1992b, 1992c) and refer to the task-involving aspect of the context as *mastery* criteria and the ego-involving aspect of the context as *performance* criteria. Finally, when we refer to the competence goals defined by Elliot (e.g., 1997) and colleagues, we use the terms *mastery* and *performance* goals.

Whether one is engaged in a state of ego or task involvement is dependent on one's dispositional orientation, as well as the perception of achievement cues in the context (Nicholls, 1989). Let us consider first two levels of individual differences: the state of goal involvement and the goal orientation.

States of Goal Involvement

Each of the theories of achievement goal motivation proffered by the major theorists (e.g., Ames, 1984a, 1984b, 1992a, 1992b, 1992c; Dweck, 1986; Dweck & Leggett, 1988; Elliot, 1997; Maehr & Braskamp, 1986; Maehr & Nicholls, 1980; Nicholls, 1984, 1989) hold that important relationships exist between the states of goal involvement and achievement striving. According to Nicholls, if the person is *task-involved,* the conception of ability is undifferentiated and perceived ability becomes less relevant, as the individual is trying to demonstrate or develop mastery at the task rather than demonstrate normative ability. As the individual is trying to demonstrate mastery or improvement, the achievement behaviors will be adaptive in that the individual is more likely to persist in the face of failure, to exert effort, to select challenging tasks, and to be interested in the task (Dweck, 1986; Nicholls, 1984, 1989; Roberts, 1984, 1992; Roberts et al., 1997). On the other hand, if the individual is *ego-involved,* the conception of ability is differentiated and perceived ability is relevant, as the individual is trying to demonstrate normative ability, or avoid demonstrating inability, and how his or her ability fares with comparative others becomes important.

If the individual is ego-involved and perceives himself or herself as high in ability, that person is likely to approach the task and engage in adaptive achievement behaviors. These are the people who seek competitive contests and want to demonstrate superiority. When perceived ability is high, demonstrating high normative ability is likely; therefore the individual is motivated to persist and demonstrate that competence to pertinent others. If one can demonstrate ability with little effort, however, this is evidence of even higher ability. Thus, the ego-involved person is inclined to use the least amount of effort to realize the goal of action (Nicholls, 1984, 1992; Roberts, 1984; Roberts et al., 1997).

On the other hand, if the perception of ability is low, the individual will realize that ability is not likely to be demonstrated, and he or she is likely to manifest maladaptive achievement behaviors (Nicholls, 1989). Maladaptive behaviors are avoiding the task, avoiding challenge, reducing persistence in the face of difficulty, exerting little effort, and, in sport, dropping out if achievement of desired goals appears difficult. These are the people who avoid competitive contests, as their lack of high normative ability is likely to be exposed. Although the participant may view these avoidance behaviors as adaptive because they disguise a lack of ability, they are considered maladaptive in terms of achievement behavior.

It has been argued (e.g., Duda & Hall, 2001; Roberts, 2001; Treasure et al., 2001) that the states of involvement are mutually exclusive (i.e., one is either ego- or task-involved), even though this notion has been questioned in light of parallel processing models of information processing (Harwood & Hardy, 2001). Goal states are very dynamic and can change from moment to moment as information is processed (Gernigon, d'Arripe-Longueville, Delignières, & Ninot, 2004). An athlete may begin a task with strong task-involved motivation, but contextual events may make the athlete wish to demonstrate superiority to others, and so the athlete becomes ego-involved in the task. Thus, goal states are dynamic and ebb and flow depending on the perception of the athlete.

The measurement of goal states is a particularly challenging task. It has been done in three ways. One has been to take an existing goal orientation measure and reword the stem to obtain a state measure (e.g., Hall & Kerr, 1997; Williams, 1998). A second has been to use single-item measures asking participants to indicate whether they focus on achieving a personal standard of performance (self-referenced) or beating others in an upcoming contest (other-referenced; e.g., Harwood & Swain, 1998). The third way is to ask participants to view video replays of the event and retrospectively reflect on their goal involvement at any one point in the contest (e.g., J. Smith & Harwood, 2001). Although the first two procedures may be more predictive of the initial state of involvement than the orientation measures per se (Duda, 2001), Duda has argued that these procedures may not capture the essence of task and ego involvement. In addition, it may be argued that because the states are so dynamic, even if you are able to reflect the state of involvement at the outset of the competition, as the state of involvement ebbs and flows as task and competitive information is processed, we have no indication of the changes that may occur (Roberts, 2001). It is naive and conceptually inconsistent to assume that the state of involvement will remain stable throughout the contest.

The best way of estimating the state of involvement currently available is the procedure used by J. Smith and Harwood (2001). At least we obtain participants' observations of their goal involvement at different times of the contest. This is a superior procedure to determine goal involvement that takes into consideration its dynamic nature. However, this procedure is very labor-intensive; it has to be done with each participant over the course of the contest.

Clearly, the development of an assessment procedure for the state of goal involvement is a major task, especially when one recognizes that achievement goal theory is predicated on one's task or ego involvement in the achievement task. As has been the case with measuring state anxiety, obtaining repeated measures while an athlete is engaged in competition is a practical nightmare. And we have to recognize that repetitive assessments of goal involvement during a competitive encounter may have the effect of changing an athlete's goal involvement state (Duda, 2001)! Certainly, forcing task-involved athletes to consider why they are doing what they are doing may make them more self-aware and ego-involved in the task. To reduce the likelihood of this happening, the retrospective recall strategy of J. Smith and Harwood (2001) is clearly the better procedure, despite its disadvantages.

GOAL ORIENTATIONS

It is assumed that individuals are predisposed (e.g., by their personal theory of achievement) to act in an ego- or task-involved manner; these predispositions are called *achievement goal orientations.* Individual differences in the disposition to be ego- or task-involved may be the result of socialization through task- or ego-involving contexts in the home or experiences in significant achievement contexts (e.g., classrooms, physical activities; Nicholls, 1989; Roberts et al., 1997).

Goal orientations are not to be viewed as traits or based on needs. Rather, they are cognitive schemas that are dynamic and subject to change as information pertaining to one's performance on the task is processed. But the orientations do have some stability over time (Duda & Whitehead, 1998; Roberts, Treasure, & Balague, 1998). These self-cognitions are assumed to be relatively enduring. As examples, Dweck (1986) considers that one's theory of intelligence is relatively stable, and Nicholls (1984) considers one's conceptualization of ability to be stable as well. Thus, being task- or ego-oriented refers to the inclination of the individual to be task- or ego-involved.

To measure goal orientations, researchers have typically created questionnaires that are assumed to assess ego and task goal orientations (e.g., Nicholls, Patashnik, & Nolen, 1985). Although Dweck and her colleagues (e.g., Dweck & Leggett, 1988) conceptualize and measure achievement goals as dichotomous, it has been more usual for researchers to assume that the two goals are conceptually orthogonal and to measure them accordingly (Duda & Whitehead, 1998; Nicholls et al., 1985; Roberts et al., 1998).

Nicholls (1989) has argued that to assess personal achievement goals, individuals should be asked about the criteria that make them feel successful in a given situation, rather than noting their definition of competence. In line with this suggestion, Roberts and colleagues (Roberts & Balague, 1989; Roberts et al., 1998; Treasure & Roberts, 1994b) have developed the Perception of Success Questionnaire (POSQ), and Duda and colleagues (Duda & Nicholls, 1992; Duda & Whitehead, 1998) have developed the Task and Ego Orientation in Sport Questionnaire (TEOSQ). Both have demonstrated acceptable reliability and construct validity (Duda & Whitehead, 1998; Marsh, 1994; Roberts et al., 1998). Although other scales exist, the

POSQ and the TEOSQ best meet the conceptual criteria of measuring orthogonal achievement goals in sport (Duda & Whitehead, 1998). When developing scales in the future, the constructs identified must be conceptually coherent with achievement goal theory. This has not always been the case in the past (e.g., Gill & Deeter, 1988; Vealey & Campbell, 1988), and this has created some conceptual confusion (Marsh, 1994).

Motivational Implications of Goal Orientations

The majority of research in goal orientations has focused on the antecedents and consequences of goal orientations. In this section, we briefly review the research on the association between achievement goals and both cognitive and affective variables, and important outcome variables.

Perceptions of Competence

One of the fundamental differences between task- and ego-oriented athletes is the way they define and assess competence. Task-oriented individuals tend to construe competence based on self-referenced criteria and are primarily concerned with mastery of the task, so they are more likely than ego-oriented individuals to develop perceived competence over time (Elliott & Dweck, 1988). In contrast, ego-oriented individuals feel competent when they compare favorably in relation to others, so high perceived relative ability or competence is less likely to be maintained in ego orientation, especially for those participants who already question their ability (see Dweck, 1986). This prediction of achievement goal theory has been supported in numerous studies with a variety of conceptualizations of competence perceptions (Chi, 1994; Cury, Biddle, Sarrazin, & Famose, 1997; Kavussanu & Roberts, 1996; Nicholls & Miller, 1983, 1984a; Vlachopoulos & Biddle, 1996, 1997).

Thus, several lines of research suggest that using the task-involving conception of achievement to judge demonstrated competence enhances resiliency of perceived competence. The implications of these findings are particularly important in learning contexts. For example, for individuals who are beginning to learn a new physical skill, holding a task orientation may be instrumental in facilitating perceptions of competence, effort, and persistence, and consequently success in the activity. It is not surprising that Van Yperen and Duda (1999), in their study with Dutch male soccer players, found that athletes high in task orientation were judged by their coaches to possess greater soccer skills from pre- to postseason. A task orientation fosters perceptions of competence and success for individuals who are either high or low in perceived competence and encourages the exertion of effort. An ego orientation, on the other hand, may lower perceptions of success, perceived competence, and thus effort, especially for those individuals who already are unsure of their ability.

Beliefs about the Causes of Success

Nicholls (1989, 1992) suggests that one's goal in conjunction with one's beliefs about the causes of success in a situation constitute one's personal theory of how things work in achievement situations. For individuals with low perceived ability, a belief that ability causes success will most likely result in frustration, a lack of confidence and may even lead to dropping out, as these individuals feel they do not possess the ability required to be successful. In the physical activity domain, where practice and hard work are so essential for improvement, especially at the early stages of learning, the belief that effort leads to success is the most adaptive belief for sustaining persistence.

Research on young athletes (e.g., Hom, Duda, & Miller, 1993; Newton & Duda, 1993), high school students (Duda & Nicholls, 1992; Lochbaum & Roberts, 1993), British youth (Duda, Fox, Biddle, & Armstrong, 1992; Treasure & Roberts, 1994a), young disabled athletes participating in wheelchair basketball (White & Duda, 1993), and elite adult athletes (Duda & White, 1992; Guivernau & Duda, 1995; Roberts & Ommundsen, 1996) has consistently demonstrated that a task goal orientation is associated with the belief that hard work and cooperation lead to success in sport. In general, ego orientation has been associated with the view that success is achieved through having high ability and using deception strategies such as cheating and trying to impress the coach. A similar pattern of results has emerged in the physical education context (Walling & Duda, 1995), as well as in research with college students participating in a variety of physical activity classes (e.g., Kavussanu & Roberts, 1996; Roberts, Treasure, & Kavussanu, 1996).

Purposes of Sport

In classroom-based research, ego orientation has been associated with the belief that the purpose of education is to provide one with wealth and social status, which is evidence of superior ability. Task orientation, on the other hand, has been linked to the view that an important purpose of school education is to enhance learning and understanding of the world and to foster commitment to society (Nicholls et al., 1985; Thorkildsen, 1988). Similar findings have been reported in the athletic arena (e.g., Duda, 1989; Duda &

Nicholls, 1992; Roberts, Hall, Jackson, Kimiecik, & Tonymon, 1995; Roberts & Ommundsen, 1996; Roberts et al., 1996, 1997; Treasure & Roberts, 1994a; White, Duda, & Keller, 1998), indicating that worldviews cut across educational and sport contexts.

Task orientation has been associated with the belief that the purpose of sport is to enhance self-esteem, advance good citizenship, foster mastery and cooperation (Duda, 1989), encourage a physically active lifestyle (White et al., 1998), and foster lifetime skills and pro-social values such as social responsibility, cooperation, and willingness to follow rules (Roberts & Ommundsen, 1996; Roberts et al., 1996). Likewise, task orientation is associated with the view that the purpose of physical education is to provide students with opportunities for improvement, hard work, and collaboration with peers (Papaioannou & McDonald, 1993; Walling & Duda, 1995). In contrast, ego orientation has been linked to the view that sport should provide one with social status (Roberts & Ommundsen, 1996; Roberts et al., 1996), enhance one's popularity (Duda, 1989; Roberts & Ommundsen, 1996) and career mobility, build a competitive spirit (Duda, 1989), and teach superiority and deceptive tactics (Duda, 1989; Duda & White, 1992). Ego orientation is also associated with the view that the purpose of physical education is to provide students with an easy class and teach them to be more competitive (Papaioannou & McDonald, 1993; Walling & Duda, 1995).

Affect and Intrinsic Interest

One of the most consistent findings in achievement goal research has been the link between task orientation and experienced enjoyment, satisfaction, and interest during participation in physical activity for high school students (Duda, Chi, Newton, Walling, & Catley, 1995; Duda & Nicholls, 1992), athletes competing in international competition (Walling, Duda, & Chi, 1993), and college students enrolled in a variety of physical activity classes (e.g., Duda et al., 1995; Kavussanu & Roberts, 1996). A positive relationship has also been reported between task orientation and flow, an intrinsically enjoyable experience in college athletes (Jackson & Roberts, 1992). In the studies just cited, ego orientation was either inversely related or unrelated to intrinsic interest, satisfaction, or enjoyment.

Participants with a high task orientation, in combination with either a high or low ego orientation, experience greater enjoyment than those participants who are high in ego orientation and low in task orientation (Biddle, Akande, Vlachopoulos, & Fox, 1996; Cury et al., 1996; Goudas, Biddle, & Fox, 1994; Vlachopoulos & Biddle, 1996, 1997). A task orientation seems to be especially important for continued participation in physical activity as it is associated with enjoyment, and this occurs regardless of one's perceived success (Goudas et al., 1994) or perceived ability (Vlachopoulos & Biddle, 1997) and intrinsic interest (Goudas, Biddle, Fox, & Underwood, 1995).

Another interesting finding of previous research is the different sources of satisfaction associated with goals. Ego-oriented athletes glean satisfaction when they demonstrate success in the normative sense and please their coach and friends, whereas task-oriented individuals feel satisfied when they have mastery experiences and perceive a sense of accomplishment during their sport participation (Roberts & Ommundsen, 1996; Treasure & Roberts, 1994a).

Probably the most significant study to illustrate the association of goals with affect was conducted by Ntoumanis and Biddle (1999). They conducted a meta-analysis with 41 independent samples and found that task orientation and positive affect were positively and moderately to highly correlated. The relationship between ego orientation and both positive and negative affect was small. In essence, being task-involved fosters positive affect in physical activities.

Anxiety

Roberts (1986) was the first to suggest that athletes adopting an ego orientation may experience anxiety as a function of whether or not they believe they can demonstrate sufficient competence in an achievement context. Anxiety should be less likely with a task orientation, because an individual's self-worth is not threatened. Research has generally supported the tenets of goal theory (Roberts, 2001). Task orientation has been negatively associated with precompetitive anxiety (Vealey & Campbell, 1988), cognitive anxiety with young athletes (Ommundsen & Pedersen, 1999), somatic and cognitive anxiety (Hall & Kerr, 1997), task-irrelevant worries and the tendency to think about withdrawing from an activity (Newton & Duda, 1992), and concerns about mistakes and parental criticisms (Hall & Kerr, 1997; Hall, Kerr, & Matthews, 1998). Further, a task orientation has been associated with keeping one's concentration and feeling good about the game (Newton & Duda, 1992) and with effective use of coping strategies in elite competition (Pensgaard & Roberts, 2003). An ego orientation, on the other hand, has been positively related to state and trait anxiety (Boyd, 1990; Newton & Duda, 1992; Vealey & Campbell, 1988; White & Zellner, 1996), cognitive anxiety in the form of worry (White & Zellner, 1996), getting upset in competition, and concentration disruption during competition (Newton & Duda, 1992; White & Zellner, 1996).

Most studies have been conducted with very young athletes (Hall & Kerr, 1997) or with recreational or physical education students (Hall et al., 1998; Ommundsen & Pedersen, 1999; Papaioannou & Kouli, 1999). Ommundsen and Pedersen remind us, however, that it is not sufficient simply to state that being task-involved is beneficial in terms of anxiety. They found that being task-involved did decrease cognitive trait anxiety, but low perceived competence increased both somatic and cognitive anxiety. This suggests that being task-involved is beneficial, but that perceived competence is an important predictor of anxiety, too. Being task-oriented and perceiving one's competence to be high are both important antecedents to reduce anxiety in sport.

The most interesting aspect of the recent work with achievement goal theory has been the attention paid to achievement strategies and outcome variables, especially performance, exerted effort, overtraining and dropping out, and cheating in sport. Achievement goal theory and research in educational and sport settings suggest that personal theories of achievement comprise different beliefs about what leads to success (Nicholls, 1989).

Achievement Strategies

Lochbaum and Roberts (1993) were the first to report that emphasis on problem-solving and adaptive learning strategies was tied to a task orientation in a sport setting. Research (Lochbaum & Roberts, 1993; Ommundsen & Roberts, 1999; Roberts et al., 1995; Roberts & Ommundsen, 1996) has demonstrated that task orientation is associated with adaptive achievement strategies, such as being committed to practice, being less likely to avoid practice, learning, and effort. Typically, in these investigations, ego orientation corresponds to a tendency to avoid practice and to a focus on winning during competition. Goals also differentiate athletes in terms of the perceived benefits of practice. Thus, ego-oriented athletes consider practice as a means to demonstrate competence relative to other athletes, whereas their task-oriented counterparts view practice as a means to foster team cohesion and skill development (Lochbaum & Roberts, 1993; Roberts & Ommundsen, 1996).

When choosing post-climbing task feedback strategies, high ego-oriented climbers who were low in perceived ability were more likely to reject task-related and objective performance feedback than were task-oriented climbers (Cury, Sarrazin, & Famose, 1997). In addition, Cury and Sarrazin (1998) found that high-ego and high-ability athletes selected normative feedback and rejected task-relevant information. High-ego-oriented athletes with low ability requested no feedback and discarded objective information. Research has also given evidence that an ego orientation is related to other unacceptable achievement strategies, such as the use of aggression (Rascle, Coulomb, & Pfister, 1998).

These studies demonstrate that the achievement strategies endorsed by physical activity participants are meaningfully related to their goal perspective. Across studies, task orientation was coupled with adaptive learning strategies, the value of practice to learn new skills and improve, and seeking task-relevant information. In contrast, ego-oriented athletes endorsed avoiding practice as an achievement strategy and avoided task-relevant information, preferring normative feedback (but only when high in perceived ability).

Exerted Effort and Performance

There is little research to date investigating exerted effort and performance. One of the first studies to provide evidence of a performance boost from being task-involved was Vealey and Campbell's (1989). Van Yperen and Duda (1999) found that when football players were task-oriented, an increase in skilled performance (as perceived by the coach) resulted. In addition, the task-oriented players believed that soccer success depended on hard work. Similarly, Theeboom, De Knop, and Weiss (1995) investigated the effect of a mastery program on the development of motor skills of children and found that the task-involved group reported higher levels of enjoyment and reliably exhibited better motor skills than those who were ego-involved.

However, the best evidence thus far that task-oriented athletes perform better than ego-oriented athletes has been presented by Sarrazin, Roberts, Cury, Biddle, and Famose (2002), who investigated exerted effort and performance of adolescents involved in a climbing task. The results demonstrated that task-involved boys exerted more effort than ego-involved boys and performed better (a success rate of 60% versus 42%), and the degree of exerted effort was determined by an interaction of achievement goal, perceived ability, and task difficulty. Ego-involved boys with high perceived ability and task-involved boys with low perceived ability exerted the most effort on the moderate and difficult courses; ego-involved boys with low perceived ability exerted the least effort on the moderate and very difficult courses. Finally, task-involved boys with high perceived ability exerted more effort when the task was perceived as more difficult.

In general, the research has shown that (a) task-involved people exhibit (or report) greater effort than others (Cury et al., 1996; Duda, 1988; Duda & Nicholls, 1992; Durand, Cury, Sarrazin, & Famose, 1996; Goudas et al., 1994; Sarrazin et al., 2002; Solmon, 1996; Tammen, Treasure, & Power, 1992), and (b) ego-involved people with low perceived ability exhibit reduced exerted effort as opposed to people with high perceived ability (Cury, Biddle, et al., 1997). And there is developing evidence that being task-involved leads to better performance. To enhance effort, one should focus on being as task-involved as possible: Task-involved people try harder! And task-involved people perform better!

Moral Functioning and Cheating

Achievement goals have also been linked to moral cognitions and moral behavior in sport. A number of recent studies have identified fairly consistent relationships between task and ego orientations and sportspersonship, moral functioning, moral atmosphere, and endorsement of aggressive tactics among both youth and adult competitive athletes. In general, studies have shown that being high in ego orientation leads to lower sportspersonship, more self-reported cheating, lower moral functioning (i.e., moral judgment, intention, and self-reported cheating behavior), and endorsement of aggression when compared to high task-oriented athletes (Kavussanu & Ntoumanis, 2003; Kavussanu & Roberts, 2001; Lemyre, Roberts, & Ommundsen, 2002; Lemyre, Roberts, Ommundsen, & Miller, 2001; Ryska, 2003).

In recent research, Lemyre and colleagues (2001, 2002) and Ryska (2003) have found that low ego/high task-oriented young male soccer players consistently endorsed values of respect and concern for social conventions, rules and officials, and opponents. Similar to sportspersonship, moral functioning and aggression, as well as gender differences among these variables, have been highlighted in recent sport psychology research. Kavussanu (Kavussanu & Roberts, 2001; Kavussanu, Roberts, & Ntoumanis, 2002) has consistently found ego orientation to positively predict lower moral functioning and males to be generally higher in ego orientation, lower in task orientation, and significantly lower in moral functioning as well as endorsing more aggression than female players.

Recent research has indicated that the coach-created motivational climate may also serve as a precursor to cheating among competitive youth sport participants. Findings by Miller and colleagues (Miller & Roberts, 2003; Miller, Roberts, & Ommundsen, 2004, 2005) show that a high ego-involving motivational climate was associated with low sportspersonship, low moral functioning and reasoning, low moral atmosphere, and endorsement of aggression. Boys cheated more than girls, but within gender, ego-involved boys and girls cheated more than task-involved boys and girls. For boys in particular, being ego-involved meant that they were more likely to engage in cheating behavior, to engage in injurious acts, to be low in moral reasoning, and to perceive the moral atmosphere in the team to be supportive of cheating.

Competitive sport often places individuals in conflicting situations that emphasize winning over sportspersonship and fair play. It would be wrong, however, to attribute this to the competitive nature of sport. The results just cited suggest that it is *not* the competitive context in itself that is the issue. Rather, it may be the salience of ego involvement in the athletic environment that induces differential concern for moral behavior and cheating, rules, respect for officials, and fair play conventions among young players. If athletes are to develop good sportspersonship behaviors and sound moral reasoning, coaches should reinforce the importance of task-involving achievement criteria in the competitive environment.

Burnout

Another outcome variable that is becoming popular in sport research is burnout (see Eklund & Cresswell, Chapter 28). Why is it that some athletes burn out, and what are the precursors of burning out? Some recent research from a motivational perspective has given us some interesting findings. Freudenberger (1980) has explained burnout as a syndrome that includes both physical and emotional exhaustion. These symptoms occur concurrently with patterns of behavior that are strongly achievement oriented (Hall & Kerr, 1997). Individuals experiencing burnout tend to show a strong commitment to the pursuit of goals and set high standards for themselves. Despite personal investment and great persistence, they often experience depression, depersonalization, disillusionment, and dissatisfaction as their goals are continually unmet. Hall et al. (1998) reported a strong relationship among elite athletes' perfectionism, achievement goals, and aptitudes to perform. It is when athletes continually perceived their ability and their effort levels to be inadequate to meet their achievement goals that the maladaptive nature of their motivational orientation became apparent. The athlete may drop out to maintain any real sense of self-worth.

Cohn (1990) has found that athletes at risk of burning out were likely to either participate in too much training and competition, lacked enjoyment while practicing their sport, or experienced too much self- or other-induced pressure. Investigating young elite tennis players, Gould and colleagues (Gould, 1996; Gould, Tuffey, Udry, & Loehr, 1996; Gould, Udry, Tuffey, & Loehr, 1996) found that burned-out athletes believed they had less input into their own training, were higher in amotivation, and were more withdrawn. The burned-out players did not differ from their non-burned-out counterparts in terms of the number of hours they trained; consequently Gould and colleagues posited that the crucial factors leading to burnout were psychological (motivational) rather than physical in nature. This was confirmed by Lemyre, Treasure, and Roberts (2006), who found that variation in motivation contributed to the onset of burnout.

In a series of studies investigating the psychological determinants of burnout, Lemyre and colleagues examined the relationship between motivational disposition variables at the start of the season and signs of burnout at season's end. Lemyre (2005) found that elite winter sport athletes who were ego-involved, focused on normative comparisons, and preoccupied with achieving unrealistic goals, who doubted their own ability, and who had a coach and parents who emphasized performance outcomes were more at risk of developing symptoms of burnout than the more task-involved athletes. Lemyre, Roberts, Treasure, Stray-Gundersen, and Matt (2004) investigated the relationship between psychological variables and hormonal variation to burnout in elite athletes. Results indicated that variation in basal cortisol accounted for 15% of the variance in athlete burnout, and the psychological variables of perfectionism (20%), perceived task involvement (12%), and subjective performance satisfaction (18%) explained 50% of the total variance (67%) in athlete burnout at the end of the season. These findings are meaningful as they underline the importance of personal dispositions (perfectionism and achievement goals) on burnout vulnerability in elite athletes.

The literature just reviewed addressed achievement goals from an individual difference perspective in the traditional achievement goal framework. It supports meaningful relationships between personal goals of achievement and cognitive and affective beliefs about involvement in physical activity. In addition, we have shown that outcomes such as exerted effort, performance, moral behavior and cheating, and burnout are affected by whether one is task- or ego-involved. But whether one is in a state of task or ego involvement is not only dependent on one's personal goal of achievement. The context also has an important influence on one's state of involvement. We address that literature next.

THE MOTIVATIONAL CLIMATE

A fundamental tenet of achievement goal theory is the central role the situation plays in the motivation process (Nicholls, 1984, 1989). Consistent with other motivation research that has emphasized the situational determinants of behavior (e.g., deCharms, 1976, 1984; Deci & Ryan, 1985, 2002), research from an achievement goal perspective has examined how the structure of the environment can make it more or less likely that achievement behaviors, thoughts, and feelings associated with a particular achievement goal are adopted. The premise of this line of research is that the nature of an individual's experience influences the degree to which task and ego criteria are perceived as salient in the context. This is then assumed to affect the achievement behaviors, cognition, and affective responses through individuals' perception of the behaviors necessary to achieve success (Roberts et al., 1997).

Adopting the term *motivational climate* (Ames, 1992b) to describe the goal structure emphasized in the achievement context, researchers have examined two dimensions of the motivational climate, mastery and performance, in sport and physical activity. Mastery (or task-involving) climates refer to structures that support effort, cooperation, and an emphasis on learning and task mastery. Conversely, performance (or ego-involving) climates refer to situations that foster normative comparisons, intrateam competition, and a punitive approach by teachers and coaches to mistakes committed by participants.

A study conducted by Parish and Treasure (2003) is representative of much of the extant literature in the area. In this case, the influence of perceptions of the motivational climate and perceived ability on situational motivation and the physical activity behavior of a large sample of adolescent male and female physical education students was examined. Consistent with achievement goal theory, the results showed that perceptions of a mastery climate were strongly related to more self-determined forms of situational motivation (intrinsic and identified motivation) and, along with gender and perceived ability, most significantly predictive of the actual physical activity behavior of the participants. In contrast, perceptions of a performance climate were found to be strongly related to less self-determined forms of situational motivation (extrinsic and amotivational) and unrelated to physical activity.

Consistent with the findings reported by Parish and Treasure (2003), the extant literature in physical education and sport suggests that the creation of a mastery motivational climate is likely to be important in optimizing positive (i.e., well-being, sportspersonship, persistence, task perseverance, adaptive achievement strategies) and attenuating negative (i.e., overtraining, self-handicapping) responses (e.g., Kuczka & Treasure, 2005; Miller et al., 2004; Ommundsen & Roberts, 1999; Sarrazin et al., 2002; Standage, Duda, & Ntoumanis, 2003; Standage, Treasure, Hooper, & Kuczka, in press; Treasure & Roberts, 2001). This pattern of findings has been confirmed in a meta-analysis consisting of statistically estimated effect sizes from 14 studies ($N = 4{,}484$) that examined the impact of different motivation climates in sport and physical education on cognitive and affective responses (Ntoumanis & Biddle, 1999). The evidence, therefore, supports the position that perceptions of a mastery motivational climate are associated with more adaptive motivational and affective response patterns than perceptions of a performance climate in the context of sport and physical education.

AN INTERACTIONIST APPROACH

Achievement goal research has shown that individual variables and situational variables separately influence achievement behavior, cognition, and affect. Although these two lines of research have been conducted in relative isolation, an interactionist approach that looks to combine both types of variable is expected to provide a far more complete understanding of the motivation process. To this end, Dweck and Leggett (1988) suggested that dispositional goal orientations should be seen as an individual variable that will determine the probability of adopting a certain goal or action, that is, task or ego state of goal involvement, and a particular behavior pattern in achievement contexts. Situational variables, such as perceptions of the motivational climate, were proposed as potential moderators of the influence of the individual variables. As Roberts and colleagues (1997) argue, when the situational criteria are vague or weak, an individual dispositional goal orientation should hold sway. In contexts where the situational criteria are particularly salient, it is possible that perceptions of the climate may override an individual's dispositional goal orientation and be a stronger predictor of behavioral, cognitive, and affective outcomes. It is also proposed that children and young adolescents, who have yet to firm up their personal theories of achievement, may be more susceptible to the influence of situational variables than older adolescents and adults (Roberts & Treasure, 1992).

The result of the limited research that has examined both individual and situational variables has shown that taking into account both of these variables enhances our understanding of the sport context (e.g., Kavussanu & Roberts, 1996; Seifriz, Duda, & Chi, 1992). The limited evidence to date also provides support for Dweck and Leggett's (1988) contention that situational variables may moderate the influence of goal orientations (e.g., Swain & Harwood, 1996; Treasure & Roberts, 1998). When significant interaction effects emerged, they did so in a manner consistent with a moderation model. Although it is often difficult to statistically find significant interaction effects (Aguinis & Stone-Romero, 1997), the findings of the limited studies that have been conducted are consistent with the fundamental tenets of achievement goal theory and speak to the veracity of investigating the interaction in addition to the main effect of individual and situational variables.

ENHANCING MOTIVATION

Research from an achievement goal perspective in sport and physical education has demonstrated that goal orientations and perceptions of the motivational climate are relevant to the ongoing stream of achievement behavior, cognition, and affect. Given the body of empirical work that has documented the adaptive motivation and well-being responses of students who perceive mastery or task-involving climates, physical education teacher and sport coach education programs would benefit from integrating educational information pertaining to the creation of mastery climates into their curricula. Specifically, researchers interested in the sport and physical education experience need to develop strategies and guidelines and explore ways in which coaches, parents, and other significant social agents can engage in the creation of a mastery or task-involving motivational climate.

A paucity of intervention research has been conducted to assess the viability of the teacher and coach education programs designed to enhance motivation from an achievement goal perspective (i.e., Lloyd & Fox, 1992; Solmon, 1996; Treasure & Roberts, 2001). Comparing two different approaches to teaching an aerobics/fitness class to adolescent females, Lloyd and Fox found that participants in the mastery condition reported higher motivation to continue participating in aerobics and more enjoyment than those who participated in the performance condition. Consistent with the findings of Lloyd and Fox, Solmon found that seventh- and eighth-grade students who participated in the mastery condition demonstrated more willingness to persist in a difficult juggling task than those in the performance condition. In addition, students in the performance condition were more likely to attribute success during the intervention to normative ability than those in the mastery condition. This finding is consistent with Nicholls's (1989) contention that achievement goals and beliefs about success are conceptually linked.

Similar to the intervention designed by Solmon (1996), Treasure and Roberts (2001) drew on strategies suggested by Ames (1992a, 1992b, 1992c) to promote either a mastery or a performance climate. The strategies were then organized into the interdependent structures that Epstein (1988, 1989) has argued define the achievement context: task, authority, recognition, grouping, evaluation, and time structures, better known by the acronym TARGET. Responses of female and male young adolescent physical education students suggest that a teacher can influence the salience of a mastery or performance climate and, in so doing, affect a child's motivation in physical education. Although the results of the studies conducted by Solmon and Treasure and Roberts indicate that adopting and adapting classroom-based intervention programs in the context of physical education may be effective, it is important to recognize that there may be significant differences between achievement contexts. This point is even more important when one considers the achievement context of youth sport. In assessing and implementing interventions to enhance the quality of motivation in youth sport, therefore, researchers need to be sensitive to differences between the achievement contexts (Nicholls, 1992).

The few intervention studies that have been conducted clearly show that a mastery climate has positive behavioral, cognitive, and affective outcomes. All of the studies conducted to date, however, have been short term and limited in what they assess. Randomized, controlled studies over time are needed to truly assess the causal role of motivational climates on motivational outcomes.

THE HIERARCHICAL APPROACH TO ACHIEVEMENT GOALS

One of the most provocative attempts at revising and extending achievement goal theory in the past decade has emerged from work on the hierarchical model of achievement motivation (Elliot, 1999). This model is based on the premise that approach and avoidance motivation represent fundamentally different strivings. The approach-avoidance distinction has a long intellectual history (Elliot & Covington, 2001) and was considered in early writing on achievement goals (e.g., Nicholls, 1984, p. 328) but, until recently, was largely neglected in subsequent empirical work.

Briefly, the hierarchical model of achievement motivation asserts that dynamic states of achievement goal involvement are influenced by (a) stable individual differences (e.g., motives, self-perceptions, relationally based variables, neurophysiologic predispositions; Elliot, 1999) and (b) situational variables (e.g., motivational climate; Ames, 1992c; Ames & Archer, 1988). In turn, these dynamic states of goal involvement are posited as direct predictors of achievement processes and outcomes. A complete presentation of the hierarchical model of achievement motivation is beyond the scope of this chapter (see Elliot, 1999). Instead, we focus on a major implication of the premise that approach and avoidance motivation are fundamentally different—specifically, the implication that approach-valenced achievement goals may be distinguished (both conceptually and empirically) from avoidance-valenced achievement goals.

An Expanded Model of Achievement Goals

As described earlier in this chapter, the prevailing models of achievement goals in the educational, industrial-organizational, social, and sport literatures have been dichotomous in nature. Goals are distinguished largely (but not always exclusively) on how competence is defined. From this perspective, competence could be defined in task-referential terms (e.g., How well did I perform this task in relation to how well it could possibly be performed?), in self-referential terms (e.g., How well did I perform this task in relation to my previous performances?), or in normative terms (e.g., How well did I perform this task in relation to others?). Due to their conceptual and empirical similarities, the vast majority of research combined task- and self-referential definitions of competence into a single task, or *mastery,* goal. Normative definitions of competence have typically been designated as ego, or *performance,* goals. We use the terms mastery and performance to refer to the goals in the hierarchical model.

In the mid-1990s, several scholars working in parallel (e.g., Elliot, 1997; Elliot & Harackiewicz, 1996; Middleton & Midgley, 1997; Skaalvik, 1997; Skaalvik & Valas, 1994) returned to the possibility that individuals may sometimes focus on striving not to be incompetent as much as or more than they are striving to be competent. In achievement situations, competence and incompetence are outcomes that individuals typically find appetitive and aversive, respectively. Thus, it is possible to differentiate goals based on their *valence,* or the degree to which the focal outcome is pleasant or unpleasant.

In reviewing the achievement goal literature, Elliot (1994) observed that performance goals that focused on the pleasant possibility of competence (approach goals) led to different outcomes from performance goals focused on the unpleasant possibility of incompetence (avoidance goals). A meta-analysis of the motivation literature revealed that goal valence moderated the effects of performance goals on participants' intrinsic motivation (Rawsthorne & Elliot, 1999). Performance-avoidance goals reduced both free-choice behavior and self-reported interest in a task, whereas performance-approach goals did not have any consistent effect on either intrinsic motivation index. This finding led to the introduction of a tripartite model of achievement goals comprising mastery, performance-approach goals, and performance-avoidance goals (Elliot & Harackiewicz, 1996). In the first empirical test of this tripartite model, the valence of performance goals moderated relations between the goals and relevant antecedents (e.g., achievement motives, competence expectations, sex) and consequences (e.g., intrinsic motivation). A subsequent series of studies extended understanding of how the valence of performance goals can moderate relations between goals and achievement processes and outcomes (e.g., Cury, Da Fonséca, Rufo, Peres, & Sarrazin, 2003; Cury, Da Fonséca, Rufo, & Sarrazin, 2002; Cury, Elliot, Sarrazin, Da Fonséca, & Rufo, 2002; Elliot & Church, 1997; Elliot & McGregor, 1999).

Thus, the argument was proffered that achievement goals should consider both the *definition of competence* and the *valence of the striving,* and the model was expanded to include a fourth possible achievement goal: mastery- avoidance goals (Elliot, 1999; Elliot & Conroy, 2005). As seen in Figure 1.1, the two definitions of competence (i.e., mastery/task versus performance/ego) and two valences of strivings (i.e., approaching competence versus avoiding incompetence) yield a 2 × 2 model of achievement goals comprising mastery-approach, mastery-avoidance, performance-approach, and performance-avoidance goals. These goals can be assessed with the 2 × 2 Achievement Goal Questionnaire for Sport (Conroy, Elliot, & Hofer, 2003).

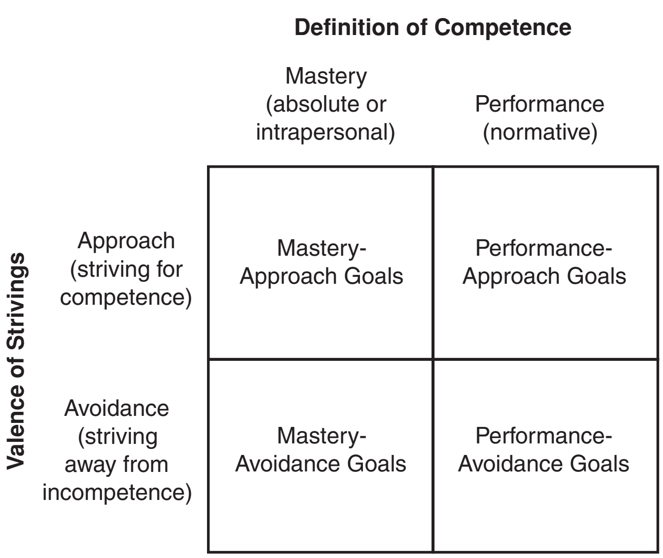


Figure 1.1 The 2 × 2 achievement goal framework. Adapted from "A 2 × 2 Achievement Goal Framework," by A. J. Elliot and H. A. McGregor, 2001, *Journal of Personality and Social Psychology, 80,* p. 502. Copyright 2001 by the American Psychological Association. Adapted with permission.

Mastery-approach (MAp) goals focus on performing a task as well as possible or surpassing a previous performance on a task (i.e., learning, improving). They are equivalent to existing conceptions of mastery or task goals in the dichotomous model of achievement goals. They are expected to be the optimal achievement goal because they combine the more desirable definition of competence with the more desirable valence. In sport settings, these goals are extremely common because they are directly implicated in individuals' striving for personal records and peak performances as well as skill acquisition processes.

Performance-approach (PAp) goals focus on outperforming others. They are equivalent to existing conceptions of performance or ego goals in the dichotomous model of achievement goals. These goals may be adaptive when, as noted earlier, they are accompanied by a high perception of competence. However, in the 2 × 2 model, PAp goals are expected to be suboptimal because of their performance definition of competence, but not entirely dysfunctional because they are valenced toward competence. PAp goals are probably especially salient because of the social comparison processes inherent in sport and other competitive activities.

Performance-avoidance (PAv) goals focus on not being outperformed by others. As described previously, PAv goals provided the impetus to consider how the valence of goals might enhance the predictive power of the goal construct. They are expected to be the most dysfunctional of all achievement goals because they combine the less desirable definition of competence with the less desirable valence. These goals may be expressed when individuals are concerned about losing a contest or appearing incompetent in comparison with others.

Mastery-avoidance (MAv) goals focus on not making mistakes or not doing worse than a previous performance. As the latest addition to the achievement goal family, relatively little is known about these goals. They combine a desirable definition of competence with an undesirable focus on avoiding incompetence, so they are expected to exhibit a mixed set of consequences. Elliot (1999; Elliot & Conroy, 2005; Elliot & McGregor, 2001) has theorized that these goals may be particularly relevant for perfectionists striving for flawlessness, for athletes focused on maintaining their skill level as they near the end of their careers, and for older adults fighting off the natural functional declines associated with aging.

Antecedents and Consequences of 2 × 2 Goal Adoption

Considering that the vast majority of the recent achievement motivation literature in sport has implicitly focused on approach goals (i.e., MAp, PAp), relatively little is known about the correlates and consequences of avoidance-valenced achievement goals in sport. This section reviews documented links between the four goals in the 2 × 2 framework and theoretically relevant antecedents and consequences (e.g., achievement processes and outcomes). The vast majority of the research on goals in the 2 × 2 framework resides outside of the sport and exercise psychology literature. Rather than relying exclusively on the nascent sport psychology literature on 2 × 2 goals, we include selected findings from broader social and educational psychology literatures in this review. There is also some conceptual confusion about whether some variables (e.g., competence valuation) belong as antecedents or consequences of different states of goal involvement; they are listed according to how they were conceptualized in their respective studies.

Antecedents of 2 × 2 Achievement Goals

Empirically-tested antecedents of the four achievement goals are summarized in Table 1.1 based on whether the antecedents have demonstrated positive, negative, or null relations with each goal. These links are based on bivariate relations between each antecedent and the goal; relatively few relations change when third variables (e.g., ability) have been controlled.

Common antecedents of MAp goal involvement appear to include appetitive motivational dispositions (e.g., motives, temperament), positive self-perceptions (e.g., competence- and attachment-related perceptions), and perceived situational importance (e.g., competence valuation, class engagement). On the other hand, aversive motivational dispositions and negative cognitive representations of self and others do not appear to be associated with MAp goal involvement.

Mastery-avoidance goal involvement appears to be linked to antecedents such as negative perceptions of self and others (e.g., anxious attachment, fear of failure), entity rather than incremental theories of intelligence, reduced self-determination, and perceived situational importance. Appetitive motive dispositions do not appear to be MAv goal antecedents.

Common antecedents of PAp goal involvement include both appetitive and aversive motivational dispositions, competence perceptions, and entity rather than incremental theories of ability. Attachment security and self-determination do not appear to be PAp goal antecedents.

Finally, PAv goal involvement appears to be linked to antecedents such as avoidance motivational dispositions, reduced competence expectations, more entity and fewer incremental beliefs about ability, and less self-determination. Appetitive motivational dispositions and attachment security do not appear to be PAv goal antecedents.

Overall, socialization processes (e.g., perceived parenting practices) were not consistently associated with the achievement goals adopted by participants. This finding should be expected because socialization processes are more likely to have direct effects on more stable individual differences (e.g., motives) than on dynamic constructs such as goals.

Consequences of 2 × 2 Achievement Goals

Table 1.2 summarizes consequences of 2 × 2 achievement goals from previous research. Given that empirical tests of the 2 × 2 model are in their early stages, conclusions drawn here should be interpreted with appropriate caution. Special attention should be given to the studies that experimentally manipulated participants' goals (e.g., Cury, Da Fonséca, et al., 2002; Cury, Elliot, et al., 2002; Elliot & Harackiewicz, 1996) because such manipulations provide a much stronger demonstration of the causal role theorized for these goals than do passive observation designs (particularly when data are collected at a single occasion from a single source).

Mastery-approach goals appear to be associated with the optimal set of consequences (e.g., enhanced intrinsic motivation and information processing, reduced anxiety, fewer health center visits). Strikingly, MAp goals have not been linked to superior performance on cognitive tasks. Mastery-avoidance goals were linked with a generally undesirable set of achievement processes (e.g., anxiety, disorganization, surface processing) but did not seem to be associated with undesirable outcomes (e.g., performance, health center visits). Performance-approach goals were the only goals to be positively associated with superior performance. These goals also were linked with a partial set of desirable (e.g., more absorption, competence valuation, and intrinsic motivation; less anxiety) achievement

Table 1.1 Summary of Empirically Tested Antecedents of 2 × 2 Achievement Goals

Goal	Positive Relations	Negative Relations	Null Relations
MAp	Approach temperament (Elliot & Thrash, 2002) Behavioral activation system (Elliot & Thrash, 2002) Competence expectancy (Elliot & Church, 1997) Competence valuation (Elliot & McGregor, 2001) Extraversion (Elliot & Thrash, 2002) *Incremental beliefs about ability* (Cury, Da Fonséca, et al., 2002*) Need for achievement (Elliot & McGregor, 2001; Elliot & Church, 1997; Thrash & Elliot, 2002) Perceived class engagement (Elliot & McGregor, 2001) *Perceived competence* (Cury, Da Fonséca, et al., 2002*; Ommundsen, 2004*) Positive emotionality (Elliot & Thrash, 2002) Secure attachment (Elliot & Reis, 2003) Secure versus avoidant attachment (Elliot & Reis, 2003) Self-determination (Elliot & McGregor, 2001) Work mastery (Elliot & McGregor, 2001)	Avoidance attachment dimension (link mediated by challenge construals; Elliot & Reis, 2003) *Self-handicapping* (Elliot & Church, 2003; Ommundsen, 2004*)	Anxious/ambivalent attachment (Elliot & Reis, 2003) Anxious attachment dimension (Elliot & Reis, 2003) Avoidant attachment (Elliot & Reis, 2003) Avoidance temperament (Elliot & Thrash, 2002) Behavioral inhibition system (Elliot & Thrash, 2002) Competitiveness (Elliot & McGregor, 2001) Defensive pessimism (Elliot & Church, 2003) Entity theory of intelligence (Elliot & McGregor, 2001) *Fear of failure* (Conroy, 2004*; Conroy & Elliot, 2004*; Conroy, Elliot, & Hofer, 2003*; Elliot & Church, 1997; Elliot & McGregor, 2001; Thrash & Elliot, 2002) Incremental theory of intelligence (Elliot & McGregor, 2001) Negative emotionality (Elliot & Thrash, 2002) Neuroticism (Elliot & Thrash, 2002) Parental behavior-focused positive or negative feedback (Elliot & McGregor, 2001) Parental conditional approval (Elliot & McGregor, 2001) Parental identification (Elliot & McGregor, 2001) Parental person-focused positive or negative feedback (Elliot & McGregor, 2001) Parental worry (Elliot & McGregor, 2001) Secure versus anxious/ambivalent attachment (Elliot & Reis, 2003)
MAv	Anxious attachment dimension (link mediated by threat construals and competence valuation; Elliot & Reis, 2003) Competence valuation (Elliot & McGregor, 2001) Entity theory of intelligence (Elliot & McGregor, 2001) *Fear of failure* (Conroy, 2004*; Conroy & Elliot, 2004*; Conroy et al., 2003*; Elliot & McGregor, 2001) Parental person-focused negative feedback (Elliot & McGregor, 2001) Parental worry (Elliot & McGregor, 2001) Perceived class engagement (Elliot & McGregor, 2001)	Incremental theory of intelligence (Elliot & McGregor, 2001) Self-determination (Elliot & McGregor, 2001)	Avoidance attachment dimension (Elliot & Reis, 2003) Competitiveness (Elliot & McGregor, 2001) Conditional parental approval (Elliot & McGregor, 2001) Maternal person-focused positive feedback (Elliot & McGregor, 2001) Need for achievement (Elliot & McGregor, 2001) Parental behavior-focused positive or negative feedback (Elliot & McGregor, 2001) Parental identification (Elliot & McGregor, 2001) Work mastery (Elliot & McGregor, 2001)

Table 1.1 (Continued)

Goal	Positive Relations	Negative Relations	Null Relations
PAp	Approach temperament (Elliot & Thrash, 2002) Avoidance temperament (Elliot & Thrash, 2002) Behavioral activation system (Elliot & Thrash, 2002) Behavioral inhibition system (Elliot & Thrash, 2002) Competence expectancies (Elliot & Church, 1997) Competence valuation (Elliot & McGregor, 2001) Competitiveness (Elliot & McGregor, 2001) Defensive pessimism (Elliot & Church, 2003) *Entity beliefs about ability* (Cury, Da Fonséca, et al., 2002*) Extraversion (Elliot & Thrash, 2002) *Fear of failure* (Conroy, 2004*; Conroy & Elliot, 2004*; Conroy et al., 2003*; Elliot & Church, 1997; Elliot & McGregor, 1999, 2001; Thrash & Elliot, 2002) Maternal worry (Elliot & McGregor, 2001) Need for achievement (Elliot & McGregor, 2001; Elliot & Church, 1997; Thrash & Elliot, 2002) Negative emotionality (Elliot & Thrash, 2002) Neuroticism (Elliot & Thrash, 2002) Parental behavior-focused negative feedback (when identification is high; Elliot & McGregor, 2001) Parental conditional approval (Elliot & McGregor, 2001) Paternal person-focused positive feedback (Elliot & McGregor, 2001) *Perceived competence* (Cury, Da Fonséca, et al., 2002*; Ommundsen, 2004*) Positive emotionality (Elliot & Thrash, 2002) Self-handicapping (Elliot & Church, 2003)	*Incremental beliefs about ability* (Cury, Da Fonséca, et al., 2002*) Parental behavior-focused negative feedback (when identification is low; Elliot & McGregor, 2001) *Self-handicapping* (Ommundsen, 2004*)	Anxious/ambivalent attachment (Elliot & Reis, 2003) Avoidant attachment (Elliot & Reis, 2003) Avoidance attachment dimension (Elliot & Reis, 2003) Anxious attachment dimension (Elliot & Reis, 2003) Entity theory of intelligence (Elliot & McGregor, 2001) Incremental theory of intelligence (Elliot & McGregor, 2001) Maternal person-focused positive feedback (Elliot & McGregor, 2001) Parental behavior-focused positive feedback (Elliot & McGregor, 2001) Paternal worry (Elliot & McGregor, 2001) Perceived class engagement (Elliot & McGregor, 2001) Secure attachment (Elliot & Reis, 2003) Secure versus anxious/ambivalent attachment (Elliot & Reis, 2003) Secure versus avoidant attachment (Elliot & Reis, 2003) Self-determination (Elliot & McGregor, 2001) Work mastery (Elliot & McGregor, 2001)
PAv	Anxious/ambivalent attachment (link mediated by threat construal and competence valuation; Elliot & Reis, 2003) Anxious attachment dimension (Elliot & Reis, 2003) Avoidance temperament (Elliot & Thrash, 2002) Behavioral inhibition system (Elliot & Thrash, 2002) Competence valuation (Elliot & McGregor, 2001) Defensive pessimism (Elliot & Church, 2003) *Entity beliefs about ability* (Cury, Da Fonséca, et al., 2002*; Ommundsen, 2004*)	Competence expectancies (Elliot & Church, 1997) *Incremental beliefs about ability* (Cury, Da Fonséca, et al., 2002*) *Perceived competence* (Cury, Da Fonséca, et al., 2002*; Ommundsen, 2004*) Self-determination (Elliot & McGregor, 2001) Secure versus anxious/ambivalent attachment (Elliot & Reis, 2003)	Approach temperament (Elliot & Thrash, 2002) Avoidant attachment (Elliot & Reis, 2003) Avoidance attachment dimension (Elliot & Reis, 2003) Behavioral activation system (Elliot & Thrash, 2002) Competitiveness (Elliot & McGregor, 2001) Extraversion (Elliot & Thrash, 2002) Incremental theory of intelligence (Elliot & McGregor, 2001) Maternal conditional approval (Elliot & McGregor, 2001)

(continued)

Table 1.1 (Continued)

Goal	Positive Relations	Negative Relations	Null Relations
PAv	Entity theory of intelligence (Elliot & McGregor, 2001) *Fear of failure* (Conroy, 2004*; Conroy & Elliot, 2004*; Conroy et al., 2003*; Elliot & Church, 1997; Elliot & McGregor, 1999, 2001; Thrash & Elliot, 2002) Parental person-focused negative feedback (Elliot & McGregor, 2001) Maternal worry (Elliot & McGregor, 2001) Negative emotionality (Elliot & Thrash, 2002) Neuroticism (Elliot & Thrash, 2002) *Self-handicapping* (Elliot & Church, 2003; Ommundsen, 2004*)		Need for achievement (Elliot & McGregor, 2001; Elliot & Church, 1997; Thrash & Elliot, 2002) Parental behavior-focused positive or negative feedback (Elliot & McGregor, 2001) Paternal conditional approval (Elliot & McGregor, 2001) Parental identification (Elliot & McGregor, 2001) Parental person-focused positive feedback (Elliot & McGregor, 2001) Paternal worry (Elliot & McGregor, 2001) Perceived class engagement (Elliot & McGregor, 2001) Positive emotionality (Elliot & Thrash, 2002) Secure attachment (Elliot & Reis, 2003) Secure versus avoidant attachment (Elliot & Reis, 2003) Work mastery (Elliot & McGregor, 2001)

Note: Antecedent variables are listed in alphabetical order. *Italicized* variables have been documented in sport contexts by the studies marked with an asterisk.

processes and were not associated with any undesirable achievement processes. Finally, PAv goals were consistently linked with the most undesirable achievement processes and outcomes of all four goals. Based on these results, MAp goals appear to be optimal, PAv goals appear to be dysfunctional, and both PAp and MAv goals are neither entirely optimal nor entirely dysfunctional (with the former appearing to be more optimal than the latter).

Critical Issues Regarding 2 × 2 Achievement Goals

Elliot and colleagues (e.g., Elliot, 1997, 1999; Elliot & Conroy, 2005; Elliot & Thrash, 2001, 2002) argue that on both theoretical and empirical grounds, the 2 × 2 model of achievement goals has demonstrated promise for enhancing understanding of achievement motivation. Nevertheless, research on this model in sport contexts has been limited, and further research is required to demonstrate its veracity and potential. Research linking goals, particularly avoidance goals, to hypothesized patterns of antecedents and consequences in sport would be a useful first step in this process. Following are some other issues that will need to be addressed in future research.

Controversy still exists over whether the approach-avoidance distinction merely represents differences in perceptions of competence, especially for the performance dimension. That is, do perceptions of competence moderate relations between goals and various consequences, and if so, would it not be simpler to omit the valence dimension from the goals model? From a conceptual standpoint, the hierarchical model of achievement motivation frames perceptions of competence as antecedents of achievement goals because high perceptions of competence orient individuals toward the possibility of success and low perceptions of competence orient individuals toward the possibility of failure (Elliot, 2005). From an empirical perspective, Elliot and Harackiewicz (1996) have found that perceived competence failed to moderate the effects of any of their tripartite goal manipulation contrasts (i.e., mastery, PAp, PAv) on intrinsic motivation, and all of their main effects for the goal manipulations remained significant with the moderator terms in the model. Based on such evidence, it is argued by Elliot and colleagues that the valence dimension of achievement goals does not appear to be a proxy for perceived competence on either conceptual or empirical grounds.

This approach does not rule out the possibility that individual differences in goal antecedents (e.g., achievement motives) may moderate the effects of the goals on various consequences. For example, PAp goal involvement has been linked to both appetitive and aversive achievement motives (need for achievement and fear of failure, respectively). It

Table 1.2 Summary of Empirically Tested Consequences of 2 × 2 Achievement Goals

Goal	Positive Relations	Negative Relations	Null Relations
MAp	*Competence valuation* (compared to PAv goal condition: Cury, Elliot, et al., 2002*; compared to PAp & PAv goal condition: Cury et al., 2003*) Deep processing (Elliot & McGregor, 2001) Intrinsic motivation (especially in combination with low PAp goals; Elliot & Harackiewicz, 1996) Long-term retention (Elliot & McGregor, 1999) *Posttask free-choice behavior* (Cury, Elliot, et al., 2002*, 2003*) *Task absorption* (compared to PAv goal condition; Cury, Elliot, et al., 2002*)	Health center visits (Elliot & McGregor, 2001) *State anxiety* (compared to PAv goal condition: Cury, Elliot, et al., 2002*; compared to PAp & PAv goal condition: Cury et al., 2003*)	Disorganization (Elliot & McGregor, 2001) Emotionality (Elliot & McGregor, 2001) Graded performance (Elliot & Church, 1997; Elliot & McGregor, 1999, 2001) State test anxiety (Elliot & McGregor, 1999, 2001) Surface processing (Elliot & McGregor, 2001) Worry (Elliot & McGregor, 2001)
MAv	Disorganization (Elliot & McGregor, 2001) Emotionality (Elliot & McGregor, 2001) State test anxiety (Elliot & McGregor, 2001) Surface processing (Elliot & McGregor, 2001) Worry (Elliot & McGregor, 2001)	None reported to date	Deep processing (Elliot & McGregor, 2001) Exam performance (Elliot & McGregor, 2001) Health center visits (Elliot & McGregor, 2001)
PAp	*Competence valuation* (compared to PAv goal condition; Cury, Elliot, et al., 2002*, 2003*) Graded performance, especially in combination with low MAp goals (Elliot & McGregor, 1999, 2001) Intrinsic motivation (compared to PAv; Elliot & Harackiewicz, 1996) *Posttask free-choice behavior* (compared to PAv goal condition; Cury, Elliot, et al., 2002*, 2003*) *Task absorption* (compared to PAv goal condition; Cury, Elliot, et al., 2002*) Surface processing (Elliot & McGregor, 2001)	*State anxiety* (compared to PAv goal condition; Cury, Elliot, et al., 2002*, 2003*)	Deep processing (Elliot & McGregor, 2001) Disorganization (Elliot & McGregor, 2001) Emotionality (Elliot & McGregor, 1999, 2001) Exam performance (Elliot & McGregor, 2001) Health center visits (Elliot & McGregor, 2001) Intrinsic motivation (compared to MAp; Elliot & Harackiewicz, 1996) Long-term retention (Elliot & McGregor, 1999) State test anxiety (Elliot & McGregor, 1999, 2001) *State anxiety* (compared to MAp goal condition; Cury, Elliot, et al., 2002*, 2003*) Surface processing (Elliot & McGregor, 2001) Worry (Elliot & McGregor, 1999, 2001)
PAv	Disorganization (Elliot & McGregor, 2001) Emotionality (Elliot & McGregor, 1999, 2001) Health center visits, especially in combination with low MAp goals (Elliot & McGregor, 2001) *State anxiety* (compared to MAp and PAp goal conditions; Cury et al., 2002*, 2003*) State test anxiety (Elliot & McGregor, 1999, 2001) Surface processing (Elliot & McGregor, 2001) Worry (Elliot & McGregor, 1999, 2001)	Change in GPA (Elliot & Church, 2003) *Competence valuation* (compared to MAp and PAp goal conditions; Cury, Elliot, et al., 2002*, 2003*) Deep processing (Elliot & McGregor, 2001) Graded performance (Elliot & McGregor, 1999, 2001, Elliot & Church, 2003) Intrinsic motivation (Elliot & Harackiewicz, 1996) Long-term retention (Elliot & McGregor, 1999) *Posttask free-choice behavior* (compared to MAp and PAp goal conditions; Cury, Elliot, et al., 2002b, 2003) *Task absorption* (compared to MAp and PAp goal conditions; Cury, Elliot, et al., 2002*)	None reported to date

Note: Antecedent variables are listed in alphabetical order. *Italicized* variables have been documented in sport contexts by the studies marked with an asterisk.

is possible that PAp goals energized by the appetitive motive may yield different consequences than would PAp goals that are energized by the aversive motive. A three-way Goal × Motive × Feedback interaction also is conceivable, as PAp goals may change differentially for individuals with different motive dispositions following failure/success feedback. These cross-level interaction hypotheses are open empirical questions.

Next, it will be important to capture the dynamic features of the goals construct to strengthen claims about the causal effects of goals on achievement processes and outcomes. Some argue that relying on dispositional conceptualizations of goals is inappropriate in the hierarchical model of achievement motivation, but researchers can vary the temporal resolution of their goal assessments. Some studies may assess goals for an event and track processes and outcomes over the course of the event to use in prospective prediction models (e.g., using preseason goals to predict changes in relevant outcomes over the course of the season). Other studies may assess goals, processes, and outcomes on more of a moment-to-moment basis (even though this is difficult to do, as we noted earlier) to capture dynamic links between goals and their consequences (e.g., using daily goals to predict daily fluctuations in relevant outcomes over the course of the season). Both approaches will be valuable provided that the temporal resolution of the goal assessment is clear when interpreting the results.

Finally, whereas a great deal of data has accumulated about individual difference antecedents of different achievement goals, relatively little is known about the situational factors that antecede 2 × 2 goals. Church, Elliot, and Gable (2001) reported differences in classroom environments that predicted students' tripartite goals. There are few published studies regarding links between situational characteristics and 2 × 2 goal involvement in sport, except research based on achievement goal theory investigating motivational climate that indirectly informs performance and mastery achievement striving (for an exception see Conroy, Kaye, & Coatsworth, 2006).

REFLECTIONS ON THE HIERARCHICAL MODEL AND ACHIEVEMENT GOAL THEORY

The introduction of the hierarchical model has challenged many of the tenets and underlying assumptions of what may be referred to as traditional achievement goal theory. One of the most important challenges and differences between the perspectives pertains to the energization of the motivational process. As we have seen, the hierarchical model differentiates goals based on both the definition of competence (a similarity with the dichotomous model) and their valence or the degree to which the focal outcome is pleasant or unpleasant (a difference between the models). The argument is that achievement goals should consider both the definition of competence and the valence of the striving. However, it may be argued that in the hierarchical model we seem to be defining achievement goals as discrete goals based on a definition of competence and achievement strategies aimed at fulfilling some particular objective. In the hierarchical model, goals are midlevel constructs that mediate the effects of a host of individual differences (e.g., achievement motives, self-perceptions, relational variables, demographic characteristics, neurophysiologic predispositions) and situational factors (e.g., norm-based evaluation) on specific motivated behaviors and serve as proximal predictors of achievement-related processes and outcomes (Elliot, 1999). But it is the appetitive (approach) and aversive (avoidance) valence of competence striving that energizes the motivational process. It is assumed that the goals are the manifestation of needs, or at least the "motivational surrogates," as Elliot and Church (1997) state of the needs of achievement motivation (approach) and the fear of failure (avoidance; Kaplan & Maehr, 2002). This suggests that achievement goals represent approaches to self-regulation based on satisfying approach and avoidance needs that are evoked by situational cues. Achievement goals arise from affect-based objectives, at least in part, in the hierarchical model.

In traditional achievement goal theory, it is the goals themselves that are the critical determinants of achievement cognition, affect, and behavior. It is the goals that give meaning to the investment of personal resources because they reflect the purposes underlying achievement actions in achievement contexts. Once endorsed, the goal defines an integrated pattern of beliefs, attributions, and affect that underlie approach and avoidance strategies, different levels of engagement, and the different responses to achievement outcomes (Duda & Hall, 2001; Kaplan & Maehr, 2002). The way an individual interprets his or her performance can be understood in terms of what an individual considers to be important in a particular context and his or her beliefs about what it takes to be successful in that situation. Achievement goals refer to achievement-oriented or achievement-directed behavior where success is the goal. Nicholls (1989) argued that these beliefs and perceptions form a personal theory of achievement in the activity that drives the motivation process, and that a conceptually coherent pattern of relationships should therefore exist between an individual's achievement goals (the subjective meaning of success) and his or her achievement striving. In the achievement goal approach, it is not how one defines competence with its attendant valence; it is how one defines success and the meaning of developing or demonstrating competence. Thus, the hierarchical approach presents energizing constructs that are different. The conceptual argument is whether we need "needs" to explain the energization of the motivational equation, or whether we can accept a cognitive theory of motivation that focuses on thoughts and perceptions as energizing motivated behavior (Maehr, 1987). We need more empirical investigation of the conceptual energizing constructs, and their roles, underlying achievement striving in achievement contexts to better understand the motivational equation.

One other conceptual difference has emerged from the development of measures for the hierarchical model of goals, especially of the 2 × 2 model in sport. Duda (2005) has argued that because the interrelationships between the performance-approach, mastery-avoidance, and performance-avoidance goals is low to moderate (e.g., Conroy et al., 2003), and only the mastery-approach and performance-avoidance goals have demonstrated independence, this creates conceptual problems for the hierarchical approach. How does this relate to the evidence that task and ego goals have been demonstrated to be orthogonal in the dichotomous achievement goal approach, at least from the Maehr and Nicholls approaches (e.g., Maehr & Braskamp, 1986; Maehr & Nicholls, 1980; Nicholls, 1989)? More research is clearly needed to explore this issue as proponents of the 2 × 2 model argue that limited positive correlations should be expected between goals that share either a definition of competence or a valence. However, this raises interesting questions: What are the expected relationships between the goals? Should they demonstrate greater independence to be recognized as extending the range of goals?

In addition, there is evidence that the hierarchical model may have different assumptions underlying performance-approach and avoidance goals. Performance-approach tendencies may be based on demonstrating normative ability and defining competence in normative terms, but recent research has suggested that performance-avoidance may be based on one of three facets: impression management, or "saving face" (Skaalvik, 1997; Skaalvik & Valas, 1994); a fear of failure (Elliot & Church, 1997); or a focus on avoiding demonstrating low ability (Middleton & Midgley, 1997). In an interesting study investigating the measurement technology underlying the hierarchical model, Smith, Duda, Allen, and Hall (2002) wished to determine whether the different measures used were measuring the same constructs. They found that impression management (Skaalvik, 1997) explained the most variance (40%), with fear of failure (Elliot & Church, 1997) and avoiding demonstrating low ability (Middleton & Midgley, 1997) explaining only 9.4% and 8% of the variance, respectively. It would seem important for future research to clarify the conceptual underpinnings of performance-avoidance: What parts are played by fearing failure, avoiding demonstrating low ability, and protecting self-worth? Given the findings of Smith and colleagues, perhaps it is more important to performance-avoiding people to protect self-esteem rather than be motivated to avoid failing. What is the role the protection of self-worth plays? When individuals begin to question their ability to present a positive sense of self, are they more likely to favor avoidance strategies?

Similar arguments may be made for mastery-avoidance goals. These goals involve focusing on not making mistakes or not doing worse than a previous performance. They combine a desirable definition of competence with an undesirable focus on avoiding incompetence. It must be confessed that little is known of these goals as yet. With the traditional achievement goal approach, it is conceptually inconsistent to have a mastery- or task-involved goal with a focus on avoiding appearing incompetent. Traditional achievement goal theory argues that because dispositional orientations are assumed to be orthogonal, the individual may also have an ego-involving orientation, and it is this that may affect whether the individual is also concerned with the demonstration of incompetence. It may be that mastery-avoidance individuals have both ego and task goals; when the context is perceived to evoke ego-involving criteria, they may wish to avoid demonstrating incompetence. However, this needs to be investigated empirically; only when we have data informing theory will we be able to determine the energizing mechanisms behind achievement striving.

This brings us to a further point of conceptual departure between the two approaches: In achievement goal theory, the orientations are considered orthogonal; that is, one can have both orientations to one degree or another. For example, Duda (1988) examined the relationship between achievement goals and specific motivated behaviors such as persistence and behavioral intensity. Participants were classified into four groups, and the findings showed that being high in task orientation (regardless of ego orientation) meant the participants persisted longer and devoted more time to practice. Similar findings were found by Walling and Duda (1995). High-task-oriented students were significantly more likely to believe that success is achieved through intrinsic interest in the activity, cooperation, and high effort, and the high-task/low-ego students were the least likely to believe that success stems from learning to skillfully deceive the teacher. Roberts et al. (1996) found that the high-task groups attributed success to effort more than did low-task groups. In contrast, high-ego groups attributed success to ability more than did low-ego groups. Even elite Olympic athletes, those we would expect to exhibit high ego involvement and to succeed with such a profile (Hardy, 1997), seem to function better when high ego involvement is tempered with high task involvement (e.g., Pensgaard & Roberts, 2002, 2003). This was also true of young elite soccer players (Lemyre et al., 2002).

Being both task- and ego-oriented is conceptually coherent with achievement goal theory. It may well be that being high in both task and ego involvement is valuable in the learning process because it provides multiple sources of competence information to the athlete. Swain and Hardwood (1996) have suggested that an individual with both goal orientations cannot fail to be satisfied. They argue that when one goal is not attained, the second goal can be achieved. Duda (1988) asserted a similar notion and states that persistence may be increased with both orientations because a person has two sources of determining success. For an athlete, being both task- and ego-involved in an activity is both intuitively plausible and conceptually consistent with achievement goal theory. Thus, an athlete may be very ego-involved in a sport when competing, but become very task-involved when training in the same sport. Further, an athlete may be ego-involved in competition, but then when the outcome is certain, or for some other reason, become task-involved before the game or event is completed. We must not forget that task and ego involvement are dynamic constructs and subject to ebb and flow as the athlete plays the game or continues with the activity (Roberts, 1992, 2001). It is not whether an individual should be either task- or ego-involved, but rather when being task-involved or ego-involved is appropriate. This shift of involvement is an important issue to investigate, as it may reflect on intervention strategies for enhancing motivation.

THE FUTURE OF ACHIEVEMENT GOALS

We have discussed the nature of achievement goals as being situated within situation and self-cognitive schemas, the traditional achievement goal approach, or being situated within affect-based incentives (at least partially) in the hierarchical model. However, achievement goals have been based in other constructs, too.

One approach has been to use the concept of value, where goal orientations emerge from the value-laden attractiveness of an achievement context. Values are directed at desirable end states of behavior, and goals are seen as objectives (Bandura, 1986; Eccles & Harold, 1991; Ford, 1992; Kaplan & Maehr, 2002). As an example, Eccles and her colleagues (Eccles & Harold, 1991; Wigfield & Eccles, 1992) suggest that achievement goals emerge from values and expectancies. Thus, mastery goals emerge from intrinsic task values and a belief in one's competence to do the task, whereas performance goals emerge from the utility value of the task for success in an important domain and the expectancy of outperforming others. The research into task value and achievement goals is promising and increasing in sport (Wiess & Ferrer-Caja, 2002), but more research is needed to develop the conceptual base of the approach in physical activity.

Goals have also been seen as "self-primes," a form of heightened self-awareness (Kaplan & Maehr, 2002). Nicholls (1984) has suggested that heightened self-awareness could make thoughts of competence salient. What is an ego goal (or performance-approach and performance-avoidance goals) may well represent a heightened awareness of the self as the person may focus on what he or she can do. However, heightened self-awareness may also affect other thoughts about oneself. Self-awareness certainly may affect ego or performance goals, especially in terms of approach and avoidance goals. It is interesting that the research into self-awareness is meaningful to achievement goal theory and may propose a fruitful line of inquiry. However, more conceptual clarification and research is needed, especially in the mastery/task achievement goal.

There are other metaphors that may guide the development of achievement goals. It will be the business of future research to attempt to combine the various perspectives into a parsimonious explanation of how contexts and individual differences forge achievement goals.

The foregoing reflects one major trend in achievement goal research: the attempt to converge achievement goals into a larger, more parsimonious framework. As discussed earlier, Elliot and colleagues (e.g., 2005) have integrated achievement goal theory with more traditional concepts of achievement needs. Kaplan and Maehr (2002) have argued for more general processes of meaning construction that involve the self and the context in a broader framework. This trend is welcome, as the development of specific achievement goals should be based on a sound conceptual framework.

Still other achievement goals have been identified. Initially pursued (e.g., Maehr & Braskamp, 1986), they fell into disuse as the parsimony of the dichotomous interpretation was demonstrated over time. One early goal was termed a social goal, referring to social approval and/or interpersonal reasons for engaging in achievement tasks (e.g., Ewing, 1981; Maehr & Nicholls, 1980). But little attention has been given to social goals in physical activity in recent times. Another early goal involved extrinsic orientation, where the individual strove to achieve an external criterion of success (e.g., Maehr & Braskamp, 1986). But little attention has been paid to extrinsic goals, except within the framework of other motivational conceptualizations (e.g., Deci & Ryan, 1985, 2002). And qualitative research has identified other goals in addition to ego and task goals (e.g., Dowson & McInerney, 2001). It may well be that future research, particularly qualitative research, may identify and demonstrate how these goals may further our understanding of the origin and development of achievement goals and their behavioral implications.

This reflects a second trend in achievement goal research, that of developing other achievement goals. In particular, there have been arguments in favor of recognizing different criteria of engagement in achievement striving, and that these have their own patterns of consequences. We have discussed the approach and avoidance arguments of Elliot and colleagues that began this trend, but it has also been suggested that we may be able to bifurcate the current mastery (task) definitions of competence into separate categories for absolute (e.g., Did I perform this task as well as this task can be performed?) and intrapersonal (e.g., Did I perform this task better than I did previously?) definitions of competence (Elliot, 1999; Elliot & Conroy, 2005; Harwood, Hardy, & Swain, 2000). The same may be argued for other goals, such as social goals and extrinsic goals, which may also be partitioned into approach and avoidance categories (Dowson & McInerney, 2001). Thus, for example, social goals can be categorized as either approach, in that one can demonstrate competence to gain friends ("If I play well, my friends will like me"), or avoidance, in that competence, or the expectation of failing to demonstrate competence, will lead to social castigation ("If I don't play well, my father shouts at me"). Thus, the trend begun by Elliot continues. However, Elliot and Conroy (2005) argue that any expansions of the achievement goal construct need to relate to existing dimensions of achievement goals (i.e., definitions of competence, valence of strivings) or provide a rationale for incorporating new dimensions of competence. But researchers need to be careful not to add unnecessary complexity to the parsimonious interpretation of achievement goals without a concomitant increase in conceptual integration.

CONCLUSION

There are two important conclusions we may draw. First, performance goals (however they have been defined and conceptualized) are more likely to lead to maladaptive achievement behavior, especially when participants perceive competence to be low, are concerned with failure, or are invested in protecting self-worth. In such circumstances, the evidence is quite clear: Motivation ebbs, task investment is low, persistence is low, performance suffers, satisfaction and enjoyment are lower, and participants feel more negatively about themselves and the achievement context. But this does not mean that ego-oriented goals are always negative; in some situations for some people they are positive. A performance-approach goal (e.g., Elliot, 1997) or an ego (or performance) goal with high perception of competence (e.g., Pensgaard & Roberts, 2002) is facilitative of achievement and functions as a motivating construct. But even then, performance (ego) goals are more fragile and can lead to maladaptive achievement striving as context information is processed (Dweck & Leggett, 1988; Midgley, Kaplan, & Middleton, 2001).

Second, the research is unequivocal that task (mastery) goals are adaptive. When task-involved participants perceive mastery criteria in the context, motivation is optimized, participants are invested in the task, they persist longer, performance is higher, satisfaction and enjoyment are higher, and participants feel more positively about themselves and the task. Being task-involved has been consistently associated with desirable cognitive and affective responses. The research is now clear that if we wish to optimize motivation in physical activity we ought to promote task involvement. It does not matter whether we do it through enhancing socialization experiences so that the individual has a task goal orientation and is naturally task-involved (Nicholls, 1989), or we structure the physical activity context to be more task-involving (e.g., Treasure & Roberts, 1995, 2001). The evidence has led many sport psychologists to conclude that task involvement better enables learners to manage motivation in the sport experience. Consequently, they have urged those involved in pedagogy to promote task involvement as well as develop mastery-oriented environments to facilitate effective motivational patterns for all participants, even if the individuals are high in ego orientation (e.g., Brunel, 2000; Duda, 1992; Hall & Kerr, 1997; Pensgaard & Roberts, 2002; Roberts, 2001; Roberts et al., 1997; Theeboom et al., 1995; Treasure & Roberts, 1995).

However, an important assumption of achievement goal theory from the Nicholls perspective is that the goals are orthogonal; that is, being task- or ego-involved is independent, which means that one can be high or low in each or in both orientations at the same time. The findings of the research discussed here suggest that rather than depressing a high-ego state of involvement and replacing it with a high-task state of involvement, as has been advocated by many researchers, we should concentrate on enhancing the task-involved state. This finding suggests that we do not have to explicitly depress ego involvement to maintain motivation; rather, we should enhance task involvement to moderate the potentially debilitating effects of a high-ego state of involvement.

It may well be that always fostering task-involving criteria may not satisfy all individuals in the sport experience, especially elite athletes (Hardy, 1997). It may well be that athletes at all levels of competition would benefit from being *both* task- and ego-involved. Being both task- and ego-involved is conceptually coherent with achievement goal theory and may be valuable in the learning process because it provides multiple sources of competence information to the athlete. Encouraging individuals to be task-involved in achievement tasks has been demonstrated to optimize motivation, even with elite athletes, but we need not be blind to the fact that some athletes do favor and are motivated by ego-involving criteria. The task for the investigator and the practitioner is to determine when task- or ego-involving criteria of success and failure are motivational. Only further research will verify this hypothesis.

As is clear from the foregoing, it may be concluded that where achievement goals come from, how they are operationalized, and how they are measured are areas with rich research traditions. We may ask: What are the key constructs underlying the motivational equation? Of all the motivational paradigms that are extant, which of the constructs is central to understanding motivation? As Duda and Hall (2001) have suggested, perhaps it is time to begin to seriously attempt to integrate some key constructs and untangle the motivation puzzle, as we and some others have attempted (e.g., Kaplan & Maehr, 2002). Are achievement goals the manifestation of needs, values, the valence of outcomes, or cognitive schemas driving how one sees one's world and responds to the environmental cues with achievement striving? What gives meaning to achievement striving? In sport and physical activity, we need to address these questions and expand our conceptual understanding of motivational processes and achievement behaviors so that we can intervene effectively to enhance motivation and make the sport and physical activity context enjoyable and satisfying for all.

REFERENCES

Aguinis, H., & Stone-Romero, E. F. (1997). Methodological artifacts in moderated multiple regression and their effects on statistical power. *Journal of Applied Psychology, 82,* 192–206.

Ames, C. (1984a). Competitive, cooperative, and individualistic goal structures: A cognitive-motivational analysis. In C. Ames & R. Ames (Eds.), *Research on motivation in education: Vol. 1. Student motivation* (pp. 117–208). New York: Academic Press.

Ames, C. (1984b). Conceptions of motivation within competitive and noncompetitive goal structures. In R. Schwarzer (Ed.), *Self-related cognitions in anxiety and motivation* (pp. 205–241). Hillsdale, NJ: Erlbaum.

Ames, C. (1992a). Achievement goals and the classroom motivational climate. In D. H. Schunk & J. L. Meece (Eds.), *Student perceptions in the classroom* (pp. 327–348). Hillsdale, NJ: Erlbaum.

Ames, C. (1992b). Achievement goals, motivational climate, and motivational processes. In G. C. Roberts (Ed.), *Motivation in sport and exercise* (pp. 161–176): Champaign, IL: Human Kinetics.

Ames, C. (1992c). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology, 84,* 261–271.

Ames, C., & Archer, J. (1988). Achievement goals in the classroom: Students' learning strategies and motivation processes. *Journal of Educational Psychology, 80,* 260–267.

Bandura, A. (1986). *Social foundation of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice-Hall.

Biddle, S., Akande, A., Vlachopoulos, S., & Fox, K. (1996). Towards an understanding of children's motivation for physical activity: Achievement goal orientations, beliefs about sport success, and sport emotion in Zimbabwean children. *Psychology and Health, 12,* 49–55.

Boyd, M. P. (1990). *The effects of participation orientation and success-failure on post-competitive affect in young adults.* Unpublished dissertation, University of Southern California, Los Angeles.

Brunel, P. (2000). Achievement motivation: Toward interactive effects of dispositional and situational variables on motivation and social cognition. *Habilitation a diriger les researches.* France: University of Limoges Press.

Chi, L. (1994). *The prediction of achievement related cognitions and behaviors in the physical activity domain: A test of the theories of goal perspectives and self-efficacy.* Unpublished doctoral dissertation, Purdue University, West Lafayette, IN.

Church, M. A., Elliot, A. J., & Gable, S. L. (2001). Perceptions of classroom environment, achievement goals, and achievement outcomes. *Journal of Educational Psychology, 93,* 43–54.

Cohn, P. J. (1990). An exploratory study on sources of stress and athlete burn out in youth golf. *Sport Psychologist, 4,* 95–106.

Conroy, D. E. (2004). The unique psychological meanings of multidimensional fears of failing. *Journal of Sport and Exercise Psychology, 26,* 484–491.

Conroy, D. E., & Elliot, A. J. (2004). Fear of failure and achievement goals in sport: Addressing the issue of the chicken and the egg. *Anxiety, Stress, and Coping, 17,* 271–285.

Conroy, D. E., Elliot, A. J., & Hofer, S. M. (2003). A 2 × 2 Achievement Goals Questionnaire for Sport: Evidence for factorial invariance, temporal stability, and external validity. *Journal of Sport and Exercise Psychology, 25,* 456–476.

Conroy, D. E., Kaye, M. P., & Coatsworth, J. D. (2006). Coaching climates and the destructive effects of mastery-avoidance achievement goals on situational motivation. *Journal of Sport and Exercise Psychology, 28,* 69–92.

Cury, F., Biddle, S., Famose, J. P., Goudas, M., Sarrazin, P., & Durand, M. (1996). Personal and situational factors influencing intrinsic interest of adolescent girls in physical education: A structural equation modeling analysis. *Educational Psychology, 16*(3), 305–314.

Cury, F., Biddle, S. J. H., Sarrazin, P., & Famose, J. P. (1997). Achievement goals and perceived ability predict investment in learning a sport task. *British Journal of Educational Psychology, 67*(3), 293–309.

Cury, F., Da Fonséca, D., Rufo, M., Peres, C., & Sarrazin, P. (2003). The trichotomous model and investment in learning to prepare for a sport test: A mediational analysis. *British Journal of Educational Psychology, 73,* 529–543.

Cury, F., Da Fonséca, D., Rufo, M., & Sarrazin, P. (2002). Perceptions of competence, implicit theory of ability, perception of motivational climate, and achievement goals: A test of the trichotomous conceptualization of endorsement of achievement motivation in the physical education setting. *Perceptual and Motor Skills, 95,* 233–244.

Cury, F., Elliot, A., Sarrazin, P., Da Fonséca, D., & Rufo, M. (2002). The trichotomous achievement goal model and intrinsic motivation: A sequential mediational analysis. *Journal of Experimental Social Psychology, 38,* 473–481.

Cury, F., & Sarrazin, P. (1998). Achievement motivation and learning behaviors in a sport task. *Journal of Sport and Exercise Psychology, 20,* S11.

Cury, F., Sarrazin, P., & Famose, J. P. (1997). Achievement goals, perceived ability and active search for information. In *European Yearbook of Sport Psychology* (Vol. 1, pp. 167–183). Sank Augustin, Germany: Sank Augustin.

deCharms, R. (1976). *Enhancing motivation: Change in the classroom.* New York: Irvington.

deCharms, R. (1984). Motivation enhancement in educational settings. In R. Ames & C. Ames (Eds.), *Research on motivation in education* (Vol. 2, pp. 275–310). New York: Academic Press.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior.* New York: Plenum Press.

Deci, E. L., & Ryan, R. M. (2002). *Handbook of self-determination research.* Rochester, NY: University of Rochester Press.

Dennett, D. C. (1978). *Brainstorms: Philosophical essays on mind and psychology.* Montgomery, VT: Bradford.

Dowson, M., & McInerney, D. M. (2001). Psychological parameters of students' social and work avoidance goals: A qualitative analysis. *Journal of Educational Psychology, 93,* 35–42.

Duda, J. L. (1988). The relationship between goal perspectives, persistence and behavioral intensity among male and female recreational sport participants. *Leisure Sciences, 10*(2), 95–106.

Duda, J. L. (1989). Relationship between task and ego orientation and the perceived purpose of sport among high school athletes. *Journal of Sport and Exercise Psychology, 11*(3), 318–335.

Duda, J. L. (1992). Motivation in sport settings: A goal perspective approach. In G. C. Roberts (Ed.), *Motivation in sport and exercise* (pp. 57–91). Champaign, IL: Human Kinetics.

Duda, J. L. (2001). Achievement goal research in sport: Pushing the boundaries and clarifying some misunderstandings. In G. C. Roberts (Ed.), *Advances in motivation in sport and exercise* (pp. 129–182). Champaign, IL: Human Kinetics.

Duda, J. L. (2005). Motivation in sport: The relevance of competence and achievement goals. In A. J. Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 318–335). New York: Guilford Press.

Duda, J. L., Chi, L., Newton, M. L., Walling, M. D., & Catley, D. (1995). Task and ego orientation and intrinsic motivation in sport. *International Journal of Sport Psychology, 26,* 40–63.

Duda, J. L., Fox, K. R., Biddle, S. J. H., & Armstrong, N. (1992). Children's achievement goals and beliefs about success in sport. *British Journal of Educational Psychology, 62*(3), 313–323.

Duda, J. L., & Hall, H. (2001). Achievement goal theory in sport: Recent extensions and future directions. In R. N. Singer, H. A. Hausenblas, & C. M. Janelle (Eds.), *Handbook of sport psychology* (2nd ed., pp. 417–443). New York: Wiley.

Duda, J. L., & Nicholls, J. G. (1992). Dimensions of achievement motivation in schoolwork and sport. *Journal of Educational Psychology, 84*(3), 290–299.

Duda, J. L., & White, S. A. (1992). Goal orientations and beliefs about the causes of sport success among elite skiers. *Sport Psychologist, 6*(4), 334–343.

Duda, J. L., & Whitehead, J. (1998). Measurement of goal perspectives in the physical domain. In J. L. Duda (Ed.), *Advances in sport and exercise psychology measurement* (pp. 21–48). Morgantown, WV: Fitness Information Technology.

Durand, M., Cury, F., Sarrazin, P., & Famose, J. P. (1996). Le Questionnaire du Succès en Sport: Validation Française du "Perception of Success Questionnaire." *International Journal of Sport Psychology, 27,* 251–268.

Dweck, C. S. (1986). Motivational processes affecting learning. *American Psychologist, 41,* 1040–1048.

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review, 95*(2), 256–273.

Eccles, J. S., & Harold, R. D. (1991). Gender differences in sport involvement: Applying the Eccles expectancy-value model. *Journal of Applied Sport Psychology, 3,* 7–35.

Elliot, A. J. (1994). *Approach and avoidance achievement goals: An intrinsic motivation analysis.* Unpublished doctoral dissertation, University of Wisconsin, Madison.

Elliot, A. J. (1997). Integrating the "classic" and "contemporary" approaches to achievement motivation: A hierarchical model of approach and avoidance achievement motivation. In M. Maehr & P. Pintrich (Eds.), *Advances in motivation and achievement* (Vol. 10, pp. 143–179). Greenwich, CT: JAI Press.

Elliot, A. J. (1999). Approach and avoidance motivation and achievement goals. *Educational Psychologist, 34,* 169–189.

Elliot, A. J. (2005). A conceptual history of the achievement goal construct. In A. J. Elliot & C. S. Dweck (Eds.), *A conceptual history of the achievement goal construct* (pp. 52–72). New York: Guilford Press.

Elliot, A. J., & Church, M. A. (1997). A hierarchical model of approach and avoidance achievement motivation. *Journal of Personality and Social Psychology, 72,* 218–232.

Elliot, A. J., & Church, M. A. (2003). A motivational analysis of defensive pessimism and self-handicapping. *Journal of Personality, 71,* 369–396.

Elliot, A. J., & Conroy, D. E. (2005). Beyond the dichotomous model of achievement goals in sport and exercise psychology. *Sport and Exercise Psychology Review, 1,* 17–25.

Elliot, A. J., & Covington, M. (2001). Approach and avoidance motivation. *Educational Psychology Review, 12,* 73–92.

Elliot, A. J., & Harackiewicz, J. M. (1996). Approach and avoidance achievement goals and intrinsic motivation: A mediational analysis. *Journal of Personality and Social Psychology, 70,* 968–980.

Elliot, A. J., & McGregor, H. A. (1999). Test anxiety and the hierarchical model of approach and avoidance achievement motivation. *Journal of Personality and Social Psychology, 76,* 628–644.

Elliot, A. J., & McGregor, H. A. (2001). A 2 × 2 achievement goal framework. *Journal of Personality and Social Psychology, 80,* 501–519.

Elliot, A. J., & Reis, H. T. (2003). Attachment and exploration in adulthood. *Journal of Personality and Social Psychology, 85,* 317–331.

Elliot, A. J., & Thrash, T. M. (2001). Achievement goals and the hierarchical model of achievement motivation. *Educational Psychology Review, 12,* 139–156.

Elliot, A. J., & Thrash, T. M. (2002). Approach-avoidance motivation in personality: Approach and avoidance temperaments and goals. *Journal of Personality and Social Psychology, 82,* 804–818.

Elliott, E. S., & Dweck, C. S. (1988). Goals: An approach to motivation and achievement. *Journal of Personality and Social Psychology, 54,* 5–12.

Epstein, J. (1988). Effective schools or effective students? Dealing with diversity. In R. Haskins & B. MacRae (Eds.), *Policies for America's public schools* (pp. 89–126). Norwood, NJ: Ablex.

Epstein, J. (1989). Family structures and student motivation: A developmental perspective. In C. Ames & R. Ames (Eds.), *Research on motivation in education* (Vol. 3, pp. 259–295). New York: Academic Press.

Ewing, M. (1981). *Achievement orientations and sport behaviors of males and females.* Unpublished doctoral dissertation, University of Illinois, Champaign.

Ford, M. (1992). *Motivating humans: Goals, emotions, and personal agency beliefs.* Boston: Sage.

Freudenberger, H. J. (1980). *Burnout: The high cost of high achievement.* Garden City, NY: Anchor Press.

Gernigon, C., d'Arripe-Longueville, F., Delignières, D., & Ninot, G. (2004). A dynamical systems perspective on goal involvement states in sport. *Journal of Sport and Exercise Psychology, 26,* 572–596.

Gill, D. L., & Deeter, T. E. (1988). Development of the Sport Orientation Questionnaire. *Research Quarterly for Exercise and Sport, 59,* 191–202.

Goudas, M., Biddle, S. J. H., & Fox, K. (1994). Perceived locus of causality, goal orientations, and perceived competence in school physical education classes. *British Journal of Educational Psychology, 64*(3), 453–463.

Goudas, M., Biddle, S. J. H., Fox, K., & Underwood, M. (1995). It ain't what you do, it's the way you do it! Teaching style affects children's motivation in track and field lessons. *Sport Psychologist, 9,* 254–264.

Gould, D. (1996). Personal motivation gone awry: Burnout in competitive athletes. *Quest, 48,* 275–289.

Gould, D., Tuffey, S., Udry, E., & Loehr, J. (1996). Burnout in competitive junior tennis players: Pt. II. Qualitative analysis. *Sport Psychologist, 10,* 341–366.

Gould, D., Udry, E., Tuffey, S., & Loehr, J. (1996). Burnout in competitive junior tennis players: Pt. I. A quantitative psychological assessment. *Sport Psychologist, 10,* 322–340.

Guivernau, M., & Duda, J. L. (1995). Psychometric properties of a Spanish version of the Task and Ego Orientation in Sport Questionnaire (TEOSQ) and beliefs about the causes of success inventory. *Revista de Psicologia del Deporte, 5,* 31–51.

Hagger, M. S., & Chatzisarantis, N. (in press). *Self-determination theory in sport and exercise.* Champaign, IL: Human Kinetics.

Hall, H. K., & Kerr, A. W. (1997). Motivational antecedents of precompetitive anxiety in youth sport. *Sport Psychologist, 11,* 24–42.

Hall, H. K., Kerr, A. W., & Matthews, J. (1998). Precompetitive anxiety in sport: The contribution of achievement goals and perfectionism. *Journal of Sport and Exercise Psychology, 20,* 194–217.

Hardy, L. (1997). The Coleman Roberts Griffith address: Three myths about applied consultancy work. *Journal of Applied Sport Psychology, 9,* 277–294.

Harwood, C., & Hardy, L. (2001). Persistence and effort in moving achievement goal research forward: A response to Treasure and colleagues. *Journal of Sport and Exercise Psychology, 23,* 330–345.

Harwood, C., Hardy, L., & Swain, A. (2000). Achievement goals in sport: A critique of conceptual and measurement issues. *Journal of Sport and Exercise Psychology, 22,* 235–255.

Harwood, C., & Swain, A. (1998). Antecedents of pre-competition achievement goals in elite junior tennis players. *Journal of Sport Sciences, 16,* 357–371.

Hom, H. L., Duda, J. L., & Miller, A. (1993). Correlates of goal orientations among young athletes. *Pediatric Exercise Science, 5*(2), 168–176.

Jackson, S., & Roberts, G. C. (1992). Positive performance states of athletes: Toward a conceptual understanding of peak performance. *Sport Psychologist, 6,* 156–171.

Kaplan, A., & Maehr, M. (2002). Adolescents' achievement goals: Situating motivation in socio-cultural contexts. In T. Urdan & F. Pajaers (Eds.), *Adolescence and education: Vol. 2. Academic motivation of adolescents* (pp. 125–167). Greenwich, CT: Information Age Publishing.

Kavussanu, M., & Ntoumanis, N. (2003). Participation in sport and moral functioning: Does ego orientation mediate their relationship? *Journal of Sport and Exercise Psychology, 25,* 1–18.

Kavussanu, M., & Roberts, G. C. (1996). Motivation in physical activity contexts: The relationship of perceived motivational climate to intrinsic motivation and self-efficacy. *Journal of Sport and Exercise Psychology, 18*(3), 264–280.

Kavussanu, M., & Roberts, G. C. (2001). Moral functioning in sport: An achievement goal perspective. *Journal of Sport and Exercise Psychology, 23,* 37–54.

Kavussanu, M., Roberts, G. C., & Ntoumanis, N. (2002). Contextual influences on moral functioning of college basketball players. *Sport Psychologist, 16,* 347–367.

Kuczka, K. K., & Treasure, D. C. (2005). Self-handicapping in competitive sport: Influence of the motivational climate, self-efficacy, and perceived importance. *Psychology of Sport and Exercise, 6,* 539–550.

Kuhl, J. (1986). Motivation and information processing: A new look at decision making, dynamic change, and action control. In R. M. Sorrentino & E. Higgins (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (pp. 403–434). New York: Guilford Press.

Lemyre, P.-N. (2005). *Determinants of burnout in elite athletes: A multidimensional perspective.* Oslo Norway: Norwegian University of Sport Science.

Lemyre, P.-N., Roberts, G. C., & Ommundsen, Y. (2002). Achievement goal orientations, perceived ability, and sportspersonship in youth soccer. *Journal of Applied Sport Psychology, 14,* 120–136.

Lemyre, P.-N., Roberts, G. C., Ommundsen, Y., & Miller, B. (2001). Sportspersonship in soccer. In A. Papaioanou, M. Goudas, & Y. Theodorakis (Eds.), *Proceedings of the 10th World Congress of Sport Psychology* (pp. 149–151). Thessaloniki, Greece: University of Thessaloniki Press.

Lemyre, P.-N., Roberts, G. C., Treasure, D. C., Stray-Gundersen, J., & Matt, K. (2004). Psychological and physiological determinants of overtraining and burnout in elite athletes. *Journal of Sport and Exercise Psychology, 26,* S118–S119.

Lemyre, P.-N., Treasure, D. C., & Roberts, G. C. (2006). Influence of variability in motivation and affect on elite athlete burnout susceptibility. *Journal of Sport and Exercise Psychology, 28*(1).

Lloyd, J., & Fox, K. (1992). Achievement goals and motivation to exercise in adolescent girls: A preliminary intervention study. *British Journal of Physical Education Research Supplement, 11,* 12–16.

Lochbaum, M. R., & Roberts, G. C. (1993). Goal orientations and perceptions of the sport experience. *Journal of Sport and Exercise Psychology, 15,* 160–171.

Maehr, M. L. (1987). Thoughts about motivation. In C. Ames & R. Ames (Eds.), *Research in motivation and education: Goals and cognitions* (Vol. 3, pp. 299–315). New York: Academic Press.

Maehr, M. L., & Braskamp, L. A. (1986). *The motivation factor: A theory of personal investment.* Lexington, MA: Lexington Books/D. C. Heath.

Maehr, M. L., & Nicholls, J. G. (1980). Culture and achievement motivation: A second look. In N. Warren (Ed.), *Studies in cross-cultural psychology* (Vol. 2, pp. 221–267). New York: Academic Press.

Marsh, H. (1994). Sport motivation orientations: Beware of jingle-jangle fallacies. *Journal of Sport and Exercise Psychology, 16,* 365–380.

Middleton, M. J., & Midgley, C. (1997). Avoiding the demonstration of lack of ability: An underexplored aspect of goal theory. *Journal of Educational Psychology, 89,* 710–718.

Midgley, C., Kaplan, A., & Middleton, M. J. (2001). Performance approach goals: Good for what, for whom, under what circumstances, and at what cost? *Journal of Educational Psychology, 93,* 77–86.

Miller, B. W., & Roberts, G. C. (2003). The effect of motivational climate on determinants of cheating among competitive Norwegian youth football players. In E. Müller, H. Schwameder, G. Zallinger, & V. Fastenbauer (Eds.), *Proceedings of the 8th Annual Congress of the European College of Sport Science* (pp. 311–312). Salzburg, Austria: University of Salzburg Press.

Miller, B. W., Roberts, G. C., & Ommundsen, Y. (2004). Effect of motivational climate on sportspersonship among young male and female football players. *Scandinavian Journal of Medicine and Science in Sports, 14,* 193–202.

Miller, B. W., Roberts, G. C., & Ommundsen, Y. (2005). The relationship of perceived motivational climate to moral functioning, moral atmosphere perceptions, and the legitimacy of intentionally injurious acts among competitive youth football players. *Psychology of Sport and Exercise, 6,* 461–477.

Newton, M., & Duda, J. L. (1992). The relationship of task and ego orientation to performance-cognitive content, affect, and attributions in bowling. *Journal of Sport Behavior, 16,* 209–220.

Nicholls, J. G. (1976). Effort is virtuous, but it's better to have ability: Evaluative responses to perceptions of effort and ability. *Journal of Research in Personality, 10,* 306–315.

Nicholls, J. G. (1978). The development of the concepts of effort and ability, perception of academic attainment, and the understanding that difficult tasks require more ability. *Child Development, 49,* 800–814.

Nicholls, J. G. (1980). The development of the concept of difficulty. *Merrill-Palmer Quarterly, 26,* 271–281.

Nicholls, J. G. (1984). Achievement motivation: Conceptions of ability, subjective experience, task choice, and performance. *Psychological Review, 91,* 328–346.

Nicholls, J. G. (1989). *The competitive ethos and democratic education.* Cambridge, MA: Harvard University Press.

Nicholls, J. G. (1992). The general and the specific in the development and expression of achievement motivation. In G. C. Roberts (Ed.), *Motivation in sport and exercise* (pp. 31–57). Champaign, IL: Human Kinetics.

Nicholls, J. G., & Miller, A. T. (1983). The differentiation of the concepts of difficulty and ability. *Child Development, 54,* 951–959.

Nicholls, J. G., & Miller, A. T. (1984a). Development and its discontents: The differentiation of the concept of ability. In J. G. Nicholls (Ed.), *Advances in motivation and achievement: Vol. 3. The development of achievement motivation* (pp. 185–218). Greenwich, CT: JAI Press.

Nicholls, J. G., & Miller, A. T. (1984b). Reasoning about the ability of self and others: A developmental study. *Child Development, 55,* 1990–1999.

Nicholls, J. G., Patashnik, M., & Nolen, S. B. (1985). Adolescent theories of education. *Journal of Educational Psychology, 77,* 683–692.

Ntoumanis, N., & Biddle, S. J. H. (1999). Affect and achievement goals in physical activity: A meta analysis. *Scandinavian Journal of Medicine and Science in Sports, 9,* 333–343.

Ommundsen, Y. (2004). Self-handicapping related to task and performance-approach and avoidance goals in physical education. *Journal of Applied Sport Psychology, 16,* 183–197.

Ommundsen, Y., & Pedersen, B. H. (1999). The role of achievement goal orientations and perceived ability upon somatic and cognitive indices of sport competition trait anxiety. *Scandinavian Journal of Medicine and Science in Sports, 9,* 333–343.

Ommundsen, Y., & Roberts, G. C. (1999). Concomitants of motivational climate in team sport. *Scandinavian Journal of Medicine and Science in Sports, 9,* 389–397.

Papaioannou, A., & Kouli, O. (1999). The effect of task structure, perceived motivational climate and goal orientations on students' task involvement and anxiety. *Journal of Applied Sport Psychology, 11,* 51–71.

Papaioannou, A., & McDonald, A. I. (1993). Goal perspectives and purposes of physical education as perceived by Greek adolescents. *Physical Education Review, 16,* 41–48.

Parish, L., & Treasure, D. C. (2003). Physical activity and situational motivation during free-choice activity in physical education: Influence of perceptions of the motivational climate and perceived ability. *Research Quarterly for Exercise and Sport, 74,* 173–182.

Pensgaard, A.-M., & Roberts, G. C. (2002). Elite athletes' experiences of the motivational climate: The coach matters. *Scandinavian Journal of Medicine and Science in Sport, 12,* 54–60.

Pensgaard, A.-M., & Roberts, G. C. (2003). Achievement goal orientations and the use of coping strategies among winter Olympians. *Psychology of Sport and Exercise, 4,* 101–116.

Pinder, C. C. (1984). *Work motivation.* Glenview, IL: Scott, Foresman.

Rascle, O., Coulomb, G., & Pfister, R. (1998). Aggression and goal orientations in handball: Influence of institutional sport context. *Perceptual and Motor Skills, 86*(3, Pt. 2), 1347–1360.

Rawsthorne, L. J., & Elliot, A. J. (1999). Achievement goals and intrinsic motivation: A meta-analytic review. *Personality and Social Psychology Review, 3,* 326–344.

Roberts, G. C. (1984). Achievement motivation in children's sport. In J. Nicholls (Ed.), *The development of achievement motivation* (pp. 251–281). Greenwich, CT: JAI Press.

Roberts, G. C. (1986). The perception of stress: A potential source and its development. In M. R. Weiss & D. Gould (Eds.), *Sport for children and youths* (pp. 119–126). Champaign, IL: Human Kinetics.

Roberts, G. C. (1992). Motivation in sport and exercise: Conceptual constraints and convergence. In G. C. Roberts (Ed.), *Mo-*

tivation in sport and exercise (pp. 3–29), Champaign, IL: Human Kinetics.

Roberts, G. C. (2001). Understanding the dynamics of motivation in physical activity: The influence of achievement goals on motivational processes. In G. C. Roberts (Ed.), *Advances in motivation in exercise and sport* (pp. 1–50). Champaign, IL: Human Kinetics.

Roberts, G. C., & Balague, G. (1989, August). *The development of a social cognitive scale of motivation.* Paper presented at the 7th World Congress of Sport Psychology, Singapore.

Roberts, G. C., Hall, H. K., Jackson, S. A., Kimiecik, J. C., & Tonymon, P. (1995). Implicit theories of achievement and the sport experience: Goal perspectives and achievement strategies. *Perceptual and Motor Skills, 33,* 219–224.

Roberts, G. C., & Ommundsen, Y. (1996). Effect of goal orientations on achievement beliefs, cognitions, and strategies in team sport. *Scandinavian Journal of Medicine and Science in Sport, 6,* 46–56.

Roberts, G. C., & Treasure, D. C. (1992). Children in sport. *Sport Science Review, 1,* 46–64.

Roberts, G. C., Treasure, D. C., & Balague, G. (1998). Achievement goals in sport: The development and validation of the Perception of Success Questionnaire. *Journal of Sport Sciences, 16,* 337–347.

Roberts, G. C., Treasure, D. C., & Kavussanu, M. (1996). Orthogonality of achievement goals and its relationship to beliefs about success and satisfaction in sport. *Sport Psychologist, 10,* 398–408.

Roberts, G. C., Treasure, D. C., & Kavussanu, M. (1997). Motivation in physical activity contexts: An achievement goal perspective. In P. Pintrich & M. Maehr (Eds.), *Advances in motivation and achievement* (Vol. 10, pp. 413–447). Stamford, CT: JAI Press.

Ryska, T. A. (2003). Sportsmanship in youth athletes: The role of competitiveness, motivational orientation, and perceived purposes of sport. *Journal of Psychology, 137,* 273–293.

Sarrazin, P., Roberts, G. C., Cury, F., Biddle, S. J. H., & Famose, J. P. (2002). Exerted effort and performance in climbing among boys: The influence of achievement goals, perceived ability, and task difficulty. *Research Quarterly for Exercise and Sport, 73,* 425–436.

Seifriz, J., Duda, J. L., & Chi, L. (1992). The relationship of perceived motivational climate to intrinsic motivation and beliefs about success in basketball. *Journal of Sport and Exercise Psychology, 14,* 375–391.

Skaalvik, E. M. (1997). Self-enhancing and self-defeating ego orientation: Relations with task and avoidance orientation, achievement, self-perceptions, and anxiety. *Journal of Educational Psychology, 89,* 71–81.

Skaalvik, E. M., & Valas, H. (1994). Task involvement and ego involvement: Relations with academic achievement, academic self-concept, and self-esteem. *Scandinavian Journal of Educational Research, 38,* 231–243.

Smith, J. M. J., & Harwood, C. G. (2001, September). *The transiency of goal involvement states in matchplay: An elite player case study.* Paper presented at the BASES conference, Newport, RI.

Smith, M., Duda, J. L., Allen, J., & Hall, H. (2002). Contemporary measures of approach and avoidance goal orientations: Similarities and differences. *British Journal of Educational Psychology, 72,* 155–190.

Solmon, M. A. (1996). Impact of motivational climate on students' behaviors and perceptions in a physical education setting. *Journal of Educational Psychology, 88,* 731–738.

Spink, K. S., & Roberts, G. C. (1980). Ambiguity of outcome and causal attributions. *Journal of Sport Psychology, 2,* 237–244.

Standage, M., Duda, J. L., & Ntoumanis, N. (2003). Predicting motivational regulations in physical education: The interplay between dispositional goal orientations, motivational climate, and perceived competence. *Journal of Sport Sciences, 21*(8), 631–647.

Standage, M., Treasure, D. C., Hooper, K., & Kuczka, K. (in press). Self-handicapping in school physical education: The influence of the motivational climate. *British Journal of Educational Psychology.*

Swain, A. B. J., & Harwood, C. G. (1996). Antecedents of state goals in age group swimmers: An interactionist perspective. *Journal of Sports Sciences, 14,* 111–124.

Tammen, V., Treasure, D., & Power, K. T. (1992). The relationship between competitive and mastery achievement goals and dimensions of intrinsic motivation. *Journal of Sport Sciences, 10,* 630.

Theeboom, M., De Knop, P., & Weiss, M. R. (1995). Motivational climate, psychological responses, and motor skill development in children's sport: A field-based intervention study. *Journal of Sport and Exercise Psychology, 17,* 294–311.

Thorkildsen, T. (1988). Theories of education among academically precocious adolescents. *Contemporary Educational Psychology, 13,* 323–330.

Thrash, T. M., & Elliot, A. J. (2002). Implicit and self-attributed achievement motives: Concordance and predictive validity. *Journal of Personality, 70,* 729–755.

Treasure, D. C., Duda, J. L., Hall, H., Roberts, G. C., Ames, C., & Maehr, M. (2001). Clarifying misconceptions and misrepresentations in achievement goal research: A response to Harwood, Hardy, and Swain (2000). *Journal of Sport and Exercise Psychology, 23,* 317–329.

Treasure, D. C., & Roberts, G. C. (1994a). Cognitive and affective concomitants of task and ego goal orientations during the middle school years. *Journal of Sport and Exercise Psychology, 16,* 15–28.

Treasure, D. C., & Roberts, G. C. (1994b). Perception of Success Questionnaire: Preliminary validation in an adolescent population [Special Issue]. *Perceptual and Motor Skills, 79*(1, Pt. 2), 607–610.

Treasure, D. C., & Roberts, G. C. (1995). Applications of achievement goal theory to physical education: Implications for enhancing motivation. *Quest, 47,* 475–489.

Treasure, D. C., & Roberts, G. C. (1998). Relationship between female adolescents' achievement goal orientations, perceptions of the motivational climate, belief about success and sources of satisfaction in basketball. *International Journal of Sport Psychology, 29,* 211–230.

Treasure, D. C., & Roberts, G. C. (2001). Students' perceptions of the motivational climate, achievement beliefs and satisfaction in physical education. *Research Quarterly for Exercise and Sport, 72,* 165–175.

Van Yperen, N. W., & Duda, J. L. (1999). Goal orientations, beliefs about success, and performance improvement among young elite Dutch soccer players. *Scandinavian Journal of Medicine and Science in Sports, 9,* 358–364.

Vealey, R. S., & Campbell, J. L. (1988). Achievement goals of adolescent figure skaters: Impact on self-confidence, anxiety, and performance. *Journal of Adolescent Research, 3,* 227–243.

Vlachopoulos, S., & Biddle, S. J. H. (1996). Achievement goal orientations and intrinsic motivation in a track and field event in school physical education. *European Physical Education Review, 2,* 158–164.

Vlachopoulos, S., & Biddle, S. J. H. (1997). Modeling the relation of goal orientations to achievement-related affect in physical education: Does perceived ability matter? *Journal of Sport and Exercise Psychology, 19,* 169–187.

Walling, M. D., & Duda, J. L. (1995). Goals and their associations with beliefs about success in and perceptions of the purposes of physical education. *Journal of Teaching in Physical Education, 14*(2), 140–156.

Walling, M. D., Duda, J. L., & Chi, L. (1993). The Perceived Motivational Climate in Sport Questionnaire: Construct and predictive validity. *Journal of Sport and Exercise Psychology, 15,* 172–183.

Weiner, B. (1972). *Theories of motivation: From mechanism to cognition.* Chicago: Markham.

Weiss, M., & Ferrer-Caja, E. (2002). Motivational orientations and sport behavior. In T. Horne (Ed.), *Advances in sport psychology* (pp. 101–184). Champaign, IL: Human Kinetics.

White, S. A., & Duda, J. L. (1993). Dimensions of goals and beliefs among adolescent athletes with physical disabilities. *Adapted Physical Activity Quarterly, 10*(2), 125–136.

White, S. A., Duda, J. L., & Keller, M. R. (1998). The relationship between goal orientation and perceived purposes of sport among youth sport participants. *Journal of Sport Behavior, 21,* 474–483.

White, S. A., & Zellner, S. R. (1996). The relationship between goal orientation, beliefs about the causes of sport success, and trait anxiety among high school, intercollegiate, and recreational sport participants. *Sport Psychologist, 10,* 58–72.

Wigfield, A., & Eccles, J. S. (1992). The development of achievement task values: A theoretical analysis. *Developmental Review, 12,* 265–310.

Williams, L. (1998). Contextual influences and goal perspectives among female youth sport participants. *Research Quarterly for Exercise and Sport, 69,* 47–57.

CHAPTER 2

Emotions in Sport

Current Issues and Perspectives

YURI L. HANIN

Selected issues and perspectives on pleasant and unpleasant emotions experienced by athletes and how and why these emotions affect athletic performance are reviewed in this chapter. A balanced view of emotion-performance relationships requires an overview of a sequence involving three groups of individual difference variables: defining characteristics of emotional experiences, antecedents of emotional experiences, and consequences of emotions for athletic performance. Kuhl (1994) used such a sequential framework for description of a theory of action and state orientations, whereas Vallerand and Blanchard (2000) proposed an "antecedents-consequences" sequence for an integrative analysis and review of emotion theory and research in sport and exercise.

The chapter is based on an individual-oriented and sport-specific framework grounded in extensive research, the individual zones of optimal functioning (IZOF) model (Hanin, 1995, 1997, 2000). A detailed description of the IZOF model is beyond the scope of this chapter; readers are referred to reviews updating the recent developments of the model (Cerin, Szabo, Hunt, & Williams, 2000; Crocker, Kowalski, Graham, & Kowalski, 2002; Hanin, 2000, 2003, 2004; Raglin & Hanin, 2000; Robazza, 2006; Ruiz, 2004: Woodman & Hardy, 2001). The main emphasis here is on defining characteristics of emotional experiences, their antecedents (determinants), and consequences (outcomes, impact). Finally, directions for future research as well as practical implications are suggested.

I would like to express my sincere thanks and deep appreciation for the thoughtful comments and suggestions from Bob Vallerand, Knut A. Hagtvet, and Claudio Robazza, who read an earlier draft of this chapter.

TERMINOLOGY

Terminology issues in emotion research involve attempts to find a more precise definition of emotion (and related affective phenomena) and to provide a detailed description of defining characteristics of emotional experiences. Both aspects are briefly reviewed in the sections that follow.

Defining Emotion

The definition of *emotion* remains ambiguous (Vallerand & Blanchard, 2000). It has even become a common practice to state that it is intuitively clear what emotion is, but difficult or even impossible to define. According to Parkinson (1994), there are several ways of approaching the definition of emotion: (a) by giving examples of items belonging to the category of emotion; (b) by looking at the different aspects and components of emotional experience (Crocker et al., 2002; Vallerand & Blanchard, 2000); and (c) by considering how various aspects combine with one another and how they interact to make an emotion episode what it is, and (d) by relating and contrasting it with other psychological functions. It is also possible to examine the dozens of already suggested definitions of emotion and select the one that best encompasses all or most of the research. However, the problem with such an ideal definition of emotion is that it requires a statement of the necessary and sufficient conditions for application of the term, and that is usually not an easy task (Plutchik, 1980). Therefore,

> an attempt to define emotion is obviously misplaced and doomed to failure. . . . To ask today what is emotion is old-fashioned and likely to lead to semantic hairsplitting; to construct systems that unequivocally explain, predict, and make understandable parts of the range of human experience and

> behavior may, in the long run, be the best or only reply. (Mandler, 1975, pp. 10–11)

Interestingly, in current practice, researchers recognize the fact that there is no perfect term and simply sidestep the search for *the* definition, instead discussing dimensions, categories, and components of emotion (Vallerand & Blanchard, 2000). Additionally, terms describing different affective phenomena (emotion, mood, affect, temperament) are often contrasted (Crocker et al., 2002), although this does not seem to be an effective strategy. Whatever the general definition of emotion proposed, it is important to distinguish among its *defining characteristics, antecedents,* and *consequences* (outcomes). Also important is that "we might start not with the aim of *explaining* emotions but rather with describing a system that has as its product some of the observations that have been called 'emotion' in common language" (Mandler, 1975, p. 4).

This is especially true in sport, as is evident in Martens's (1987, p. 51) comment:

> Sport psychology is theory poor. . . . We have been so eager to test theories of the larger field of psychology in order to confirm our scientific respectability that we have not adequately observed, described, and theorized about our own thing—SPORT. We clearly need to spend more time observing behavior in sport and building our own theories unique to sport.

Unfortunately, this concern remains current in sport psychology research, and a need for an accurate and detailed description of emotional experiences is often underestimated or simply ignored. This results in a premature theoretical speculation in the absence of an adequate database (Hanin, 1997; Raglin & Hanin, 2000). To summarize, one option is to continue a search for a more precise definition of emotion; the other option is to focus on an accurate and detailed description of defining characteristics of emotion and relating it to some specific category.

Emotion as a Category of Experience

Traditionally, emotion as a category is defined as an organized psychophysiological *reaction* to ongoing person-environment (P-E) relationships. For instance, Deci's (1980, p. 85) working definition conveys at least the meaning of emotion:

> An emotion is a reaction to a stimulus event (either actual or imagined). It involves change in the viscera and musculature of the person, is experienced subjectively in characteristic ways, is expressed through such means as facial changes and action tendencies, and may mediate and energize subsequent behaviors.

Another working characterization views emotions as valenced reactions to events, agents, or objects, with their particular nature being determined by the way the eliciting situation is construed (Ortony, Clore, & Collins, 1988). In this approach, there are three broad classes of emotions that result from focusing on one of three salient aspects of the world: events and their consequences, agents and their actions, or objects, pure and simple (p. 13). Finally, a widely accepted proposal of an emotion as a set of stages or a process (Izard, 1977, 1993) was made by Frijda (1986). It includes the following sequence: Appraisal → Context evaluation → Action readiness → Physiological change, expression, action (see Oatley & Jenkins, 1992, for review).

In most cases, the definition of emotion as a reaction captures only one aspect of the P-E interaction. The person's response is related to, but still separate from, the environment. Moreover, a descriptive definition of emotion is somewhat limited because it does not include the causal cognitive, motivational, and rational variables and processes involved in arousing and sustaining an emotion (Lazarus, 2000, p. 230). The cognitive-relational motivational theory of emotion elaborates the notion of P-E interaction as applied to stress-related emotions and later to pleasant and unpleasant emotions.

To study something as an *indivisible unity,* according to Vygotsky (1926/1984), it is necessary to find a construct that appropriately captures the characteristics of both interacting elements. In psychology, *experience* is a relevant construct to study P-E interactions because it reflects a person's attitude toward different aspects of the environment and the meaning of the environment for the person. Experience has a biosocial orientation as every experience is always someone's experience of something and, as such, is best represented as a unit of consciousness. Thus, the analysis of any difficult situation should focus not so much on the situation or on the person per se but on *how this situation is experienced by this person.*

Emotional experience as an indivisible component of total human functioning reflects the nature of past, ongoing, or anticipated P-E interactions. Vygotsky (1926/1984) identified at least three types of P-E interactions: the predominance of an organism over the environment, the P-E balance, and the predominance of the environment over an organism. These notions were applied to performance emotions in sport (Hanin, 1989, 1997), and it was proposed that P-E interactions are best represented by the relationships between task demands and a person's resources (Hanin, 2003, 2004). From this perspective, emotion research in sport should describe, predict, and explain an athlete's optimal and dysfunctional *experiences* accompanying individually successful and poor performances. A working definition of experience includes the totality of past and present characteristics that determines the particular quality of a person's performance (Hanin, 2003).

In the sport context, there are three interrelated types of performance-related experiences: *state-like experiences,* or emotional states, as a component of situational, multimodal, and dynamic manifestations of total human functioning; *traitlike experiences,* or relatively stable emotion patterns (emotionality, dispositions, qualities) reflecting a repeated nature of athletic activity; and *meta-experiences* (awareness, attitudes, preferences/rejections of one's experiences; Mayer & Stevens, 1994), which are lessons learned or reflected experiences in successful and less than successful performances (Hanin, 2004).

In contrast to situational states and repeated patterns of experience, meta-experiences reflect how an athlete feels about his or her past, present, or anticipated emotional experiences and the perceived effects of these emotional experiences on performance or general well-being. For instance, an athlete may feel nervous and uncertain prior to a competition. That characterizes his or her situational emotional state as triggered by a specific meaning of the particular situation for this athlete. On the other hand, feeling nervous can be a typical (repeated) pattern of this athlete's emotional response in similar situations. Therefore, in this particular case, trait competitive anxiety would indicate how often the athlete experiences elevated anxiety and feels nervous, tense, or apprehensive prior to or during competition. However, an athlete's meta-experience (attitude to experiencing a high level of competition anxiety and awareness of its helpful or harmful effects on performance) is even more important to estimate. Meta-experiences are formed when athletes (and coaches) spontaneously and deliberately reflect on the conditions leading to their successful, and less than successful, performances. Meta-experiences determine an athlete's perception and a choice of coping and self-regulation strategies, and therefore should be a major target of interventions.

Interestingly, most research in sport psychology during the past 2 decades has focused mainly on situational emotional states (such as competition anxiety) and relatively stable emotion patterns (e.g., trait anxiety). Meta-experiences in sport, although undefined as a separate parameter (Hanin, 2003), were actually implied in the assessment of optimal and dysfunctional zones of emotion intensity (Hanin, 1978, 1986; Hanin & Syrjä, 1995) and in the ratings of "directional" anxiety (or perceived impact) on performance (Jones, 1995). On the other hand, in practice, emotion regulation is often based on reframing an athlete's attitude toward specific emotional experiences. For instance, it is difficult to imagine how an athlete can constructively use high anxiety without a positive attitude and expectation of its helpful effects. In other words, meta-experience adds a special meaning and a new quality to perceived situational state, which is interpreted (or reinterpreted) as facilitating or debilitating. Therefore, the role of meta-experiences as determinants of appraisal and coping processes should be reemphasized, especially in intervention studies. Based on Vygotsky's suggestion, emotion is construed not as a reaction, but as experience (situational and repeated) and meta-experience reflecting the dynamics of P-E interactions.

DEFINING CHARACTERISTICS OF EMOTION EXPERIENCE

A comprehensive analysis and understanding of emotion experiences in sport requires an accurate description of their basic dimensions or defining characteristics. What are these basic (i.e., sufficient and necessary) dimensions? Apparently, emotion experiences are complex phenomena requiring multidimensional characterization.

For decades in emotion research, typical dimensions were *valence* (i.e., hedonic tone) and *intensity.* Both were used in conceptualizing global emotion content (pleasure/displeasure and high and low activation). On the other hand, historically, emotion *components* have been characterized by three parameters derived from measurement methods rather than from the conceptualization of emotion dimensions. These include physiological concomitants, introspective (verbal) self-reports, and behavioral observation (Eysenck, 1975). From this perspective, typical dimensions are emotion intensity, emotion valence, and emotion manifestation as assessed by cognitive labels, bodily response, and behavioral displays (expression or suppression). A need to go beyond these widely accepted dimensions to capture a more complete picture of emotional experiences is clearly indicated (Hanin, 1995, 1997, 2000, 2003). In the sections that follow, a brief description of the five basic dimensions characterizing emotion experiences is provided.

Multidimensionality of Emotion Experiences

An alternative multidimensional approach was proposed in the IZOF model (see Hanin, 1997, 2000, for a review). It was derived from the *method of bases* developed for the systems description of complex phenomena (Ganzen, 1984). In the systems description, a multitude of elements of the object under investigation is contrasted with the elements of the basis (the logical foundation). Ganzen, having analyzed the descriptions of different objects and phenomena, proposed that "spatiality, time, information and energy were the basic characteristics of any object that typically functions as their integrator" (p. 44). These separate concepts (space, time, energy, information, and a substrate) were suggested as a conceptual basis (pentabasis, or a five-element foundation) to integrate existing concepts and empirical research findings. This descriptive framework makes it possible to (a) examine the completeness of description of the phenomenon, (b) better organize the components, (c) compare different descriptions, and (d) discover the similarity in the objects or phenomena of different natures (pp. 41–42).

This approach has been theoretically substantiated and empirically validated in the systems descriptions of psychological subdisciplines, general characteristics of the nervous system, and the description of human personality and individuality (Ganzen, 1984). In the sports setting, the pentabasis and the idea of systems description were used in the longitudinal study of communication patterns in top sport teams (Hanin, 1980, 1992), in sports career and athlete crisis research (Stambulova, 2000), and in investigations of performance-related emotions (Hanin, 1993, 1995, 1997, 2000).

In its current form, the IZOF model posits five basic dimensions that capture defining characteristics of emotion experience as a component of different psychobiosocial states related to performance (Hanin, 2000, 2003). I argue that emotional experience is always manifested in some *form* (subjectively perceived or observable); it has specific *content* (or quality); it is characterized quantitatively by its *intensity* and as a process that unfolds over *time* (Folkman & Lazarus, 1985) in a particular *context.* Thus, the multilevel and system description of emotion as a component of performance-related states should include at least five interrelated dimensions: form, content, intensity, time, and context. Three of these dimensions (form, content, and intensity) describe the structure and function of the subjective emotional experiences and meta-experiences; time and context characterize dynamics of performers' subjective experiences in a specific social setting. Actually, these five basic dimensions include traditional emotion components (implied form, valence, and intensity) and provide a tool for a systems description of emotional experiences (for more detail, see Hanin, 1997, 2000, 2003, 2004; Robazza, 2006). The following sections focus mainly on emotion form, content, and intensity.

Situational Emotion and Nonemotion Experiences

An athlete's performance state manifests itself in the form dimension, which consists of seven basic components or modalities: cognitive, emotional (affective), motivational, bodily, behavioral, operational (action tendencies), and communicative (see Hanin, 1997, 2000, for a review). From this perspective, situational emotional experience (e.g., anxiety or anger) is a component of the *psychobiosocial state* related to nonemotion components.

Current individual-oriented research focuses on emotional, motivational, and bodily components of performance state and their interactive effects. Recent empirical evidence indicates that to describe performance-related experiences, athletes use their own vocabulary of idiosyncratic labels. However, an athlete's vocabulary describing performance-related states usually includes not only self-generated emotion words but also labels describing nonemotion experiences: cognitive, motivational, bodily, motor-behavioral, operational, and communicative (Hanin, 1997; Hanin & Stambulova, 2002; Ruiz & Hanin, 2004a, 2004b). For instance, Hanin and Stambulova examined emotional experiences prior to, during, and after personally best and worst competitions in 85 skilled Russian athletes using a metaphor-generation method. Each athlete had to complete a sentence, "Prior to my best competition I felt like . . . ," that generated a metaphor (e.g., "I felt like a *tiger*") as a symbolic representation of a feeling state. Completing a paraphrased sentence, "In other words, I felt myself . . . ," elicited an interpretation (e.g., "I felt strong and focused") of an athlete's state as symbolized in the metaphor. Then athletes generated metaphors and interpretative descriptors for competition situations during and after performance. The same procedure was repeated to describe how they felt prior to, during, and after worst-ever competitions. These six situations elicited 510 idiosyncratic and functionally meaningful metaphors and 922 interpretative descriptors. As predicted, metaphors and descriptors reflected high action readiness in best-ever competition and low action readiness in worst-ever competition. Athletes also used different metaphors to describe, symbolically, their experiences prior to, during, and after performance as the meaning of these situations changed. Interestingly, the accompanying idiosyncratic labels described not only emotional experiences but also the multiple connotations of nonemotion components of the psychobiosocial states. Similar findings based on self-generated metaphors and accompanying interpretative descriptors were obtained in studying a sample of top Spanish karate athletes (Ruiz & Hanin, 2004b).

Because emotion, as a concept, remains largely undefined, it is not surprising that distinctions between emotions and nonemotions are sometimes not quite clear, especially in assessments. For instance, an inspection of the 10 global affect scales described by Watson and Tellegen (1985) shows that some of the items are "conceptually faulty and would not be considered emotions by appraisal-centered theorists" (Lazarus, 2000, p. 239). In other words, emotion descriptors in existing emotion scales often represent not only "pure" emotions, but also nonemotion components of a state (cognitive, motivational, bodily, and behavioral). Apparently, research-wise, it is important to clearly distinguish among emotion, nonemotion, and borderline modalities of a state (Lazarus, 2000). From the applied perspective, however, a more holistic description of the performance-related state, including emotions and nonemotion experiences, could be equally important and sometimes perhaps even more appropriate.

Recently, Robazza, Bortoli, and Hanin (2004) showed that athletes are well aware of several nonemotion modalities of their performance state (motivational, bodily, sensory-motor, and behavioral). In another study (Hanin, 1999), seven positively toned items (*motivated, willing, desirous, hopeful, keen, daring,* and *interested*) and seven negatively toned descriptors (*unmotivated, unwilling, reluctant, hopeless, bored, compelled,* and *uninterested*) discriminated quite well the motivational states of 29 highly skilled ice hockey players before their successful and less than successful games (see Figure 2.1).

In contrast, motivational domains in this sample had multiple and diverse connotations. Table 2.1 provides a summary of responses of these players to a question about what motivates (and what does not motivate) them before the game.

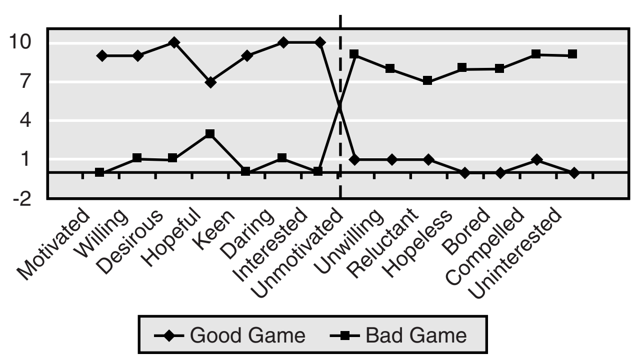


Figure 2.1 Individualized motivational profile of ice hockey players ($N = 29$). Adapted from "Sports-Specific Emotion-Motivational Profiling: An Individualized Assessment Program" (pp. 238–240), by Y. Hanin, in *Psychology of Sport: Enhancing the Quality of Life,* V. Hosek, P. Tilinger, and L. Bilek (Eds.), 1999, proceedings of the 10th European Congress of Sport Psychology: Part 1, Prague, Czech Republic: Charles University Press. Adapted with permission.

Table 2.1 Enhancing and Detrimental Motivational Domains for Ice Hockey Players

Enhancing Motivational Domains
"I'm motivated if . . . "

Focus on:	*Feeling state:*	*Our game:*
• Winning • Fighting • Doing my best • Learning	• Self-confident • Trust myself • Enjoying the game • Psyched up	• Important • Challenging • Tough • Well started
Ice hockey:	*Opponent:*	*Own team:*
• My serious hobby • My future profession • My life	• Tough • Good • Strong	• I play for my team • I work for team's success • Good climate in the team

Detrimental Motivational Domains
"I'm not motivated if . . . "

Preparation:	*Feeling state:*	*Our game:*
• Insufficient recovery • Poor shape • Poor planning	• Too tired • Health problems • Dissatisfied • Too satisfied	• Too easy • "Meaningless" • Nothing works • Clearly lost • Bad start
Outside sport:	*Opponent:*	*Own team:*
• Family • School • Other concerns	• Too easy • Clearly weaker	• Repeated losses • Poor team climate

Note: $N = 29$ Finnish ice hockey players.

Adapted from *Emotions in Hockey,* by Y. L. Hanin, May 2000, paper presented at the IIHF International Coaching Symposium: Building a Hockey Base for the 21st Century, St. Petersburg, Russia. Adapted with permission.

Numerous athlete-generated bodily descriptors are examples of another component in the form dimension. These idiosyncratic bodily labels included different experiences located in face, legs/feet, arms/hands, neck/shoulders, and stomach (see Table 2.2). Also mentioned were characteristics of movements, heart rate, and feeling thirsty, hungry, cold, and pain (Robazza, Bortoli, et al., 2004). Interestingly, these symptoms are more diverse compared to researcher-generated items, for instance, in the Competitive State Anxiety Inventory (CSAI-2). Future research might identify idiosyncratic bodily descriptors of different emotional experiences related to successful and poor performances across different sports and groups of athletes.

Although "reading the players" is an important social psychological skill for a coach, especially in team sports, behavioral indicators of specific emotional experiences have not yet become a focus of systematic studies in sport psychology. Several attempts to examine this modality suggest that coaches and athletes are well aware of the behavioral symptoms of certain emotions. For instance, in an unpublished

Table 2.2 Idiosyncratic Bodily Experiences

Face	*Legs/feet*	*Arms/hands*	*Neck/shoulders*	*Stomach*
• Tense/relaxed • Nervous tics • Yawns • Dry mouth	• Tense • Loose • Cold	• Tense/relaxed • Sweaty/cold	• Tense	• Tense
Movements	*Heart rate*	*Feeling*	*Pain*	
• Energetic • Vigorous • Sharp • Smooth • Slow • Stiff	• Perceived • Irregular • Accelerated	• Fresh • Thirsty • Hungry/no appetite • Exhausted/tired • Cold/warm • Sweating • Urinary pressure • Lightness	• Physical pain • Headache • Back pain • Stomachache • Lack of pain	

Adapted from *Emotions in Hockey* by Y. L. Hanin, May 2000, paper presented at the IIHF International Coaching Symposium: Building a Hockey Base for the 21st Century, St. Petersburg, Russia; and "Pre-Competition Emotions, Bodily Symptoms, and Task-Specific Qualities as Predictors of Performance in High-Level Karate Athletes," by L. C. Robazza, Y. Bortoli, and Hanin, 2004, *Journal of Applied Sport Psychology, 16*(2), pp. 151–165. Adapted with permission.

exploratory study, Hanin (2005) asked 16 ice hockey coaches to describe behavioral markers of a player who feels self-confident. According to these coaches, such a player

> *looks purposeful, relaxed, calm, certain, focused, determined, happy and willing to go on ice. His body language is active. He stands up tall; his nose is not facing the ground; his voice is very sure; he radiates energy; he smiles and talks but stays focused; he looks forward to the situation; he enjoys playing (expressive movements); he makes eye contact with the coach and does not rush.* In contrast, a player with low self-confidence prior to the game, is *silent; thinks a lot; wants to be alone; sometimes talks too much to forget the game; tries to relax by laughing; worries a lot; asks when to go on the ice.* [italics added for emphasis]

These coaches were also able to describe, in much detail, observable behaviors of the players who feel high or low anxiety, complacency (satisfaction), and anger. There is clearly a need for development of behaviorally anchored scales enabling controlled observation of athletes' displays (expression or suppression) of emotional experiences prior to, during, and after successful and poor performances. In team sports, the major focus and concern of the coach are the emotional states of the goal keeper and the key players (leaders and subleaders), who affect the emotional dynamics of the entire team.

Emotion Content

Emotion content as a qualitative characteristic includes such general categories of emotional experiences as positive-negative (Russell, Weiss, & Mendelsohn, 1989; Watson & Tellegen, 1985), functionally optimal-dysfunctional (Hanin, 1978, 1993), and facilitating-debilitating (Alpert & Haber, 1960; Jones, 1991, 1995). Therefore, content is one of the basic dimensions in the systematic study of emotional experiences. It is difficult to imagine an emotion without a distinctive content and intensity (Lazarus, 2000). Both quality and intensity determine the functional impact of emotions on performance and well-being.

Two traditional approaches to categorizing emotion content are the *dimensional* (global affect) approach and the *discrete* (basic) emotion approach. The global approach emphasizes pleasantness-unpleasantness (valence or hedonic tone), tension-relaxation, and quiescence-activation (Russell, 1980; Watson & Tellegen, 1985). The discrete emotion approach centers on discrete categories of emotion based on their qualitative content (anxiety, anger, joy, etc.) and claims that there are clusters of "universal" and discrete emotion syndromes (Lazarus, 2000).

Although several emotion researchers embrace the notion of emotion types, they are still inclined to reject the idea that there is a set of "basic" emotions such that they, together with their combinations, account for all emotions (see, e.g., Ortony, Clore, & Collins, 1988, p. 25). Another objection is that any list of basic (discrete) emotions, ranging from 3 (Spinoza) to 6 (Ekman), 10 (Izard), and 15 (Lazarus), remains arguable. Hanin (1999) compared basic emotion labels proposed by 23 investigators representing eight different approaches to emotion research. It was found that, all in all, there were 47 labels of basic emotions (with 32 negatively toned and 15 positively toned emotion descriptors). The most selected emotion labels were *fear* (19 researchers), *anger* (18), *sadness* (9), *and disgust* (7); 23 labels were proposed only once, and 10 labels were selected twice (see Table 2.3).

Although any list of discrete emotions is arguable, at least two important aspects were clearly identified by Lazarus (2000). First, the list should include both negatively toned emotions (e.g., anger, anxiety, fright, sadness, guilt, shame, envy, jealousy, disgust) and positively toned emotions (relief, hope, happiness/joy, pride, love, gratitude, compassion). Second, regardless of the exact list, "a primary empirical and theoretical concern is to identify the *most important emotions,* their distinctive characteristics, antecedent causal variables and consequences, and *how they might influence competitive performance* in sports" (Lazarus, 2000, p. 232, italics added).

In competitive and high-achievement sports, the most important emotions are usually personally relevant, task-specific, and functionally helpful or harmful emotions really experienced by athletes. This assumption has received strong empirical support (Hanin, 1997, 2000, 2004; Robazza, 2006) and is based on the notion that "under similar environmental conditions, people perceive themselves differently, think differently, cope differently, and experience and display emotions differently" (Lazarus, 1998, p. 213). Thus, the functional importance of emotional experiences is associated with their goal relevance and with the extent that each athlete is able to perform up to his or her potential using effectively available resources.

In contrast, the usual laboratory study of emotion assumes that if the stimulus conditions are equal for all subjects, then the average of all subjects' responses best represents the group for the variable measured. Implicit in this assumption is the idea of equivalent life and performance histories, which obviously cannot be met in studies with humans. Lacey (1967) has demonstrated that different subjects tend to respond by activating different major physiological response systems, and that within any large group of subjects, several types of responders always exist. Obviously, this is true not only for bodily responses, but also for emotional experiences described by athletes' self-generated idiosyncratic labels (see Hanin, 2000, for a review).

Table 2.3 Basic Emotions: Frequencies of Label Selection

Fear (19)	Anxiety (2)	Pain (1)
Anger (18)	Curiosity (2)	Panic (1)
Sadness (9)	*Elation* (2)	Pity (1)
Disgust (7)	*Enjoyment* (2)	*Pride* (1)
Joy (6)	*Expectancy* (2)	Resignation (1)
Happiness (5)	Loneliness (2)	Sleepiness (1)
Interest (5)	Rage (2)	Sensuous comfort (1)
Surprise (5)	Contempt (2)	Sex-lust (1)
Love (4)	Appetite (1)	Shock (1)
Pleasure (3)	Grief (1)	Subjection (1)
Satisfaction (3)	*Acceptance* (1)	Succor (1)
Shyness (3)	*Amazement* (1)	Tenderness (1)
Distress (3)	Anticipation (1)	Tension (1)
Shame (3)	Boredom (1)	Want (1)
Guilt (2)	Despair (1)	Wonder (1)
Sorrow (2)	*Quiet* (1)	

Note: $N = 23$ researchers. Positively toned emotions are in italics.

Adapted from *Emotions in Hockey* by Y. L. Hanin, May 2000, paper presented at the IIHF International Coaching Symposium: Building a Hockey Base for the 21st Century, St. Petersburg, Russia. Adapted with permission.

Idiosyncratic Emotion Content

To identify person-relevant and functionally important emotional experiences, the IZOF model proposes that athletes use their own vocabulary of self-generated idiosyncratic labels. These self-generated emotion labels describe athletes' subjective pleasant and unpleasant experiences prior to (or during) their successful and poor performances. The implication is that success-related experiences are helpful for (or at least do not disturb) an athlete's performance, whereas failure-related experiences are detrimental (harmful) for individual performance. Although the main emphasis of the IZOF model is on emotion effects on athletic performance, the functionality-dysfunctionality of emotions is not limited to perceived (anticipated) helpful/harmful effects on performance. For instance, the functionality of emotions can be based on anticipated emotion effects on postperformance recovery (Hanin, 2002), performance-induced injuries (Devonport, Lane, & Hanin, 2005; Würth & Hanin, 2005), or an athlete's general well-being (Diener, 2000). Moreover, empirical findings suggest that the functionality of emotions relevant with respect to one criterion, for instance, performance, is not necessarily relevant for other outcomes, such as leisure quality, postinjury recovery, or general well-being in healing or educational settings. In other words, in each particular setting, functionality-dysfunctionality should be clearly specified as a set of intrapersonal, interpersonal, health, or well-being consequences (see Oatley & Jenkins, 1992, for a general discussion of emotion function and dysfunction).

In the IZOF approach developed for the high-achievement setting, emotion content is conceptualized within the framework of two interrelated factors: *hedonic tone,* or valence (pleasure-displeasure), and *performance functionality* (optimal-dysfunctional effects on performance processes and outcomes). Both factors reflect qualitatively different aspects of emotional experiences related to individually successful and poor performances (Hanin, 1997). Selected idiosyncratic emotion labels are classified into one of the four global emotion categories derived from hedonic tone and performance functionality: pleasant and functionally optimal emotions (P+), unpleasant and functionally optimal emotions (N+), pleasant and dysfunctional emotions (P–), and unpleasant and dysfunctional (N–) emotions. Optimal (P+ and N+) emotional experiences accompany successful performances, whereas dysfunctional (N– and P–) emotional experiences are usually related to poor performance.

These four emotion categories provide an initial structure that is sufficiently broad and robust to generate a pool of idiosyncratic, individually relevant, and task-specific emotions experienced by athletes prior to, during, and after their successful and less than successful performances. It is important that athlete-generated labels describe idiosyncratic and experientially grounded emotions. Moreover, the individualized framework provides an opportunity for athletes to reflect on and report their most significant pleasant and unpleasant emotional experiences related to their individually successful and poor performances. Self-generation of idiosyncratic personally relevant labels, assisted by an emotion stimulus list (Hanin, 1997, 2000, 2003; Robazza & Bortoli, 2003), is a feature that makes the IZOF approach different from both global affect and discrete emotion approaches.

In the individualized approach, the pleasure-displeasure distinction is similar to a global dimensional approach, which, however, does not have the functionality-dysfunctionality distinction. Additionally, the four-category global framework does not limit, in any way, selection of the most appropriate idiosyncratic emotion descriptors. Therefore, athletes reconstruct their performance-related experiences by generating their own idiosyncratic labels. They are not forced to squeeze their unique subjective experiences into researcher-generated descriptors of preselected discrete emotions (anxiety, anger, joy, etc.). Moreover, self-generated labels reflecting an athlete's perspective, when aggregated across athletes and sport events, identify prototype (most often selected) emotional experiences that can be recategorized using a selected discrete emotion framework (Hanin, 2000, 2004; Hanin & Syrjä, 1995; Robazza, 2006; Ruiz & Hanin, 2004a).

It is reasonable to ask about the extent to which the content of athlete-generated emotion labels are similar to (or different from) researcher-generated emotion labels used in existing standardized scales. Conversely, how are self-generated idiosyncratic emotion labels related to the existing lists of discrete emotions? To answer these questions, emotion experiences of individual athletes should be contrasted with standardized group-oriented emotion scales that are currently used to describe how athletes feel before, during, or after performance. The most popular scales developed in nonsport settings are Spielberger, Gorsuch, and Lushene's (1970) State-Trait Anxiety Inventory (STAI), McNair, Lorr, and Droppleman's (1971) Profile of Mood State (POMS), and Watson and Tellegen's (1985) Positive and Negative Affect Schedule (PANAS). Sport-specific scales include Martens, Vealey, and Burton's (1990) CSAI-2 and Smith, Smoll, and Schutz's (1990) Sport Anxiety Scale (SAS).

One problem with most group-oriented scales is that they use a pool of researcher-generated items with "fixed" emotion content (global or discrete). These similar emotion items usually imply the same psychological meaning of emotion descriptors for all athletes. However, in most cases, it is not known to what extent emotion content assessed with the group-oriented scales reflects emotion content really experienced by individual players in their successful and poor performances. Two studies involving 50 skilled soccer players and 46 ice hockey players compared the content of emotion items in STAI, POMS, PANAS, and CSAI-2 scales and individual emotional experiences assessed by athlete-generated labels (Syrjä & Hanin, 1997, 1998). The findings revealed that 80% to 85% of self-generated emotion labels were not included in the selected standardized scales. In other words, the scales with researcher-generated items did not assess 80% to 85% of the emotional content of athletes' performance-related subjective experiences. These findings received additional empirical support in another study involving Spanish elite karate athletes who expressed individual preferences in the selection of idiosyncratic labels describing their anger states of varying intensity (Ruiz & Hanin, 2004a).

In another study (Ruiz & Hanin, 2004b), idiosyncratic emotion labels generated by 16 high-level Spanish karate athletes were compared with the list of 15 discrete emotions proposed by Lazarus (2000). In individualized emotion profiling, these athletes generated 98 idiosyncratic, symbolic, and functionally meaningful metaphors and 167 interpretative labels describing how they felt prior to, during, and after their best and worst performances. As expected, self-generated interpretative emotion descriptors were highly idiosyncratic and context-specific. These self-generated idiosyncratic labels were related to three pleasant discrete emotions (happiness, pride, and relief) and three stress-related unpleasant emotions (anger, anxiety, and sadness). Additionally, athletes' experiences in worst performance were related to fright and shame. Interestingly, the athletes' self-generated labels had no content overlap with seven other discrete emotions (love, hope, compassion, gratitude, envy, jealousy, and guilt) proposed by Lazarus (1991, 2000). These findings suggest a specificity of emotion content in high-achievement settings, especially if the emphasis is on such extreme and qualitatively different situations as success and failure.

Pure or Mixed Emotions

Systematic assessment of the idiosyncratic emotion content of athletes' experiences provides an answer to the question about pure and mixed emotions. Most of the research in sport psychology during the past decades has focused on selected stress-related emotions, such as anxiety. As a result, the complex picture of actual emotional experience was oversimplified and incomplete at best. Research into pleasant and unpleasant idiosyncratic emotions has made it increasingly clear that in real-life situations, athletes' experiences are better described by mixed rather than pure selected emotions (Diener & Emmons, 1985; Gould & Tuffey, 1996; Hanin, 1997, 2000, 2003; Hanin & Syrjä, 1995; Jones & Hanton, 2001; Morgan, 1984; Plutchik, 1980; Schimmack, 2001).

To illustrate this notion, idiosyncratic emotion labels generated by a junior international-level tennis player describing his emotional experiences prior to, during, and after his best and worst games are presented in Figure 2.2a and 2.2b. Prior to his best-ever game (Figure 2.2a), the player felt high intensity of pleasant optimal emotions (P+): He felt highly *determined, confident, excited, dynamic,* and *comfortable.* He also felt moderately *aggressive, alarmed,* and somewhat *uncertain* (N+) at the same time. Moreover, his unpleasant dysfunctional emotions (N−; *nervous, afraid, worried, and intense*) were of low intensity. This pattern was similar during that game, except that he felt *alert* and *quick* but not too *excited* and had no premature *satisfaction.* In contrast, prior to his worst-ever game (Figure 2.2b), this player felt highly *nervous* and *worried* (N−), and these experiences were even more intense during the game. Interestingly, at the same time, his optimal pleasant emotions prior to and during the game were of moderate and low intensity, respectively. If only the anxiety level in this player in his best and worst games were measured, the entire profile of his emotional experiences and their impact on his performance would be missed.

Clusters of emotion content and intensity change from pregame to midgame and postgame situations for this player. Because his emotional experiences are related to different aspects of the environment, they are, again, better described by a cluster of mixed emotions rather than by a few pure or discrete emotions. Mixed emotions reflect a set of different domains that are perceived by an athlete in a particular performance situation or significant events outside sport. Interestingly, a similar mixture of motivational domains was established in ice hockey players describing what can motivate or de-motivate them before the game (see Table 2.1).

Future research in sport psychology should focus on mixed pleasant and unpleasant emotions representing actually experienced states rather than pure emotions. Also, the effect of discrete emotions, such as anxiety or anger, should be analyzed in the context of other, potentially related emotions. Finally, although mixed emotions certainly represent one important aspect of performance-related experiences, another aspect emerged in the analysis of labels generated by athletes. It was revealed that there are emotion mixtures and mixtures of nonemotion components (alert, energized, motivated, determined) of the psychobiosocial state (Hanin, 1993, 1997). Similar supporting data were obtained when standardized normative scales were contrasted with idiosyncratic emotion descriptors generated by athletes (Hanin, 2000; Syrjä & Hanin, 1997, 1998). Developing an empirical typology of "emotion mixture" seems like a promising future direction in emotion content research in sport (Diener & Emmons, 1985; Hanin, 1993, 1997; Schimmack, 2001).

Emotion Intensity

Emotion intensity is one of the most important dimensions; together with emotion content, it determines the effect of emotion on athletic performance. Numerous studies focused on the link between intensity of anxiety and performance outcomes in different athletes. However, assumptions that the optimal level of anxiety intensity in all athletes should be either moderate (U-inverted hypothesis), high (drive theory), or low (quiescence model) did not receive much empirical support. In most cases, the curves describing, for instance, the shape of anxiety-performance relationships in the zero-maximum range of intensity (from sleep to extreme excitement) were tentative at best. Most of these curves were based on two or three cross-sectional comparisons of anxiety levels in groups of athletes (Landers, 1994). These data usually did not include the entire working range of intensity because under laboratory conditions it is quite a challenge to manipulate the intensity level along the entire

(a)

Emotion dynamics in a "best-ever" game

	N− (Poor)	N+ (Successful)	P+ (Successful)	P− (Poor)
Before the game	• Nervous 2 • Afraid 2 • Worried 1 • Intense 1	• Alarmed 3 • Aggressive 5	• Determined 9 • Confident 8 • Excited 8 • Comfortable 9 • Dynamic 7	• Satisfied 2 • Sure 3 • Easy 3
During the game	• Tense 2 • Nervous 2 • Intense 1 • Anxious 2	• Aggressive 4 • Unsafe 4 • Uncertain 2 • Alarmed 4	• Confident 9 • Determined 10 • Alert, quick 9 • Comfortable 7	• ------ • ------ • ------
After the game	• Exhausted 1 • Restless 1	• Concerned 1	• Comfortable 8 • Inspired 7 • Determined 8 • Focused 1	• Happy 8 • Satisfied 9 • Easy 4 • Pleased 2

(b)

Emotion dynamics in a "worst-ever" game

	N− (Poor)	N+ (Successful)	P+ (Successful)	P− (Poor)
Before the game	• Nervous 9 • Afraid 7 • Worried 7 • Intense 6	• Alarmed 4 • Aggressive 6	• Determined 5 • Confident 4 • Excited 3 • Comfortable 3 • Dynamic 2	• Satisfied 2 • Sure 1 • Easy 2
During the game	• Tense 8 • Nervous 9 • Insecure 9 • Anxious 9 • Angry 9	• Aggressive 3 • Unsafe 6 • Uncertain 5 • Alarmed 5	• Confident 2 • Determined 1 • Alert, quick 3 • Comfortable 1	• Relaxed 3 • Easy 2
After the game	• Exhausted 8 • Unhappy 8 • Irritated 7 • Dissatisfied 7 • Restless 6	• Angry 6 • Annoyed 4 • Concerned 3	• Comfortable 1 • Inspired 1 • Determined 4	• Satisfied 1 • Easy 2 • Pleased 3

Figure 2.2 Emotional dynamics in an international-level tennis player in best (a) and worst (b) games. Adapted from "Performance Related Emotional States in Sport: A Qualitative Analysis" [48 paragraphs, Online journal], by Y. L. Hanin, February 2003, *Forum Qualitative Sozialforschung, 4*(1), available from http://www.qualitative-research.net/fqs-texte/1-03/1-03hanin-e.htm. Adapted with permission.

range of intensity. Interestingly, Yerkes and Dodson (1908) were not sure if the levels of intensity of the stimulus used in their experiments with mice were "most favorable."

The problem becomes even more complicated when separate and interactive effects of different components of anxiety, or multiple pleasant and unpleasant emotions, are examined. Applied research and practice in high-achievement sport, however, require a more individualized approach that can predict an individual performance. One strategy to solve the problem was proposed by Hanin (1978, 1995, 1997, 2000), who argued that it is unproductive to focus only on actual anxiety and corresponding levels of performance, matters that are difficult to compare across athletes. For instance, what one athlete would consider a good or even excellent performance could be perceived by another athlete as poor. Therefore, the emphasis should be on analysis of past performance history and estimation of intensity of emotions accompanying individually successful and unsuccessful performances.

Because the "moderate anxiety for all" assumption did not work in practice, a more intraindividual focus and individualized criteria in the evaluation of current anxiety intensity were needed (Hanin, 1978, 1995; Raglin & Hanin, 2000). Several studies have reported the percentage of athletes performing their best when experiencing high, moderate, or low anxiety (see Jokela & Hanin, 1999). The distribution of athletes in these categories was surprisingly well balanced across different studies: high ($M = 34.2$; 26% to 50%), moderate ($M = 34.6$; 22% to 44%), and or low ($M = 35$; 25% to 48%). Moreover, Jokela and Hanin (1999) were unable to identify a single study in their meta-analysis that demonstrated that different athletes had the same (or similar) optimal levels of anxiety.

The individual-oriented strategy proposed by Hanin (1978, 1986, 1989) to predict the effects of anxiety on athletic performance emphasized a need to analyze an athlete's past performance history to identify emotions accompanying individually best performances. The main emphasis in this approach is on predicting individual performance by contrasting, for instance, current anxiety level with the previously established success-related anxiety level (high, moderate, or low). The concept of zones of optimal functioning (ZOF) initially proposed in precompetition anxiety research was a tentative optimal range of intensity scores predicting individually successful performance. Later, the ZOF concept, extended to pleasant and unpleasant emotions, was later termed IZOF (individual zones of optimal functioning) to emphasize the within-individual focus of the model (Hanin, 1995, 1997, 2000).

Probability of successful performance was high when current precompetition anxiety was near or within the previously established individually optimal intensity zones. When precompetition anxiety fell outside the zones (i.e., higher or lower), individual performance usually deteriorated. The interest in individually oriented optimal zones of anxiety intensity reflected the fundamental fact that each athlete has a unique set of resources that are situationally available (or unavailable) for coping with the demands of an environment. Recently, similar results were obtained in studies of optimal and dysfunctional effects of situational anger on athletic performance (Ruiz & Hanin, 2004a, 2004b).

There were several advantages of the individualized approach to precompetition anxiety based on the realities of high-achievement sport and an accurate description. First, the step-by-step methodology for establishing the IZOFs was proposed. Second, an athlete's past performance history was considered, and individually optimal anxiety level and zones were established. Third, testable predictions of individual (and group) performance based on current anxiety and IZOFs were available. Fourth, the approach was empirically tested using different anxiety measures (STAI, CSAI-2, POMS, and the Body Awareness Scale; Koltyn & Morgan, 1997; Wang & Morgan, 1987) across different samples, different sports, and different countries.

Numerous studies provided strong empirical support for the approach and the recall methodology of assessing optimal levels and zones of individually optimal anxiety (Hanin, 1995; Jokela & Hanin, 1999, meta-analysis). However, initially, the IZOF anxiety model focused on precompetition anxiety as a discrete stress-related emotion syndrome with "fixed" emotion content, and the main emphasis in the IZOF anxiety research was on identifying the individually salient intensity of state anxiety (Raglin & Hanin, 2000).

The IZOF notion was proposed as an experience-based, individualized criterion to predict individual performance. The concept was derived from observations of real emotional experiences of athletes that were optimal in individually successful performances. When an athlete's anxiety was out of the optimal zone, his or her performance clearly deteriorated. Empirical findings consistently demonstrated high interindividual variability of optimal precompetition anxiety across different samples of elite and competitive athletes (Hanin, 1978, 1995; Raglin, 1992; Raglin & Hanin, 2000; Raglin & Turner, 1993). Therefore, the IZOF concept became a guiding principle in the assessment, prediction, and optimization of an individual's performance.

Despite encouraging empirical support for the validity of individual-oriented performance predictions based on the IZOF anxiety hypothesis, many questions arise: Do optimal and dysfunctional intensity levels and zones change during a season? And if they do, how are these changes related to an athlete's available resources and readiness for a competition? Does the accuracy of recall change with an athlete's increased self-awareness? What is the validity and reliability of the empirical method of intensity zone estimation (direct observations)? Can it be used without a recall method? How are the intensity levels and zones related to the optimal and dysfunctional impact of emotion on performance? How and why, for instance, is high anxiety helpful or harmful to individual performance? Finally, how can we enhance the accuracy of intensity zone estimation based either on categorical (either in or out of the optimal zone) or continuous measures along the entire working range of intensity? These and other questions provide directions for future work.

For instance, the empirical (direct) method of estimation of intensity zones consists of repeating actual assessments in several successful and unsuccessful competitions, plotting emotion intensity levels, and evaluating the distribution of optimal intensity scores (Hanin, 2000, p. 164). Traditionally, optimal intensity levels and zones are based on either the mean ±0.5 standard deviation range or on the interquartile range (IQR), which includes the range of scores from the 25th percentile to the 75th percentile. The IQR is one of several interpercentile measures of variability that tell how the middle 50% of the distribution is scattered. The clear disadvantages of the direct assessment method are that it requires many data points, it ignores an athlete's past performance history, and it is usually limited to pre- and postperformance assessments and is cost- and time-ineffective (Hanin, 2000; Raglin & Hanin, 2000). Finally, the direct method, if used without recall of individually best and worst performances, has a very limited and sometimes dubious value in prediction. On the other hand, it is important to explore the accuracy of zone estimation in direct assessments using different methods.

Kamata, Tenenbaum, and Hanin (2002) proposed a probabilistic approach to zone estimation based on frequencies of different performance levels related to corresponding perceived or objective measures of emotion intensity. This exploratory study aimed to improve the categorical approach to zone estimation using two hypothetical cases with 50 and 33 data points, respectively, and laboratory data (105 trial observations) from a single individual (Freeman, 1940). The relationships between reaction time (performance) and palmar skin resistance (anxiety) were examined. To determine the IZOFs and their associated probabilistic curve thresholds, observable performance outcomes were categorized into four levels (poor, moderate, good, and excellent), and then intensity scores were regressed onto the corresponding performance categories using logistic ordinal regression. The regression coefficients were used to establish emotion-related probability curves associated with each performance category. Thus, for each performance category, a range of arousal/affect level was determined so that within this range the probability of performing at this level was higher than in the other performance categories. It was also revealed that the probabilistic method of zone estimation had wider zones than in the traditional method of estimation. Additionally, more correct classifications within the zones and fewer incorrect classifications outside the zones were obtained.

These findings and the subsequent replication studies (Cohen, Tenenbaum, & English, in press; Golden, Tenenbaum, & Kamata, 2004) provide preliminary evidence of how to improve the accuracy of categorical assessments of performance-related emotion zones. These results should be accepted with caution, however, because the Kamata et al. (2002) study used only hypothetical and laboratory data. Again, many questions arise: What is the minimum number of observations in each performance category required to estimate the probability-based zones? This method of estimation of intensity zones requires a large number of direct observations, which is often impractical and ineffective in terms of cost or time. On the other hand, too few observations in a particular performance category (optimal or poor) preclude the possibility of establishing the optimal or dysfunctional zones. Can the probability curves be used to predict future performance? At this point, there is no empirical evidence to suggest that the probability curves for different performance levels based on observations of only actual (but not the best ever) performance can predict future performance. Classification of observations using frequencies of observed performance categories seems circular. Considering a high variability of athletic performance in each season, how often (during the season and across several seasons) should the probability-based zones of intensity (and performance ranges) be estimated? How are the probability zones related to direct emotion effects on performance? What are the practical implications of these probability-based zones? This method in its present form has a strong categorical focus and what is beyond the zones of intensity is still not assessed. These and other questions provide directions for future work. A more radical approach involving the estimation of emotion impact on performance along the entire range of working intensity ("intensity-impact" contingencies; Hanin, 1997, 2000; Robazza, Bortoli, & Hanin, in press) is briefly described later in the chapter.

From Anxiety to Multiple Emotions

There is a growing consensus in applied sport psychology that prediction of athletic performance should be based on multiple pleasant (positively toned) and unpleasant (negatively toned) emotions rather than only on precompetition anxiety (Cerin et al., 2000; Crocker et al., 2002; Gould & Tuffey, 1996; Hanin, 1993, 1997, 2004; Jones & Hanton, 2001; Kerr, 1997; Lane, Terry, & Karageorghis, 1995; Lazarus, 1993; Raglin & Hanin, 2000; Robazza, 2006). Substantial empirical evidence indicates that unpleasant emotions do not always harm athletic performance. For instance, such emotions as anger, anxiety, and tension can sometimes be beneficial in competition (for reviews, see Hanin, 1978, 1995; Jones, 1995; Raglin, 1992; Raglin & Hanin, 2000). These findings are in accord with the earlier observations and anecdotal evidence indicating that highly skilled and experienced athletes can deliberately use relatively high anxiety to their advantage (Hanin, 1978; Mahoney & Avener, 1977). As a result, these expert performers often perceive anxiety as facilitating their performance (Jones, 1995).

On the other hand, the findings indicate that pleasant emotions are not always beneficial for successful performance (Hanin, 1997, 2000). Too much of some pleasant emotions can sometimes lead to a poor performance due to complacency and underestimation of task demands and insufficient focus and dysfunctional energy levels (too high or too low). Therefore, although some athletes perform up to their potential when they are stress-free, others deliberately generate and use competitive stress to their advantage as an additional resource and a tool for mobilization in emergency situations.

Much of the earlier research proceeded from a nomothetic perspective with the aim of making predictions regarding athletes and exercise participants in general (Smith, 1996; Vallerand, 1997). Recent numerous studies, however, have begun to reflect an idiographic perspective with the aim of making predictions about individuals or subsets of athletes (Hanin, 1995, 1997, 2000, 2004; Robazza, 2006; Vallerand & Blanchard, 2000).

Although precompetition anxiety is an important stress-related emotion, it is still only part of the emotional mix that influences athletic performance. Determining the interactive effects of emotions enhancing and impairing sporting activity is crucial for an accurate prediction of emotion-performance relationships. In this case, a high probability of individually successful performance is expected when combined maximum enhancing and minimum impairing effects are observed. On the other hand, a high probability of individually average and poor performance is expected when a combination of high enhancing and high impairing effects or low enhancing and low inhibitory effects are observed. Finally, a high probability of poor performance is expected when low enhancing and high inhibitory effects are observed.

In the case of pleasant-unpleasant and optimal-dysfunctional emotion intensities, it is important to assess interactive effects of four different categories of emotions: P+ (pleasant optimal), N+ (unpleasant optimal), P− (pleasant dysfunctional), and N− (unpleasant dysfunctional). Therefore, the IZOF principle was further developed to account for these interactive effects. With the development of individualized emotion profiling (Hanin, 1997, 2000; Hanin & Syrjä, 1995, 1996), the extended IZOF concept is used to describe separate and interactive effects of both pleasant and unpleasant emotions using athlete-generated items. Specifically, the individual zone of optimal intensity is identified for each functionally optimal emotion, and the individual zone of dysfunctional intensity is identified for each dysfunctional emotion. In both cases, recall is used to examine past performance history rather than wait and see when successful and extremely poor performances occur. Past experiences were used to predict present and future performances.

It is assumed that there are IZOFs in some emotions (P+, N+) within which the probability of successful performance is the highest. There are also dysfunctional zones in other emotions (P−, N−) within which the probability of poor performance is the highest. Optimal and dysfunctional intensity levels can be low, moderate, or high and vary for the same and different emotions in different athletes (Hanin & Syrjä, 1995). Moreover, it is possible to estimate functionally optimal and dysfunctional effects, separately and jointly, only when these emotions are near or within these previously established individual zones. In other words, the total effect of pleasant and unpleasant emotions on performance appears to be determined by the interaction of optimal and dysfunctional effects. Although functionally optimal emotions are important predictors of

Emotion effects		Harmful effects (N–P–)	
		High	Low
Helpful effects (P+N+)	High	Average performance	Successful performance
	Low	Poor performance	Average performance

Figure 2.3 Interactive effects of enhancing and harmful emotions.

successful performance, they alone may not be sufficient due to the fact that emotional experiences involve mixed feelings. Therefore, potential detrimental effects of dysfunctional emotions should be considered as these emotions are sometimes experienced at the same time as optimal emotions. Four quadrants in Figure 2.3 illustrate this principle in a matrix form, and the IZOF iceberg, or bell-shaped emotion profile, visually represents interactive effects (Hanin, 1997, 2000, 2003). Therefore, the notion of a zone, as applied to a wide range of pleasant and unpleasant emotions, seems appropriate in providing individualized criteria to evaluate both optimal and dysfunctional effects separately and jointly.

Empirical research revealed a high degree of *interindividual variability* in the intensity and content of idiosyncratic optimal and dysfunctional emotions related to individually successful and poor performances. It was also shown that different athletes perform up to their potential experiencing emotions of different content and intensity, and there is no universal intensity level and zone that are similar and optimal or dysfunctional for all athletes.

Beyond Optimal Intensity Zones

Prediction of individual performance based on contrasts of precompetition emotional states with previously established IZOFs in multiple emotions received fairly good empirical support (Annesi, 1998; Hanin, 2000, 2004; Robazza, Pellizzari, & Hanin, 2004). In most cases, the optimal and dysfunctional zones were established using the focused recall procedures described earlier (Hanin, 2000, 2003; Hanin & Syrjä, 1995, 1996). This proved to be effective with highly skilled and experienced athletes, who are usually well aware of their personally significant experiences, and meta-experiences, related to successful and poor performances. Therefore, previously established zones were useful as individualized criteria to predict individual performance.

In earlier research on optimal anxiety, the main emphasis was on personally best and worst performance and emotions accompanying these two personally significant situations. However, it was not known if experienced emotions represented also an optimal or dysfunctional (repeated) pattern. All other performance levels were assumed to be between these two extremities. When the focus of research shifted from anxiety to pleasant and unpleasant emotions, a new construct was proposed: a notion of *individual performance range* with distinctions between personal best and personal worst categories, including personally standard and substandard performances. Although the initial approach was based on categorical assessments (in or out of the zone), a more comprehensive approach (Hanin, 1997, 2000) required continuous (along the entire working range of intensity) estimation of what was beyond the zones of intensity and performance ranges. Such an assessment strategy is important when multiple items of emotion and nonemotion experiences are used to estimate the partial and total impact of emotional experiences on performance.

The IZOF-based research in performance anxiety has also indicated that if intensity was closely out of the zones, performance deteriorated, but in some cases, performance did not deteriorate when intensities were further from the zones (Turner & Raglin, 1996). Finally, several IZOF emotion studies revealed that different emotions can be optimal or dysfunctional or both. These findings suggest that each emotion (in each of the four emotion categories) may have a different effect (optimal or dysfunctional) depending on its intensity level. In other words, a categorical approach, as a practical tool for a rough estimate of optimal and dysfunctional intensity, is practically acceptable when we have a total intensity score. But what is the impact of emotion on performance when the intensity is well beyond the zones or even along the entire range of working intensity? To answer this question, a continuous approach in establishing intensity-impact contingencies for each emotion (partial effect) and for all emotions (total effect) was needed. The multiple emotion assessment requires the assessment of partial effects continuously rather than categorically and the use of the principle of being in or out of the zone for total scores.

In an exploratory study, 12 top Finnish cross-country skiers estimated perceived effects of each self-generated emotion on their performance along the entire range of intensity (Hanin, 1997, 2000). As a result, the intensity-impact contingency for each idiosyncratic emotion generated by the athletes was created. This study provided initial empirical support for a more detailed estimation of the interactive effects of different emotions on athletic performance. Specifically, it was shown that being outside the optimal zones may indeed produce a less enhancing effect, or even have a detrimental effect (e.g., an absence of motivation or energy), on individual performance.

Similarly, being out of the dysfunctional zones in performance-inhibiting emotions can be not only less detrimental but sometimes can even enhance individual performance effects (e.g., an absence of fatigue or depression). Therefore, a more accurate estimation of total emotion impact on performance was possible, providing it was based on individualized intensity-impact contingencies developed by athletes for each emotion. The development of intensity-impact contingencies is based on an athlete's awareness and ability to report his or her own experiences. Additional research is needed to estimate how accurately athletes of varying skill and experience are able to do such estimations and how accurate are the predictions that are based on these contingencies.

A recent study by Robazza et al. (in press) examined the perceived effect of idiosyncratic emotions and bodily symptoms on athletic performance along the entire emotion-intensity range. The participants were 35 elite Italian athletes (16 females and 19 males) competing in either figure skating or gymnastics. Idiosyncratic emotional descriptors were rated on Borg's Category Ratio (CR-10) scale to estimate the perceived impact on performance and hedonic tone for each level of emotion intensity range. The findings revealed large interindividual variability in the content of emotions as well as in the shape of the curves representing the intensity-impact contingencies. At the group level, the emotion-performance link was positively linear for optimal-pleasant emotions, bell-shaped for optimal-unpleasant emotions, and negatively linear for both dysfunctional-unpleasant and dysfunctional-pleasant emotions. Future research should focus on how intensity-impact contingencies can be used in the estimation of total impact to predict individual performance.

By definition, emotion is an unfolding process (Folkman & Lazarus, 1985). Its dynamics involve two basic dimensions: *context* and *time* (Hanin, 1997). The context dimension is an environmental characteristic reflecting the impact of situational, interpersonal, intragroup, and organizational factors on emotion intensity and content in sport settings. Emotional experiences of varying form, content, and intensity are usually observed in different settings (context). Situational impact is manifested in emotions experienced in practices and competitions during athletes' anticipated or real contacts and interactions with significant others (a partner, a coach, and teammates). Context dimension also includes culturally coded and culturally determined beliefs of participants about the expected impact of specific emotions on their performance and about the rules of emotion display (expression or suppression) in a particular subculture.

Current emotion research in sport psychology focuses on several contexts, such as successful and unsuccessful competitions of varying significance (local, national, international), and different practices. Additionally, there are a number of individually difficult situations, or specific performance episodes, that have a special meaning for athletes and teams (weather conditions, competition sites, good and bad memories of past performances). These situations may also include qualifications, performance in the finals, play-offs, meeting a weaker opponent, and performing after repeated success or a series of slumps.

As for the *time* dimension, traditionally it is associated with a short-term situational emotion dynamics across three interrelated situations: prior to an action, during task execution, and after performance in a single competition (or practice; Cerin et al., 2000; Hanin, 1993, 1997, 2000; Jones, 1991; Syrjä, Hanin, & Pesonen, 1995). The time dimension, however, is not limited to what is going on cross-sectionally in a single competition. Moreover, cross-sectional assessments do not usually reflect the specifics of transitions of emotional experience from pre-event to midevent to postevent situations (Hanin & Stambulova, 2002; Ruiz & Hanin, 2004a). Thus, to reflect a real dynamics of emotional experience as a process, cross-sectional measures should be supplemented by qualitative methods, such as narratives or video-assisted self-confrontation interviews (Hanin, 2003; Sève, Ria, Poizat, Saury, & Durand, in press).

Long-term temporal dynamics are related to emotion-performance relationships during a competitive season (seasons), the 4-year Olympic cycle, or an athlete's sports career. The best indicators of long-term development of emotional experiences are relatively stable emotion patterns and especially meta-experiences. In the assessment of temporal patterns of emotional experiences, future researchers should include both *topological* (phases, cycles, sequencing, periodicity, timing) and *metric* (duration, frequency) characteristics. Research on topological characteristics of temporal patterns in the dynamics of emotions in sport remains nonexistent.

Finally, emotion-performance relationships are dynamic and bidirectional: pre-event emotions produce beneficial or detrimental effects on performance and ongoing performance process (successful or unsuccessful) affects an athlete's emotional state. Thus, to describe emotion-performance relationships, it is important to establish the patterns of emotion impact on performance and performance impact on emotions. This latter aspect of performance-emotion relationships is especially important in research into temporal patterns of emotions across several game episodes, especially in ball games and combat sports (Sève et al., in press).

Most sport events are continuous, and in long duration sports, much happens between the start and the finish. Therefore, temporal patterns are important to consider in explaining how emotion affects performance and performance-induced emotions. For instance, preperformance situations can be explained by the "anticipated gain-loss" appraisals involving challenge and threat and related emotions (Lazarus, 2000). However, what happens when "occurred gain-loss" appraisals involving benefit and harm are triggered? And how do intermediate occurrences during performance affect appraisals and emotional experiences? All these are promising directions for future researchers.

EMOTION-PERFORMANCE RELATIONSHIPS

A detailed description of defining characteristics of emotional experiences based on systematic observations of athletic performance is an important starting point. However, to explain emotion-performance relationships in sport, it is also necessary to look at the antecedents and consequences (effects) of emotions relating to athletic performance. After that, a tentative explanation of individual differences in emotion response is possible. In this section a brief overview of antecedents and consequences of emotional experiences and two interconnected explanations of their effects on performance are suggested.

Antecedents of Emotions in Sport

According to Vallerand and Blanchard (2000), theory and research on antecedents of emotions deal with psychological processes eliciting emotions with the aim to understand and predict how an individual will feel in a given sport situation. Several existing cognitive theories and research on antecedents of emotion in sport illustrate well past research and recent trends potentially important in sport settings. Vallerand and Blanchard provide a detailed review of the early contributions to theory on emotion, selected appraisal theories, goal and motivational theory, and research. Readers are also referred to another excellent review of selected cognitive theories and sports-specific models by Crocker et al. (2002) that deals with emotion antecedents.

Most of these approaches emphasize the role of a variety of *intrapersonal* determinants of self-directed emotions, including individual differences in traitlike characteristics. These are achievement needs, anxiety, mastery orientation, cognitions (expectancy of success), efficacy beliefs, causal ascriptions, and incentives related to goal orientations and their sources or locus (Hareli & Weiner, 2002). Weiner's extension of his previous attribution-emotion model suggests that *interpersonal* context gives rise to a variety of socially related emotions and personality inferences that have far-reaching consequences. Specifically, a good deal of individuals' self-definition and emotional experiences are derived from how they are perceived and the feelings they elicit from others in achievement settings (p. 183). For instance, just as the player is experiencing different emotions based on the task outcome and the perceived cause of the outcome, involved observers (teammates, coach, fans) also are experiencing different emotions. *Self-directed* emotions include pride, gratitude, shame and guilt, and hopelessness; *other-directed* emotions are pride, envy, admiration, schadenfreude (joy at the shame of another), sympathy and contempt, anger, arrogance, modesty, and deceit.

Potentially interesting as a future research direction in sport is an emphasis on self- and other-directed social emotions. This is a neglected area of research both in general and sport psychology. This direction focuses on *interpersonal* and *intragroup* determinants of emotional experiences. For instance, several earlier studies of interpersonal and intragroup anxiety in sports setting are examples of how emotions can reflect an athlete's interactions and communication with partners or coach or how an athlete feels in different groups, including the team, study group, family, and friends (Cratty & Hanin, 1980; Hanin, 1980, 1989, 1992; Hanin & Bulanova, 1981).

It is important to distinguish intrapersonal, interpersonal, and intragroup antecedents of emotional experiences. Intrapersonal factors include those that affect a person's perception of person-environment interaction. Person-environment interactions are important, and a psychosocial perspective is central in the functional interpretation of the dynamics of emotion-performance relationships. As discussed earlier, emotion is conceptualized as an unfolding process reflecting person-environment interactions. Ongoing appraisals of these interactions result in a change in the personal meaning of a situation, which exerts influence on emotional experiences related to performance. Changes in personal meaning as well as in a situational mind-set reflecting the dynamics of the performance process can trigger considerable functional shifts in emotion content and intensity.

In Lazarus's (1991, 2000) emotion theory explaining the dynamic, unfolding nature of emotion, the notion of personal relational meaning is especially useful. Lazarus conceptualized this in terms of two basic performance outcomes: gain and loss. These outcomes are either anticipated (challenge and threat) or occurred (benefit and harm). As a two-factor categorization of relational meaning and time, these four basic appraisal patterns can partly explain the dynamics of emotion-performance relationships. Specifically, functionally optimal pleasant and unpleasant emotions (P+, N+) prior to and during activity are usually anticipatory and are triggered by the appraisals of challenge and/or threat. These appraisals activate strong action tendencies prior to and during performance and help to recruit available resources and to use them effectively. In other words, these emotions, if interpreted from the goal reprioritization approach (Carver, 2003; Simon, 1967), seem to signal a call for even greater investment of resources and effort. In contrast, situationally dysfunctional pleasant and unpleasant emotions (P–, N–), prior to and during performance, are usually triggered by premature perception of already achieved or occurred outcomes (appraisals of benefits and harm) before the task is completed. These appraisals activate weak or distracting emotions, sending a signal that the main goals have already been achieved (P–) or could not be achieved (N–), and there is no need for (or no sense in) further exertion. These dysfunctional emotions signal either a call for less investment (P–) or a failure to maintain efforts due to a lack of resources.

Finally, most of these approaches emphasize *distal,* or traitlike and relatively stable, antecedents that function across repeated typical situations. In a single situation, more attention is required for *proximal* antecedents that act as *situational* determinants of concrete emotional experiences (Kuhl, 1994). Table 2.1 illustrates this distinction by listing different situational motivational domains generated by the players. Thus, proximal antecedents of a highly motivated state include a special focus (winning and fighting), trying to do one's best, a specific feeling state, and perception of the game (as important, challenging, tough, and well started) and perception of the opponent (as tough, good, strong). Important but more distal antecedents include perception of ice hockey (as a serious hobby, future profession, life) and one's own team (playing for the team and team climate). In contrast, Figure 2.2b lists antecedents of negative motivation (or a lack of motivation) along the same domains; most of these have proximal and direct de-motivational effects.

Consequences of Emotions

In discussing the consequences (functional impact, effects) of emotional experiences, several aspects should be considered. First, emotion functional effects observed in sport settings could be either *facilitating* (helpful, beneficial, optimal, useful, positive) or *debilitating* (harmful, detrimental, dysfunctional, negative) or *neutral* (nondisturbing, having no impact). Second, a target (or direction) of emotion impact could be the situational *performance* (process or outcomes) or a psychobiosocial *state* (and its cognitive, motivational, bodily, behavioral, or communicative components) or *relationships* (interpersonal or intragroup) or general *well-being* and *health,* or *multitarget* combined effects. Third, due to the social nature of emotional experiences reflecting person-environment interactions, emotion consequences are usually both self-directed and other-directed (see Hareli & Weiner, 2002, for a more detailed discussion). Emotion functional effects therefore include not only intrapersonal but also interpersonal and intragroup consequences. Fourth, as in the case with antecedents, emotion consequences can also be distal (long term or accumulated) or proximal (more immediate, situational, and short term; Kuhl, 1994). Here I limit discussion to functional effects of emotion on athletic performance. These effects are apparently different from the functional (or dysfunctional) effects of emotions, for instance, in educational or clinical settings as compared to high-achievement sport.

The basic question in performance-related emotion research is how to define and describe emotion functionality or the effect of emotion on performance (or well-being, health, leisure). The notion of functional effect is not new. It has been around in psychology for some time under different labels: most favorable stimulus (Yerkes & Dodson, 1908), optimal arousal (Berlyne, 1960; Schlosberg, 1954), and facilitating-debilitating anxiety (Alpert & Haber, 1960; Jones, 1991; Liebert & Morris, 1967). Initially, optimal (or dysfunctional) effects were simply assumed. The main focus, for instance, in test anxiety research and in clinical psychology was on contrasting anxiety intensity and performance and on alleviating debilitative consequences of high anxiety. In elite sports, however, it was clear that state anxiety does not necessarily impair athletic performance and, in some circumstances for some athletes, can enhance it. Moreover, experienced and elite athletes were usually well aware of the impact of various emotional states on their performance (Hackfort & Schwenkmezger, 1993; Hanin, 1978, 1986, 1995; Jones, 1995; Mahoney & Avener, 1977).

As was shown earlier, the interaction of specific emotion content (anxiety, anger, etc.) with emotion intensity (high, moderate, or low) produces specific optimal or dysfunctional effects on athletic performance (Emotion content X* Intensity = Emotion impact). Several strategies exist in the practice of sport psychology to assess emotion effects on performance. First, the *emotion-based* strategy involves the collection of multiple measures of emotion intensity in a sample of athletes and contrasting them with the corresponding performance outcomes. Current models of competitive anxiety are examples of such an approach. Second, the *performance-based* approach identifies personally best and worst performances and focuses on accompanying success-related and failure-related emotion content and intensity of individual athletes (Hanin, 1986, 1997, 2000; Raglin, 1992; Raglin & Hanin, 2000; Robazza 2006). Here, functional effects of emotions are established by identifying individually successful performance (personal best) and accompanying emotions that were helpful or at least not detrimental to an individual athlete's performance. In other words, in both strategies, functionality of emotions is implied but not assessed directly as a special construct. Third, the *perception-based* strategy focuses directly on assessment of the functional and dysfunctional effects of emotions using athletes' subjective experiences (or rather, meta-experiences) and self-ratings of anticipated or already experienced impact on performance. One option here is that athletes simply rate the magnitude of facilitating or debilitating effects (called the "directional" approach; see Jones, 1995), or they can report qualitative characteristics of specific emotion effects on their performance (Hanin, 1993, 1997, 2000, 2003; Hanin & Syrjä, 1995; Sève et al., in press; Syrjä, 2000). In the perception-based approach to emotion impact estimation, athletes' experiences and especially meta-experiences (self-awareness) are important. Finally, direct emotion effects on performance process can be estimated in controlled observations of changes in movement patterns, muscular tension, or frequency of preliminary or performance movements under different emotion intensity levels (e.g., Pijpers, Oudejans, Holsheimer, & Bakker, 2003; Weinberg, 1978; Weinberg & Hunt, 1976).

Direct Rating of Emotion Effects

In early test anxiety literature, Alpert and Haber (1960) were among the first to assess whether test anxiety was facilitative, debilitative, or had no effect on subsequent performance. They proposed the "direction of effect" dimension, operationalized in two independent constructs of facilitating and debilitating anxiety as *response tendencies* in test situations. The Achievement Anxiety Test (AAT), with two separate subscales as trait-specific measures of facilitating and debilitating anxiety, was constructed. The facilitating scale of nine items was based on a prototype of the item "Anxiety helps me to do better during examinations and tests." The debilitating scale of 10 items was based on a prototype of the item "Anxiety interferes with my performance during examinations and tests." Although the AAT did not assess the specific effects of test anxiety (in what way it was helpful or harmful) on the individual performance process, relatively stable "facilitating anxiety added significantly to the prediction of grade-point average (performance outcomes) when it was combined with a measure of debilitating anxiety" (p. 215).

In sports, the concept of facilitating-debilitating effects of anxiety on performance with some modification was introduced by Jones (see Jones, 1995, for review), who proposed using a single-item bipolar direction scale to rate the degree to which the situationally experienced intensity of each symptom on the Martens et al. (1990) CSAI-2 was either facilitative or debilitative to subsequent performance. The response scale ranged from –3 ("very debilitative") to +3 ("very facilitative"), so that possible direction scores on the CSAI-2 subscales ranged from –27 to + 27. The major emphasis in the "directional perception" approach is on rating perceived effects of situational anxiety symptoms on performance within the sequence of *anxiety intensity → perceived effects → performance outcomes.* In contrast, earlier approaches focused on the *anxiety intensity ≥ performance outcomes* relationships did not assess anxiety effects directly.

Research provides reasonable empirical support for the validity and potential utility of the direction construct in the assessment of situational states and relatively stable patterns of anxiety. However, it should be recognized that optimal and dysfunctional effects of high and low anxiety on athletic performance are well-known in competitive and especially in elite sports (Hanin, 1978, 1986, 1995; Mahoney & Avenir, 1977; Raglin, 1992). Moreover, it is not surprising that elite athletes sometimes experience lower anxiety intensity and rate its effects as more facilitating than do nonelite and less experienced athletes.

Although directional research seems intuitively appealing, in its present form it has several limitations. First, the construct of emotion effect (direction) has been neither defined nor adequately described. Second, similar to test anxiety studies, current research is limited to rating only the extent to which anxiety is either helpful (facilitating) or harmful (debilitative) to an athlete's performance. These ratings fail to indicate the way a specific anxiety intensity affects (or does not affect) an athlete's performance process positively or negatively. Third, in most cases, researchers failed to collect performance data directly to examine anticipated and actual impact of anxiety intensity on performance (see, e.g., Jones & Hanton, 2001). Therefore, it is still not clear if athletes who rated anxiety as facilitating really succeeded and those who rated anxiety as debilitating really failed to perform up to their potential. Fourth, it is also not known if the direction ratings of similar anxiety intensity are stable over time or if they change from competition to competition. Fifth, it is not clear how direction scores, in their present form, can be used for prediction of individual performance. Finally, although the directional approach begins to consider different feeling states (pleasant and unpleasant), the anxiety-oriented framework does not estimate the functional impact on performance of a wide range of pleasant and unpleasant emotions.

Two questions are relevant to the discussion of emotion functionality: Are negatively toned emotions invariably detrimental to sporting performance? Are positively toned emotions always beneficial for performance? Numerous IZOF-based studies (Hanin, 1978, 1986, 1995, 1997, 2000; Hanin & Syrjä, 1995, 1996; Jokela & Hanin, 1999; Raglin & Hanin, 2000; Robazza, 2006; Ruiz, 2004; Ruiz & Hanin, 2004a, 2004b; Syrjä, 2000) provide strong empirical evidence suggesting a clearly negative response to both questions. In other words, unpleasant emotions can sometimes be helpful for performance (see Hanin, 1978, 1986; Hardy, 1990; Jones, 1995; Jones & Hanton, 2001; Ruiz, 2004), and pleasant emotions are sometimes harmful for performance (see Carver, 2003; Fredrickson, 2001; Fredrickson & Losada, 2005; Hanin, 1993, 1997, 2000). Thus, the view that emotion valence is the only or a major predictor of the effect of emotion or its regulation is oversimplistic at best (Cole, Martin, & Dennis, 2004).

Therefore, attempts to propose the notion of positive and negative anxiety based on its perceived effects seem questionable at best. Much confusion in this positive-negative anxiety debate (Burton & Naylor, 1997; Hardy, 1997; Jones & Hanton, 2001) comes from a failure to distinguish between emotion content, emotion intensity, and emotion functionality (helpful or harmful effects). For instance, Jones and Hanton argue that anxiety by definition is a negative (unpleasant) feeling state but claim that the CSAI-2 does not measure competitive anxiety directly, but only the symptoms associated with the response. They believe that "if a negative score on the direction scale is revealed then this signifies a state of anxiety. If a positive direction score is found, this points to another state previously mislabeled as anxiety" (p. 393). This assumption is actually true if it suggests that there are mixed emotions, besides pure anxiety, that add to positive impact on performance. However, this assumption is not true, and is even contradictory, if labeling of anxiety state depends entirely on a negative direction score. Qualitatively, anxiety is a negatively toned unpleasant state reflected in several specific symptoms (feelings of tension, apprehension, nervousness, etc.). Actually, anxiety and nonanxiety labels describe fixed or conventionally defined emotion content, whereas functional effects represent a different characteristic. Thus, using an athlete's own vocabulary of emotion labels along with researcher-generated items could be instrumental in the partial solution of this problem.

The main issue in emotion research now is not only to rate the perceived impact of emotions, but to identify, for instance, in what way high, moderate, or low anxiety (or any other emotion) is helpful or harmful to athletic performance. Hanin and coworkers (Hanin & Syrjä, 1995; Syrjä, 2000) collected qualitative data describing how highly skilled ice hockey and soccer players perceive the functional effects of facilitating and debilitating emotions for their performance. Two major functions emerged in the content analysis of players' interpretations of perceived emotion effects: enhancing or detrimental to effort and skill. For instance, a player who experiences dissatisfaction perceives it as a helpful emotion because this emotion helps him or her to try harder, to maintain a fighting spirit, to be better than his or her opponent, to put more effort into the game, and to be more alert. Harmful effects of too much satisfaction (complacency) are reflected in being too concerned with success, not trying to play better, being too arrogant, not careful, and too risky; as result, skating becomes difficult (Hanin & Syrjä, 1995, pp. 180–181). A more detailed description of perceived functional effects of selected emotions across four global categories (P+, N+, P–, and N–) is found elsewhere (Ruiz, 2004; Syrjä, 2000).

Explaining Individual Differences

Numerous empirical studies revealed large interindividual variability of emotion intensity and emotion content in athletes performing similar and different sporting tasks. How can these findings be explained? Why do some athletes perform well while experiencing high anxiety, whereas others fail to cope with competitive stress? Why is emotion content different in different athletes performing the same task? I propose two possible explanations to account for these differences: a *resource-matching hypothesis,* based on the construct of internal and external resources, and two constructs, *energy mobilization* and *energy utilization* (Hanin, 1997, 2000, 2004).

The construct of internal and external resources proposed here is not new. For example, it is used in the conservation of resources (COR) model proposed by Hobfoll (1989) to define and explain psychological stress. Examples of broadly defined resources include not only personal characteristics (self-esteem, mastery, and well-being) but also interpersonal, material, and work-related resources. The basic tenet of the COR model is that people strive to retain, protect, and build resources because the potential or actual loss of these resources is a threat and a source of psychological stress. From this perspective, psychological stress is defined as a reaction to the environment in which there is (a) the threat of a net loss of resources, (b) the net loss of resources, or (c) a lack of resource gain following the investment of resources. There is a clear overlap of these ideas with the relational themes and appraisal patterns (anticipated and occurred) proposed by Lazarus (2000). Hobfoll also proposed an instrument to measure a gain and a loss of resources that was used in empirical studies with different populations outside the sport setting.

The life span model of developmental challenge proposed by Hendry and Kloep (2002) employs the constructs of resources and challenges to explain the processes of human growth. Examples of potential resources include *biological dispositions* (health, personality, "talents," intelligence, body shape, attractiveness); *social resources* (trust, attachment, size and quality of network); *skills* (basic, learning, social, psychomotor); *self-efficiency* (self-efficacy appraisals, experience with success, assurance from others, locus of control); and *structural resources* (country, race, class, family, income, gender).

To explain intraindividual and interindividual variability of emotion content and intensity in similar and different performance situations, a *resource-matching hypothesis* was proposed (Hanin, 2000, 2004; Hanin & Stambulova, 2002, 2004). Based on the idea that emotional experiences reflect person-environment interaction, it was suggested that it is not so much the task requirements per se that determine optimal and dysfunctional content and intensity of situational emotional experiences but an interaction (match or mismatch) between task demands and an athlete's resources (available, recruited, and utilized).

In competitive sport, resources are defined as psychobiosocial assets that determine athletes' ability to perform consistently up to their potential. Here the emphasis is on how available resources are identified and then systematically and effectively recruited, used, recuperated, and further developed. Thus, for instance, a complex task can be very easy for an athlete with sufficient resources that can be recruited when needed and utilized effectively. In contrast, a task generally considered relatively easy can be very demanding and difficult if an athlete is unable to recruit available resources or not ready to use them efficiently (Hanin, 2003, 2004; Hanin & Stambulova, 2002, 2004; Ruiz & Hanin, 2004a, 2004b).

The resource-matching hypothesis proposes three potential causes of intraindividual and interindividual variability in optimal emotion content and intensity. These include interindividual differences in (a) *available* resources, (b) the ability to *recruit* them at the right time and place, and (c) the skill to *use* them *efficiently.* Finally, there are clear intraindividual and interindividual differences in situational *readiness* to recruit, utilize, and recuperate these resources.

The four categories of emotion content proposed in the IZOF model and derived from the interaction of two factors (hedonic tone and performance functionality) also reflect a resources-based interpretation of emotion function and provide important signals. Specifically, pregame or midgame optimal pleasant emotions (P+) reflect a state of being in the *challenge zone,* when an athlete is well prepared (ready for the game) and his or her available resources are sufficient, can be recruited when needed, and can be used effectively, matching well the task demands. It is also suggested that these emotions are essential elements of optimal functioning as vehicles for individual growth and social connection, building people's personal and social resources. These emotions can broaden thought-action repertoires, undo lingering negative emotions, fuel and build psychological resilience, and enhance emotional well-being (Fredrickson, 2001). Pregame or midgame optimal unpleasant emotions (N+) reflect a state of being in the *emergency zone,* when an athlete's normal resources are not sufficient for the task at hand or task demands exceed available resources, producing a threat to goal achievement. Additionally, there can be situational problems with the recruitment or utilization of available resources. Thus, an athlete is not completely ready for the task and there is a need to compensate for the lack of resources or their insufficient use.

Pregame or midgame dysfunctional pleasant emotions (P–) reflect a state of being in the *comfort zone,* or excessive complacency, when an athlete tends to underestimate task demands and overestimate his or her own resources, usually after successful performance or playing with a weaker opponent. Situational complacency and too much confidence result in failure to recruit and use needed resources (insufficient mobilization), and an athlete is actually not ready for the game. Pregame or midgame dysfunctional unpleasant emotions (N–) reflect a state of being in the *dejection zone,* when an athlete, for some reason, overestimates task demands and underestimates his or her resources, especially after a series of unsuccessful performances, a performance slump, or overtraining. In this situation, there is a clear lack of resources, serious problems with their recruitment and utilization, and therefore inability to compensate situationally.

The resource-matching hypothesis suggests that emotional experiences related to athletic performance serve a very important regulatory function. Emotions are elicited by appraisals and produce a strong regulatory effect on performance. On the other hand, any unexpected change in performance process affects situational appraisals of ongoing person-environment interactions, which often result in emotion shifts or reversals (Kerr, 1997). Therefore, emotional experiences in athletic performance have not only a *regulatory* function, but also a *signal* function reflecting an athlete's perception of situational match or mismatch between task demands and available resources. From this perspective, in midevent situations emotions are indicators of effectiveness of ongoing action that correspond either to "rate of progress" or "error signal" (Carver, 2003, p. 243). Moreover, pleasant optimal emotions "represent a sign that things are going better than necessary and are presumed to induce coasting that facilitates the shift of attention and effort to other behavioral domains" (p. 241).

Two constructs and their opposites related to energizing and organizing effects of emotion account for the possible impact of emotions on the athletic performance process (Hanin, 1997, 2000, 2004): energy mobilization (and energy de-mobilization) and energy utilization (and misuse of energy). Optimal and dysfunctional emotion function can be conceptualized within the framework of two closely related but independent factors: energy mobilization (optimal effort, intensity) and energy utilization (efficiency, optimal information processing). The former is related to the situational resources available to an individual performer, whereas the latter characterizes the efficiency of using these resources. Based on these two factors, four relatively independent global effects of emotions are derived: (1) energizing or energy-mobilizing effects, (2) energy de-mobilizing effects, (3) energy utilization or regulation effects, and (4) energy misuse or deregulation effects. These four types of effects provide a framework for interpretation of separate and interactive impacts of pleasant and unpleasant emotions on individual performance. Based on the nature of these interactions, the total impact of emotions on athletic performance can be optimal (regarding effort and skill), para-optimal (with only effort or skill being optimal), or dysfunctional (both in effort and skill).

From the functional effect perspective, the constructs of energy mobilization-utilization (and their opposites) seem useful in explaining why, for some athletes, optimal emotions are predominantly pleasant, whereas, for other athletes, they are unpleasant. For instance, low-anxious athletes are typically smart users of available energy and are less distracted by task-irrelevant and energy-wasting concerns. In contrast, high-anxious athletes typically generate more energy, especially in stressful or emergency situations, because they are often less efficient in its use due to a narrow attention focus and an overload in information-processing function. Thus, unpleasant emotions, such as anxiety, are functionally useful for these athletes in that they help to generate additional energy to compensate for the apparent limitation in information processing or the use of energy.

Effectiveness of athletic performance is usually related to the amount of available energy and its efficient use. Different athletes can be successful by using different resources. In other words, the same level of performance may be achieved either through the increase of total effort or via skillful (smart) utilization of available resources (efficiency). However, usually optimal emotion regulatory function is manifested in an athlete's efficient recruitment (effort) and utilization (skill) of available resources, resulting in energizing and organizing effects on performance. In contrast, emotion dysfunction in self-regulation usually reflects a failure to recruit resources and their inefficient utilization, resulting in de-energizing and disorganizing effects of emotion on athletic performance.

Optimality of emotions, then, is related to their mobilizing function and getting ready for a task at hand by using either normal resources, as in the case of pleasant optimal (P+) emotions, or emergency resources, as in the case of unpleasant optimal (N+) strong emotions. In contrast, dysfunctional emotions (both unpleasant, N–, and pleasant, P–) are signals of inability to effectively use available resources or to compensate for their situational depletion. Too much satisfaction or celebration of intermediate success can be really distracting and demobilizational. Therefore, both positive and negative emotions can produce adaptive and maladaptive outcomes. Apparently, total effects depend on the interaction of mixed (pleasant and unpleasant) emotions and their ratio (of positive and negative).

There is evidence suggesting that high ratios of positive to negative affect would distinguish individuals who flourish (live within an optimal range of human functioning) from those who do not (Fredrickson & Losada, 2005). These investigators, applying the reformulated balanced-states-of-mind model (Schwartz, 1997), showed that positivity ratios at or above 2.9 are associated with human flourishing (Fredrickson & Losada, 2005, p. 685). Problems occur with too much positivity, and appropriate negativity may play an important role in the complex dynamics of human flourishing. Moreover, certain forms of negativity promote flourishing better than others (pp. 684–685). Although the positivity ratio was found to be one of the correlates of successful athletic performance (Hanin, Jokela, & Syrjä, 1998), both positivity and negativity of emotions should be appropriate or optimal for the task at hand, especially in high-achievement sports. Future research could also examine the role of the functionality-to-dysfunctionality ratio reflecting interactive effects of different emotion effects.

CONCLUSION

The main purpose of this chapter was to review selected issues and perspectives with a focus on defining characteristics, antecedents, and consequences of emotional experiences related to athletic performance. The emphasis on basic emotion dimensions (form, content, intensity, and partially time and context) seems especially appropriate. It provides conceptual and methodological tools to describe, predict, and partly explain situational emotional experiences and meta-experiences related to athletic performance. From the applied perspective, the major advantage of the individualized approach to studying emotion-performance relationships is in its ability to describe and explain findings that are often missed or ignored in group-oriented models. The resource-matching hypothesis was proposed to explain intra- and interindividual variability of optimal and dysfunctional emotion experiences. Future research may focus on relatively stable emotion patterns and meta-experiences that explain idiosyncratic preference in appraisals and coping processes.

There is ample empirical evidence that unpleasant emotions such as anxiety, anger, and tension are often situationally helpful for athletic performance. Such strong unpleasant emotions can help generate more energy and sustain effort; they often can compensate for a situational lack or depletion of needed resources, for instance, in the case of extreme fatigue. These emotions, if well channeled in the task process, can substantially postpone fatigue, sustain alertness, and maintain the right focus. In other words, coping with competitive stress involves not only alleviating it, but also using it to enhance performance.

There is also evidence that pleasant emotions are not always beneficial for performance, especially in sports requiring sustained focus, effort, and persistency for a relatively long time. Excessive complacency and satisfaction following unexpected or repeated successes can present a special problem in high-achievement settings because of the de-motivational impact. Moreover, high self-confidence can sometimes lead to excessive complacency and underestimation of an opponent, resulting in insufficient alertness, lack of focus, or carelessness and too much risk taking. These, in turn, can have harmful effects on performance, often leading to unexpected and season-ending injuries (Devonport, Lane, & Hanin, 2005; Würth &

Hanin, 2005). In such cases, self-generated labels of idiosyncratic emotional experiences are the best indicators of how an athlete can perform up to his or her potential (either stress-free or using competitive stress to advantage). These findings suggest that another promising area in emotion research in high-achievement sport is to establish the role of emotion in optimal recovery. Similar to identification of emotions that have optimal and dysfunctional effects on individual performance, it is possible to estimate which emotions are optimal for effective recovery after considerable training loads or important competitions (Hanin, 2002).

Research on emotional experiences related to athletic performance has direct practical implications. For instance, competitive athletes usually face three issues: how to identify emotional states related to individually successful and poor performances, how to predict emotion-performance relationships, and how to select person- and task-relevant techniques of self-regulation. Compelling empirical evidence described in this chapter provides several tentative guidelines on how to deal with these three issues.

First, to identify individually optimal and dysfunctional emotional experiences, establish the individually relevant cluster (constellation) of emotions and their intensities prior to, during, and after successful and less than successful (poor, average, or customary) performances. These qualitatively and quantitatively extreme situational experiences serve as individualized criteria in the evaluation of currently anticipated and experienced emotional states. Additionally, it is important to identify athletes' specific beliefs and attitudes about their emotion impact on performance (their meta-experiences). Are they aware of such effects? How do they usually cope with stress- and complacency-producing situations? Are these situational emotional experiences random or relatively stable patterns, which athletes can or cannot reproduce in important competitions? The main purpose of such individualized assessments is to enhance an athlete's awareness and acceptance of these experiences.

Second, prediction of emotion-performance relationships is based on the notion of being in or out of the zone, using categorical or continuous (intensity-impact contingencies) approaches. A categorical approach predicts performance based on the comparison between previously established individual zones and actual scores of intensity. A continuous approach is based on perceived intensity-impact contingencies along the entire working intensity range of each emotion. Here the emphasis is on an estimation of partial and total effects rather than only a selected optimal range of each emotion. In both cases, a decision about emotion regulation is based on the magnitude of deviations either from optimal and dysfunctional zones or from a total effect in the selected emotion modality. Furthermore, intervention should aim not only at helping athletes to enter or reenter their optimal zones, but also to stay away from the dysfunctional zones. Finally, predictions should also consider the total anticipated functional effects of emotion on performance that are usually manifested in an increase (or a decrease) of effort (energy) and efficiency (or inefficiency) in the utilization of available resources.

Third, emotion regulation refers to changes associated with activated emotions. These include changes in the emotion itself (e.g., changes in intensity, duration; Thompson, 1994) or in other psychological processes (e.g., memory, social interaction). However, emotion regulation is not defined by which emotions are activated but by systematic changes associated with activated emotions. Thus, evidence that one person is angrier than another does not by itself show that the first person is regulating anger differently from the second (Cole et al., 2004).

Although there are numerous techniques of emotion regulation in the practice of sport psychology, effective emotion regulation should be based on individualized assessments and predictions of emotion performance relationships. Moreover, a selected method or intervention strategy (technique) should match an athlete's resources and individual style, as well as the demands of the situation. In other words, the method should match previously established individual patterns of coping with emotion-inducing situations. Additionally, the effective intervention program usually includes not one but several appropriate methods of self-regulation. Finally, a focus on different modalities of psychobiosocial state with multimodal and intermodal orientation is another new research direction worth exploring in the future.

Cole et al. (2004) provide a detailed discussion of an emotion regulation construct that could be relevant in sport. For instance, it is suggested that the term *emotion regulation* can denote two types of regulatory phenomena: emotion as *regulating* and emotion as *regulated*. Emotion as regulating refers to changes that appear to result from the activated emotion. Emotion as regulated refers to changes in the activated emotion (in emotion valence, intensity, or time course). These changes may occur within the individual (e.g., reducing stress through self-soothing) or between individuals (e.g., a player provides support for a teammate).

Finally, there are several directions for effective emotion regulation. Most focus directly on emotional response by using different mental skills. However, there are other options, such as a change in the current situation or its perception (personal meaning) by an athlete, or a special organization of athletic activity for an athlete or a team (role expectations and game tactics).

The performance focus in emotion research is central in high-achievement sport. However, it does not preclude seeing these results in a wider context. Specifically, emotion impact (outcomes) can have optimal and dysfunctional outcomes not only for performance but also for general well-being (Diener, 2000) of athletes and their health status, quality of leisure time, and other domains of their life. The emphasis on performance, however, is understandable, as sport and athletic achievement is one of the most important domains in the life of athletes.

REFERENCES

Alpert, R., & Haber, R. N. (1960). Anxiety in academic achievement situations. *Journal of Abnormal and Social Psychology, 61,* 207–215.

Annesi, J. J. (1998). Applications of the individual zones of optimal functioning model for the multimodal treatment of precompetitive anxiety. *Sport Psychologist, 12*(3), 300–316.

Berlyne, D. E. (1960). *Conflict, arousal, and curiosity.* New York: McGraw-Hill.

Burton, D., & Naylor, S. (1997). Is anxiety really facilitative? Reaction to the myth that cognitive anxiety always impairs sport performance. *Journal of Applied Sport Psychology, 9,* 295–302.

Carver, C. (2003). Pleasure as a sign you can attend to something else: Placing positive feelings within a general model of affect. *Cognition and Emotion, 17*(2), 241–261.

Cerin, E., Szabo, A., Hunt, N., & Williams, C. (2000). Temporal patterning of competitive emotions: A critical review. *Journal of Sports Sciences, 18,* 605–626.

Cohen, A. B., Tenenbaum, G., & English, R. W. (in press). Emotions and golf performance: An IZOF-based applied sport psychology case study. *Journal of Behavioral Modification.*

Cole, P. M., Martin, S. E., & Dennis, T. A. (2004). Emotion regulation as a scientific construct: Methodological challenges and directions for child development research. *Child Development, 75,* 317–333.

Cratty, B. J., & Hanin, Y. L. (1980). *The athlete in the sports team: Social psychological guidelines for coaches and athletes.* Denver, CO: Love Publishing.

Crocker, P. R. E., Kowalski, K. C., Graham, T. R., & Kowalski, N. P. (2002). Emotion in sport. In J. M. Silva & D. E. Stevens (Eds.), *Psychological foundations of sport* (pp. 107–131). Boston: Allyn & Bacon.

Deci, E. L. (1980). *The psychology of self-determination.* Lexington, MA: Heath.

Devonport, T. J., Lane, A. M., & Hanin, Y. L. (2005). Emotional states of athletes prior to performance-induced injury. *Journal of Sports Science and Medicine, 4,* 382–394.

Diener, E. (2000). Subjective well-being. *American Psychologist, 55*(1), 34–43.

Diener, E., & Emmons, R. A. (1985). The independence of positive and negative affect. *Journal of Personality and Social Psychology, 47*(5), 1105–1117.

Eysenck, H. J. (1975). The measurement of emotions: Psychological parameters and methods. In L. Levi (Ed.), *Emotions: Their parameters and measurement* (pp. 439–467). New York: Raven Press.

Folkman, S., & Lazarus, R. S. (1985). If it changes it must be a process: Study of emotion and coping during three stages of a college examination. *Journal of Personality and Social Psychology, 48*(1), 150–170.

Fredrickson, B. L. (2001). The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American Psychologist, 56*(3), 218–226.

Fredrickson, B. L., & Losada, M. F. (2005). Positive affect and the complex dynamics of human flourishing. *American Psychologist, 60*(7), 678–686.

Freeman, G. L. (1940). The relationships between performance level and bodily activity level. *Journal of Experimental Psychology, 26,* 602–608.

Frijda, N. (1986). *The emotions.* Cambridge, England: Cambridge University Press.

Ganzen, V. A. (1984). *Systemnyje opisanija v psikhologii* [Systems descriptions in psychology]. Leningrad, Russia: Leningrad University Press.

Golden, A. S., Tenenbaum, G., & Kamata, A. (2004). Affect-related performance zones: An idiographic method for linking affect to performance. *International Journal of Sport and Exercise Psychology, 2,* 24–42.

Gould, D., & Tuffey, S. (1996). Zones of optimal functioning research: A review and critique. *Anxiety, Stress, and Coping, 9*(1), 53–68.

Hackfort, D., & Schwenkmezger, P. (1993). Anxiety. In R. N. Singer, M. Murphey, & L. K. Tennant (Eds.), *Handbook of research on sport psychology* (pp. 328–364). New York: Macmillan.

Hanin, Y. L. (1978). A study of anxiety in sports. In W. F. Straub (Ed.), *Sport psychology: An analysis of athlete behavior* (pp. 236–249). Ithaca, NY: Movement Publications.

Hanin, Y. L. (1980). *Psychology of communication in sports.* Moscow, Russia: Physical Culture and Sport Publishers.

Hanin, Y. L. (1986). The state-trait anxiety research on sports in the USSR. In C. D. Spielberger & R. Diaz-Guerrero (Eds.), *Cross-cultural anxiety* (Vol. 3, pp. 45–64). Washington, DC: Hemisphere.

Hanin, Y. L. (1989). Interpersonal and intragroup anxiety in sports. In D. Hackfort & C. D. Spielberger (Eds.), *Anxiety in sports* (pp. 19–28). Washington, DC: Hemisphere.

Hanin, Y. L. (1992). Social psychology and sport: Communication processes in top performance teams. *Sports Science Review, 1*(2), 13–28.

Hanin, Y. L. (1993). Optimal performance emotions in top athletes. In S. Serpa, J. Alves, V. Ferreira, & A. Paula-Brito (Eds.), *Proceedings of the 8th World Congress of Sport Psychology: Sport psychology: An integrated approach* (pp. 229–232). Lisbon, Portugal: ISSP.

Hanin, Y. L. (1995). Individual zones of optimal functioning (IZOF) model: An idiographic approach to performance anxiety. In K. Henschen & W. Straub (Eds.), *Sport psychology: An analysis of athlete behavior* (pp. 103–119). Longmeadow, MA: Movement Publications.

Hanin, Y. L. (1997). Emotions and athletic performance: Individual zones of optimal functioning model. *European Yearbook of Sport Psychology, 1,* 29–72.

Hanin, Y. L. (1999). Sports-specific emotion-motivational profiling: An individualized assessment programme. In V. Hosek, P. Tilinger, & L. Bilek (Eds.), *Proceedings of the 10th European Congress of Sport Psychology: Pt. 1. Psychology of sport: Enhancing the quality of life* (pp. 238–240). Prague, Czech Republic: Charles University Press.

Hanin, Y. L. (Ed.). (2000). *Emotions in sport.* Champaign, IL: Human Kinetics.

Hanin, Y. L. (2000, May). *Emotions in hockey.* Paper presented at the IIHF International Coaching Symposium: Building a Hockey Base for the 21st Century, St. Petersburg, Russia.

Hanin, Y. L. (2002). Individually optimal recovery in sports: An application of the IZOF model. In M. Kellmann (Ed.), *Enhancing recovery: Preventing underperformance in athletes* (pp. 199–217). Champaign, IL: Human Kinetics.

Hanin, Y. L. (2003, February). Performance related emotional states in sport: A qualitative analysis [Online journal, 48 paragraphs]. *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research, 4*(1). Available from http://www.qualitative-research.net/fqs-texte/1-03/1-03hanin-e.htm.

Hanin, Y. L. (2004). Emotions in sport: An individualized approach. In C. D. Spielberger (Ed.), *Encyclopedia of applied psychology* (Vol. 1, pp. 739–750). Oxford, England: Elsevier Academic Press.

Hanin, Y. L. (2005, June). *Psychology of coaching excellence.* Paper presented at the International Conference of Ice-Hockey Coaches, The International Center of Excellence in Ice-Hockey, Vierumäki, Finland.

Hanin, Y. L., & Bulanova, G. V. (1981). Status i emotsional′noe samochuvstvie lichnosti v gruppakh raznogo urovnya razvitija [Status and emotional state in groups of different level of development]. *Voprosy Psykhologuii, 5,* 124–129.

Hanin, Y. L., Jokela, M., & Syrjä, P. (1998). Emotion correlates of successful and poor performances: A comparison of individualized and group-oriented measures. In A. J. Sargent & H. Siddons (Eds.), *Proceedings of 3rd Annual Congress of the European College of Sport Science: From community health to elite sport* (p. 136). Manchester, England: Centre for Health Care Development.

Hanin, Y. L., & Stambulova, N. B. (2002). Metaphoric description of performance states: An application of the IZOF model. *Sport Psychologist, 16*(4), 396–415.

Hanin, Y. L., & Stambulova, N. B. (2004). Sport psychology: Overview. In C. D. Spielberger (Ed.), *Encyclopedia of applied psychology* (Vol. 3, pp. 463–477). Oxford, England: Elsevier Academic Press.

Hanin, Y. L., & Syrjä, P. (1995). Performance affect in junior ice hockey players: An application of the individual zones of optimal functioning model. *Sport Psychologist, 9,* 169–187.

Hanin, Y. L., & Syrjä, P. (1996). Predicted, actual and recalled affect in Olympic-level soccer players: Idiographic assessments on individualized scales. *Journal of Sport and Exercise Psychology, 18*(3), 325–335.

Hardy, L. (1990). A catastrophe model of performance in sport. In J. G. Jones & L. Hardy (Eds.), *Stress and performance in sport* (pp. 81–106). Chichester, West Sussex, England: Wiley.

Hardy, L. (1997). Three myths about applied consultancy work. *Journal of Applied Sport Psychology, 9,* 277–294.

Hareli, S., & Weiner, B. (2002). Social emotions and personality inferences: A scaffold for a new direction in the study of achievement motivation. *Educational Psychologist, 37*(3), 183–193.

Hendry, L. B., & Kloep, M. (2002). *Lifespan development: Resources, challenges, and risks.* London, England: Thomson Learning.

Hobfoll, S. E. (1989). Conservation of resources: A new attempt at conceptualizing stress. *American Psychologist, 44*(3), 513–524.

Izard, C. E. (1977). *Human emotions.* New York: Plenum Press.

Izard, C. E. (1993). Four systems for emotion activation: Cognitive and non-cognitive processes. *Psychological Review, 100,* 68–90.

Jokela, M., & Hanin, Y. (1999). Does individual zones of optimal functioning model discriminate between successful and less successful athletes? A meta-analysis. *Journal of Sport Sciences, 17,* 873–887.

Jones, G. (1991). Recent developments and current issues in competitive state anxiety research. *Psychologist, 4,* 152–155.

Jones, G. (1995). Competitive anxiety in sport. In S. J. H. Biddle (Ed.), *European perspectives on exercise and sport psychology* (pp. 128–153). Leeds, England: Human Kinetics.

Jones, G., & Hanton, S. (2001). Pre-competition feeling states and directional anxiety interpretations. *Journal of Sports Sciences, 19,* 385–395.

Kamata, A., Tenenbaum, G., & Hanin, Y. L. (2002). Individual zone of optimal functioning (IZOF): A probabilistic conceptualization. *Journal of Sport and Exercise Psychology, 24*(2), 189–208.

Kerr, J. H. (1997). *Motivation and emotion in sport: Reversal theory.* East Sussex, England: Psychology Press.

Koltyn, K. F., & Morgan, W. P. (1997). Influence of wet suit wear on anxiety responses to underwater exercise. *Undersea and Hyperbaric Medicine, 24,* 23–28.

Kuhl, J. (1994). A theory of action and state orientations. In J. Kuhl & J. Beckmann (Eds.), *Volition and personality* (pp. 9–46). Göttingen, South Lower Saxony, Germany: Hogrefe & Huber.

Lacey, J. I. (1967). Somatic patterning and stress: Some revisions of the activation theory. In M. H. Appley & R. Trumbell (Eds.), *Psychological stress* (pp. 14–37). New York: Appleton-Century-Crofts.

Landers, D. M. (1994). Performance, stress, and health: Overall reaction. *Quest, 46,* 123–135.

Lane, A., Terry, P., & Karageorghis, L. (1995). Antecedents of multidimensional competitive state anxiety and self-confidence in duathletes. *Perceptual and Motor Skills, 80,* 911–919.

Lazarus, R. S. (1991). Progress on a cognitive-motivational-relational theory of emotion. *American Psychologist, 46,* 819–834.

Lazarus, R. S. (1993). From psychological stress to the emotions: A history of changing outlooks. *Annual Review of Psychology, 44,* 1–21.

Lazarus, R. S. (1998). Coping from the perspective of personality. *Zeitschrift für Differenzialle und Diagnostische Psychologie, 19*(4), 211–225.

Lazarus, R. S. (2000). How emotions influence performance in competitive sports. *Sport Psychologist, 14,* 229–252.

Liebert, R. M., & Morris, L. W. (1967). Cognitive and emotional components of test anxiety: A distinction and some initial data. *Psychological Reports, 20,* 975–978.

Mahoney, M. J., & Avener, M. (1977). Psychology of the elite athlete: An exploratory study. *Cognitive Therapy and Research, 1,* 135–141.

Mandler, G. (1975). The search for emotion. In L. Levi (Ed.), *Emotions: Their parameters and measurement* (pp. 1–15). New York: Raven Press.

Martens, R. (1987). Science, knowledge, and sport psychology. *Sport Psychologist, 1*(1), 29–55.

Martens, R., Vealey, R. S., & Burton, D. (1990). *Competitive anxiety in sport.* Champaign, IL: Human Kinetics.

Mayer, J. D., & Stevens, A. A. (1994). An emerging understanding of the reflective (meta-)experience of mood. *Journal of Research in Personality, 28,* 351–373.

McNair, D. M., Lorr, M., & Droppleman, L. F. (1971). *Manual for the Profile of Mood States.* San Diego, CA: Educational and Industrial Testing Service.

Morgan, W. P. (1984). Selected psychological factors limiting performance: A mental health model. In D. H. Clarke & H. M. Eckert (Eds.), *Limits of human performance* (pp. 70–80). Champaign, IL: Human Kinetics.

Oatley, K., & Jenkins, J. M. (1992). Human emotions: Function and dysfunction. *Annual Review of Psychology, 43,* 55–85.

Ortony, A., Clore, G. L., & Collins, A. (1988). *The cognitive structure of emotions.* Cambridge, England: Cambridge University Press.

Parkinson, B. (1994). Emotion. In A. M. Colman (Ed.), *Companion encyclopedia of psychology* (Vol. 1, pp. 485–505). New York: Routledge.

Pijpers, J. R., Oudejans, R. R. D., Holsheimer, F., & Bakker, F. C. (2003). Anxiety-performance relationships in climbing: A process-oriented approach. *Psychology of Sport and Exercise, 4,* 283–304.

Plutchik, P. (1980). *Emotion: A psychobioevolutionary synthesis.* New York: Harper & Row.

Raglin, J. S. (1992). Anxiety and sport performance. In J. O. Holloszy (Ed.), *Exercise and sports sciences reviews* (Vol. 20, pp. 243–274). Baltimore: Williams & Wilkins.

Raglin J. S., & Hanin, Y. (2000). Competitive anxiety and athletic performance. In Y. L. Hanin (Ed.), *Emotions in sport* (pp. 93–112). Champaign, IL: Human Kinetics.

Raglin, J. S., & Turner, P. E. (1993). Anxiety and performance in track and field athletes: A comparison of the inverted-U hypothesis with zone of optimal function theory. *Personality and Individual Differences, 14,* 163–171.

Robazza, C. (2006). Emotion in sport: An IZOF perspective. In S. Hanton & S. D. Mellalieu (Eds.), *Literature reviews in sport psychology* (pp. 127–158). New York: Nova Science.

Robazza, C., & Bortoli, L. (2003). Intensity, idiosyncratic content and functional impact of performance-related emotions in athletes. *Journal of Sports Sciences, 21,* 171–189.

Robazza, C., Bortoli, L., & Hanin, Y. (2004). Pre-competition emotions, bodily symptoms, and task-specific qualities as predictors of performance in high-level karate athletes. *Journal of Applied Sport Psychology, 16*(2), 151–165.

Robazza, C., Bortoli, L., & Hanin, Y. (in press). Perceived effect of emotion intensity on athletic performance: A contingency-based individualized approach. *Research Quarterly for Exercise and Sport.*

Robazza, C., Pellizzari, M., & Hanin, Y. (2004). Emotion self-regulation and athletic performance: An application of the IZOF model. *Psychology of Sport and Exercise, 5*(4), 379–404.

Ruiz, M. C. (2004). *Anger and optimal performance in karate: An application of the IZOF model* (University of Jyväskylä, Jyväskylä, Jyväskylä Studies in Education). *Psychology and Social Research, 254,* 130.

Ruiz, M. C., & Hanin, Y. L. (2004a). Idiosyncratic description of anger states in skilled Spanish karate athletes: An application of the IZOF model. *Revista de Psicologia del Deporte, 13*(1), 75–93.

Ruiz, M. C., & Hanin, Y. L. (2004b). Metaphoric description and individualized emotion profiling of performance related states in high-level karate athletes. *Journal of Applied Sport Psychology, 16*(3), 1–16.

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology, 39,* 1161–1178.

Russell, J. A., Weiss, A., & Mendelsohn, G. A. (1989). Affect grid: A single-item scale of pleasure and arousal. *Journal of Personality and Social Psychology, 57*(3), 493–502.

Schimmack, U. (2001). Pleasure, displeasure, and mixed feelings: Are semantic opposites mutually exclusive? *Cognition and Emotion, 15*(1), 81–97.

Schlosberg, H. (1954). Three dimensions of emotion. *Psychological Review, 61*(2), 81–88.

Schwartz, R. M. (1997). Consider the simple screw: Cognitive science, quality improvement, and psychotherapy. *Journal of Consulting and Clinical Psychology, 65,* 970–983.

Sève, C., Ria, L., Poizat, G., Saury, J., & Durand, M. (in press). Performance-induced emotions: Experienced during high-stakes table tennis matches. *Psychology of Sport and Exercise.*

Simon, H. A. (1967). Motivational and emotional controls of cognition. *Psychology Review, 74,* 29–39.

Smith, R. E. (1996). Performance anxiety, cognitive interference, and concentration enhancement strategies in sports. In I. G. Sarason, G. R. Pierce, & B. R. Sarason (Eds.), *Cognitive interference: Theories, methods, and findings* (pp. 261–284). Hillsdale, NJ: Erlbaum.

Smith, R. E., Smoll, F. L., & Schutz, R. W. (1990). Measurement and correlates of sport specific cognitive and somatic trait anxiety: The Sport Anxiety Scale. *Anxiety Research, 2,* 263–280.

Spielberger, C. D., Gorsuch, R. L., & Lushene, R. E. (1970). *Manual for the State-Trait Anxiety Inventory (STAI).* Palo Alto, CA: Consulting Psychologist Press.

Stambulova, N. B. (2000). Athletes' crises: A developmental perspective. *International Journal of Sport Psychology, 31*(4), 584–601.

Syrjä, P. (2000). *Performance-related emotions in highly skilled soccer players: A longitudinal study based on the IZOF model—Studies in sport, physical education and health* (Vol. 67). Jyväskylä, Finland: Jyväskylä University Printing House. Available from http://selene.lib.jyu.fi:8080/gradu/g/psyrjan.pdf.

Syrjä, P., & Hanin, Y. (1997). Measurement of emotion in sport: A comparison of individualized and normative scales. In R. Lidor & M. Bar-Eli (Eds.), *Proceeding of the ISSP IX World Congress of Sport Psychology* (Pt. 2, pp. 682–684). Netanya, Israel: Wingate Institute.

Syrjä, P., & Hanin, Y. (1998). Individualized and group-oriented measures of emotion in sport: A comparative study. *Journal of Sports Sciences, 16*(5), 398–399.

Syrjä, P., Hanin, Y., & Pesonen, T. (1995). Emotion and performance relationship in soccer players. In R. Vanfraechem-Raway & Y. Vanden Auweele (Eds.), *Proceedings of the 9th European Congress on Sport Psychology* (Pt. 1, pp. 191–197). Brussels, Belgium: Belgian Federation of Sport Psychology.

Thompson, R. A. (1994). Emotion regulation: In search of definition. *Monographs of the Society for Research in Child Development, 59*(2/3, Serial No. 240), 25–52.

Turner, P. E., & Raglin, J. S. (1996). Variability in precompetition anxiety and performance in college track and field athletes. *Medicine and Science in Sports and Exercise, 28*(3), 378–385.

Vallerand, R. J. (1997). Towards a hierarchical model of intrinsic and extrinsic motivation. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 29, pp. 271–360). San Diego, CA: Academic Press.

Vallerand, R. J., & Blanchard, C. M. (2000). The study of emotion in sport and exercise. In Y. L. Hanin (Ed.), *Emotions in sport* (pp. 3–37). Champaign, IL: Human Kinetics.

Vygotsky, L. S. (1984). Sobranie sochinenii [A 6-volume collection of works]. In D. B. El'konin (Ed.), *Child psychology* (Vol. 4, p. 247). Moscow, Russia: Pedagogika. (Original work published 1926)

Wang, Y., & Morgan, W. P. (1987). Convergent validity of a body awareness scale. *Medicine and Science in Sports and Exercise, 19,* S579.

Watson, D., & Tellegen, A. (1985). Towards a consensual structure of mood. *Psychological Bulletin, 98,* 219–235.

Weinberg, R. S. (1978). The effects of success and failure on patterning of neuromuscular energy. *Journal of Motor Behavior, 10,* 53–61.

Weinberg, R. S., & Hunt, V. V. (1976). The interrelationships between anxiety, motor performance andelectromiography. *Journal of Motor Behavior, 8,* 219–224.

Woodman, T., & Hardy, L. (2001). Stress and anxiety. In R. N. Singer, H. A. Hausenblas, & C. M. Janelle (Eds.), *Handbook of sport psychology* (2nd ed., pp. 290–318). New York: Wiley.

Würth, S., & Hanin, Y. L. (2005). Der emotionale vorstartzustand im zusammenhang mit sportververletzungen [Pre-performance emotional state related to sport injuries]. *Leipziger Sportwissenschaftliche Beitrage (LSB), 46*(1), 117–143.

Yerkes, R. M., & Dodson, J. D. (1908). The relation of strength of stimulus to rapidity of habit-formation. *Journal of Comparative Neurology and Psychology, 18,* 459–482.

CHAPTER 3

Intrinsic and Extrinsic Motivation in Sport and Physical Activity

A Review and a Look at the Future

ROBERT J. VALLERAND

Motivation has been repeatedly reported as a key element of athletes' success in sports (Gould, Dieffenbach, & Moffett, 2002) and exercisers' persistence with an exercise regimen (Wilson & Rodgers, in press). Thus, it is not surprising that much research has been conducted on motivation in sport and physical activity. Intrinsic motivation (doing something for its own sake) and extrinsic motivation (doing something as a means to an end and not for its own sake), in particular, have been very popular topics and have allowed researchers to make sense of several phenomena of importance in sport and physical activity (see Vallerand, Deci, & Ryan, 1987; Vallerand & Rousseau, 2001). The purpose of this chapter is to present a review of research on intrinsic and extrinsic motivation with a keen eye on the most recent research and trends. I start by defining motivation in general and intrinsic and extrinsic motivation in particular. I then present a brief overview of the organismic approach, specifically self-determination theory (SDT; Deci & Ryan, 2000). I present the hierarchical model of intrinsic and extrinsic motivation (HMIEM; Vallerand, 1997, 2001, in press; Vallerand & Ratelle, 2002), which serves as the organizing framework for the review. I then focus on recent research that has appeared since our initial review (Vallerand & Rousseau, 2001). Finally, I conclude by highlighting recent research trends considered to be important and provide suggestions for future research directions that appear promising.

MOTIVATION AND SELF-DETERMINATION THEORY

The concept of motivation can be defined as "the hypothetical construct used to describe the internal and/or external forces that produce the initiation, direction, intensity, and persistence of behavior" (Vallerand & Thill, 1993, p. 18; translated from French). The emphasis on internal and external forces fits in very well with the presence of two major types of motivation that have been heavily researched, namely, intrinsic and extrinsic motivation. Whereas initially research and models focused on the reactive or passive role of humans in their action with the environment, later research showed that people don't merely react to rewards (Weiner, 1972). In fact, a movement gathered momentum in the late 1950s and early 1960s positing that the innate needs of competence (White, 1959), autonomy (Angyal, 1941; deCharms, 1968), and relatedness (Harlow, 1958) were important in leading the person to be proactive in exploring the environment. This led to the development of a second position, termed the organismic approach, where it is proposed that individuals are actively engaged and proactive in their interaction with the environment because "people are inherently motivated to feel connected to others within a social milieu [*relatedness*], to function effectively in that milieu [*competence*], and to feel a sense of personal initiative while doing so [*autonomy*]" (Deci & Ryan, 1994, p. 7).

Self-determination theory (Deci & Ryan, 1985, 2000) has pursued the work of early need theorists. It posits that competence, autonomy, and relatedness are universally essential for optimal human development, motivation, and integrity. That is, a need serves the function of promoting psychological health; conversely, when needs are not met, psychological health is undermined. Research supports this crucial hypothesis with students (Reis, Sheldon, Gable, Roscoe, & Ryan, 2000) and athletes (Gagné, Ryan, &

Bargman, 2003) in different cultures (Sheldon, Elliot, Kim, & Kasser, 2001). Thus, clearly needs do matter with respect to people's well-being and motivation. However, needs matter for at least two other reasons. First, from a motivational perspective, needs represent the energy underlying people's behavior. That is, people engage in certain activities in order to satisfy their needs. To the extent that their needs are satisfied, people will be motivated to engage in such activities out of their own choosing without any prodding (self-determined motivation). A second reason needs are important is because they represent the process through which changes in motivation take place. The fulfillment of our psychological needs is important because it orients us toward certain types of behaviors and activities in the hope that they will fulfill our needs. In such a quest, the social environment is as much an opponent as an ally, at times leading us to activities that satisfy our needs and at other times steering us in directions that go counter to the adaptive development of the self and the experience of positive outcomes.

A HIERARCHICAL MODEL OF INTRINSIC AND EXTRINSIC MOTIVATION

Over the years, research conducted on intrinsic and extrinsic motivation has shown that personality, situational-level-based motivation, and intermediate contextual level (or life domain) motivations are influenced by a host of factors and lead to various outcomes. Various conceptual frameworks in addition to SDT have been advanced to explain the major findings (see Vallerand, 1997). Building on such research and theory and especially SDT, a model has been proposed relative to the integration of the different levels at which motivation research has been conducted. The HMIEM (Vallerand, 1997, 2001, in press; Vallerand & Perreault, 1999; Vallerand & Ratelle, 2002) comprises five postulates and five corollaries. Taken together, these postulates and corollaries explain (a) the motivational determinants and consequences at three levels of generality as well as (b) the interactions among motivation at the three levels of generality, while taking into account the complexity of human motivation (see Figure 3.1). The model is briefly described next.

A Multidimensional Perspective of Motivation

A first postulate of the HMIEM is that the concepts of intrinsic motivation, extrinsic motivation, and amotivation are needed to make sense of a full range of motivational processes. Intrinsic motivation refers to performing an activity for itself and the pleasure and satisfaction derived from participation (Deci, 1971). Vallerand and his colleagues (Vallerand, Blais, Brière, & Pelletier, 1989; Vallerand et al., 1992, 1993) posited the existence of three types of intrinsic motivation: intrinsic motivation to know, intrinsic motivation to accomplish things, and intrinsic motivation to experience stimulation. Intrinsic motivation to know refers to engaging in an activity for the pleasure and satisfaction that one experiences while learning, exploring, or trying to understand something new. Basketball players who practice because they enjoy learning new offensive moves display intrinsic motivation to know. Intrinsic motivation to accomplish things pertains to engaging in a given activity for the pleasure and satisfaction experienced while one is *attempting* to accomplish or create something or to surpass oneself. Finally, intrinsic motivation to experience stimulation is at work when one engages in an activity to experience pleasant sensations associated mainly with one's senses (e.g., sensory and aesthetic pleasure). Swimmers who swim because they enjoy the pleasant sensations they experience while their bodies glide through water display this type of intrinsic motivation. This tripartite distinction highlights the different fashions in which intrinsic motivation may be experienced in sport and exercise. Much research (Fairchild, Horst, Finney, & Barron, 2005; Hein, Müür, & Koka, 2004) supports this taxonomy.

Extrinsic motivation refers to engaging in an activity as a means to an end and not for its own sake. There are different types of extrinsic motivation, some of which are more self-determined in nature (Deci & Ryan, 1985, 2000). In other words, individuals may *choose* to perform an activity, even though they do *not* do it for pleasure. Deci and Ryan (1985) have proposed four types of extrinsic motivation. External regulation refers to behavior that is regulated through external means, such as rewards and constraints. For instance, an athlete might say, "I'm going to today's practice because I want the coach to let me play tomorrow." With introjected regulation, individuals begin to internalize the reasons for their actions. However, this type of extrinsic motivation is not self-determined because individuals still experience pressure, although this time the pressure is self-imposed (e.g., through guilt and anxiety). An example of introjected regulation is the athlete who goes to a practice because he would feel guilty if he missed it. It is only with identified regulation that behavior is done out of choice. When they display

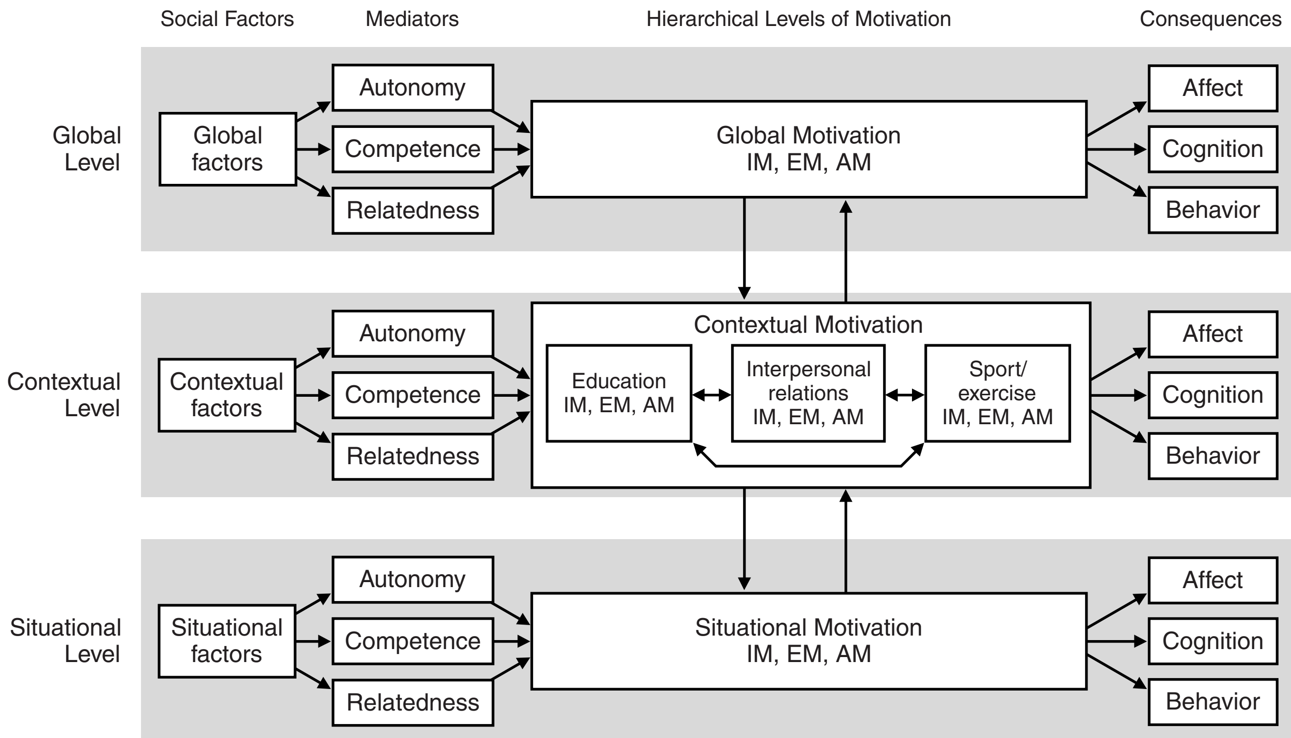


Figure 3.1 The hierarchical model of intrinsic and extrinsic motivation. *Note:* IM = Intrinsic Motivation; EM = Extrinsic Motivation; AM = Amotivation. *Source:* "Intrinsic and Extrinsic Motivation in Sport and Exercise: A Review Using the Hierarchical Model of Intrinsic and Extrinsic Motivation" (p. 391), by R. J. Vallerand and F. L. Rousseau, in *Handbook of Sport Psychology,* second edition, R. N. Singer, H. A. Hausenblas, and C. M. Janelle (Eds.), 2001, New York: Wiley. Reprinted with permission.

identified regulation, athletes freely perform the activity even if it is not pleasant in itself. An example of identified regulation is the soccer player who does not like weight lifting but who nevertheless chooses to do it because she knows that building her strength will allow her to become a better player. Integrated regulation also involves doing an activity out of choice; however, in this case, the choice represents a harmonious part of the individual's self. In other words, one's choices are made as a function of their coherence with other aspects of the self. An example of integrated regulation is the ice hockey player who chooses to postpone a night out with his friends on Friday to be in top shape for the big game on Saturday afternoon.

Finally, amotivation refers to the lack of intentionality and thus the relative absence of motivation. When amotivated, athletes experience feelings of incompetence and expectancies of uncontrollability. They are relatively without purpose with respect to the activity and therefore have little motivation (intrinsic or extrinsic) to perform it.

Motivation at Different Levels of Generality

A second issue underscored by Postulate 2 of the HMIEM is that intrinsic and extrinsic motivation and amotivation exist at three levels of generality: global, contextual, and situational. Motivation at the global level refers to a general motivational orientation to interact with the environment in an intrinsic, extrinsic, or amotivated way. It is similar to a personality trait where one is predominantly intrinsically or extrinsically motivated, or even amotivated. Motivation at the contextual level is an individual's usual motivational orientation toward a specific context or a set of specific and related activities. Research on intrinsic and extrinsic contextual motivation has typically focused on three contexts: education (or work), interpersonal relationships, and leisure (of which sport is an important part; see

Vallerand, 1997). Finally, motivation at the situational level refers to the motivation individuals experience when engaging in a specific activity at a given moment in time. Situational motivation refers to a motivational state. It is important to distinguish among these three levels as such a conceptualization provides a more refined understanding of motivational processes involved in human behavior.

Assessing Motivation

It is important to have a brief look at methodological advances that have taken place to assess the different types of motivation across the three levels of generality. This will facilitate the understanding of the review presented in the later sections.

At the situational level, researchers have developed the Situational Motivation Scale (SIMS; Guay, Vallerand, & Blanchard, 2000), which measures intrinsic motivation (without distinguishing the three types), identified and external types of extrinsic motivation, and amotivation. The choice to measure only four motivational types was dictated by the need to keep the scale as brief as possible (16 items, although an introjected regulation scale is also available) to capture situational motivation in many lab and field situations without overloading participants with a long questionnaire. The results of several studies (Edwards, Portman, & Bethea, 2002; Guay et al., 2000; Lévesque & Pelletier, 2003; Standage & Treasure, 2002; Standage, Treasure, Duda, & Prusak, 2003) have shown that the scale displays adequate factorial structure and internal consistency and leads to theory-informed predictions. Although several studies typically yielded support for the factorial structure of the scale (see Guay et al., 2000), some authors (Standage, Treasure, et al., 2003) suggested that the factorial structure of a 14-item version of the scale might be more appropriate than the 16-item original version. Close inspection of the Standage, Treasure, et al. (2003) data supports this. However, the data also reveal that overall the factorial structure of the 16-item scale is still appropriate. Because the use of the scale in sport has just begun and support for the full-scale version has been obtained in several studies, it is recommended that researchers use the full-scale and not the 14-item version at this point.

Scales assessing motivation at the contextual level have also been developed. Because we were mainly interested in college students and because research revealed that college students rated education, leisure, and interpersonal relationships as their three main life contexts (Blais, Vallerand, Gagnon, Brière, & Pelletier, 1990), scales were developed to measure motivation in these contexts. The Academic Motivation Scale (AMS; Vallerand et al., 1989, 1992, 1993) assesses contextual motivation toward education; the Interpersonal Motivation Inventory (Blais, Vallerand, Pelletier, & Brière, 1994) assesses contextual motivation in interpersonal relationships; and the Leisure Motivation Scale (Pelletier, Vallerand, Green-Demers, Blais, & Brière, 1996) measures contextual motivation toward leisure activities. Because sport represents an important type of leisure activity for most people and a full-fledged life context for athletes, we have also developed a scale to assess sport motivation, both in French (the Echelle de Motivation dans les Sports; Brière, Vallerand, Blais, & Pelletier, 1995) and in English (Sport Motivation Scale; SMS; Pelletier et al., 1995). The SMS assesses the seven types of motivational constructs described earlier, although recently Pelletier and Kabush (2005, cited in Pelletier & Sarrazin, in press) added an integrated regulation subscale to the SMS. The SMS has been translated into several languages and fully validated in French, English, Greek, and Finnish and used in a variety of sports too numerous to mention. Overall, the validity and reliability of the SMS has been repeatedly supported (see Pelletier & Sarrazin, in press, for a review). This also applies to measures of the other life contexts.

Scales assessing some of the constructs proposed by SDT and the HMIEM have been developed to measure motivation toward exercise, such as the Behavioral Regulation in Exercise Questionnaire (BREQ; Markland & Tobin, 2004; Mullan, Markland, & Ingledew, 1997), the Exercise Motivation Scale (Li, 1999), and the Perceived Locus of Causality Scale (Goudas, Biddle, & Fox, 1994). These scales have shown adequate levels of validity and reliability.

Finally, the Global Motivation Scale (GMS; Guay, Vallerand, Pelletier, & Blais, 1999) has been developed to assess the three different types of intrinsic motivation, and the identified, introjected, and external types of extrinsic motivation, as well as amotivation toward life in general. More recently, Pelletier and his colleagues (Pelletier, Dion, & Lévesque, 2004) have added an integration subscale. Results with the GMS indicate that the scale is both reliable and valid and relatively free from social desirability (Guay, Mageau, & Vallerand, 2003; Guay et al., 1999).

Motivation as a Social Phenomenon

A third issue of interest is that motivation is a social phenomenon. Corollary 3.1 of the hierarchical model states that motivation can result from social factors that can be global, contextual, or situational, depending on the level of generality. Global social factors are so pervasive that they are present in most aspects of a person's life. An example of a global factor is the role of parents, as their presence is felt across children's life and as such should affect their global motivation. On the other hand, contextual social factors are present on a general or recurrent basis in one specific life context but not necessarily in another. For example, a controlling coach may influence an adolescent's motivation toward sport but not toward education. Finally, situational social factors are present at a given point in time (e.g., receiving positive feedback from the coach after completing a great catch in baseball).

Corollary 3.2 is closely related to Corollary 3.1. In line with the work of several theorists (deCharms, 1968; Deci & Ryan, 2000; White, 1959), it states that the impact of social factors on motivation is mediated by perceptions of competence, autonomy, and relatedness. This means that motivation is not influenced by social factors per se, but by the way individuals *interpret* those factors in terms of facilitating their needs for competence, autonomy, and relatedness.

Motivation as an Intrapersonal Phenomenon

Motivation is also an intrapersonal phenomenon. According to Corollary 3.3, motivation at one level of the hierarchy also results from top-down effects of motivation at the proximal level higher up in the hierarchy. For example, if one's predominant contextual motivation toward a given sport is intrinsic motivation, then, all other factors being equal, one should have a tendency to display intrinsic motivation toward an activity related to one's sport at a specific point in time (at the situational level). Moreover, the dynamic nature of the relationship among motivations at different levels can result not only in top-down effects, but also in bottom-up effects. Thus, Postulate 4 states that over time, there is a recursive bottom-up relationship between motivation at a given level and motivation at the next higher level in the hierarchy. For example, an athlete repeatedly experiencing situational intrinsic motivation in a particular sport should eventually develop an increase in contextual intrinsic motivation toward this sport. In addition, contextual motivations can have facilitative or debilitative effects toward one another, depending on their level of self-determined motivation. The more self-determined one's motivation toward a given life context, the more it will facilitate one's motivation toward another life context because it is more fully integrated in the self. Finally, global motivation can also serve an integrative function regarding the interplay between two or more life contextual motivations and the experiences related to them (see Koestner, Bernieri, & Zuckerman, 1992).

Motivational Consequences

Motivation can also lead to important consequences of at least three types: affective, cognitive, and behavioral (Postulate 5; Vallerand, 1997). Furthermore, according to Corollary 5.1, consequences are hypothesized to be decreasingly positive from intrinsic motivation to amotivation. Finally, consequences can occur at all three levels of generality depending on the level of motivation that has produced them (Corollary 5.2).

In summary, the HMIEM deals with at least two important elements. First, it identifies the psychological mechanisms underlying the determinants and outcomes of motivation. In doing so, the model provides a rich framework to integrate existing knowledge on intrinsic and extrinsic motivation. Second, the hierarchical model proposes new directions for future research. Table 3.1 summarizes the

Table 3.1 Postulates and Corollaries of the Hierarchical Model

Postulate 1	A complete analysis of motivation must include intrinsic and extrinsic motivation and amotivation.
Postulate 2	Intrinsic and extrinsic motivation exist at three levels of generality: the global, contextual, and situational levels.
Postulate 3	Motivation is determined by social factors and top-down effects from motivation at the proximal level higher up in the hierarchy.
Corollary 3.1	Motivation can result from social factors that are either global, contextual, or situational depending on the level of generality.
Corollary 3.2	The impact of social factors on motivation is mediated by perceptions of competence, autonomy, and relatedness.
Corollary 3.3	Motivation results from top-down effects from motivation at the proximal level higher up in the hierarchy.
Postulate 4	There is a recursive bottom-up relationship between motivation at a given level and motivation at the next higher level in the hierarchy.
Postulate 5	Motivation leads to important consequences.
Corollary 5.1	Consequences are decreasingly positive from intrinsic motivation to amotivation.
Corollary 5.2	Motivational consequences exist at the three levels of the hierarchy, and the degree of generality of the consequences depends on the level of the motivation that has produced them.

Adapted from "Toward a Hierarchical Model of Intrinsic and Extrinsic Motivation" (Vol. 29, pp. 271–360), by R. J. Vallerand, in *Advances in Experimental Social Psychology,* M. P. Zanna (Ed.), 1997, New York: Academic Press.

postulates and corollaries of the model. This framework is used in this chapter to review the literature on intrinsic and extrinsic motivation in sport and physical activity.

RESEARCH ON MOTIVATION AT THE SITUATIONAL LEVEL

As discussed previously, situational motivation refers to the motivation individuals experience while engaging in a given activity at a specific point in time. An example would be the basketball player who is practicing her jump shot at 3:00 P.M. on a Saturday for the sheer pleasure of executing the movement and feeling the flow of the movement. In this section, the studies dealing with the determinants and consequences of situational motivation in sport and physical activity are reviewed.

Determinants

Several motivational determinants have been studied. Below, we focus on rewards and awards, competition, positive and negative feedback, and choice.

Rewards and Awards

The use of rewards, in particular, has attracted a lot of attention at the situational level over the past 10 years. Deci, Koestner, and Ryan (1999, 2001) conducted a meta-analysis of 128 laboratory experiments that revealed that rewards that are provided contingent on engaging in the activity, completing the activity, or reaching a certain level of performance all decrease intrinsic motivation. However, rewards that are not expected and that are task-noncontingent (not related to the task) do not decrease intrinsic motivation. Finally, although all participants (no gender effects) experience negative effects, children are more affected than college-age students. Laboratory research involving tasks associated with sport or exercise has yielded findings similar to that of the Deci et al. (1999) meta-analysis. Thus, athletes and participants who engage in a sport-related activity to receive a trophy or a reward display a decrease in situational intrinsic motivation as assessed by self-report scales (e.g., Thomas & Tennant, 1978) and the free-choice measure (Orlick & Mosher, 1978). Additional research is needed to determine if the negative effects of rewards and awards findings replicate in actual sport settings and to identify the boundaries of such effects.

Competition

In the context of competitive sport, the focus is often on beating the opponent. Initial research using a cognitive task has shown that such a competitive focus undermines the intrinsic motivation of young adults (Deci, Betley, Kahle, Abrams, & Porac, 1981). Results from the Vallerand, Gauvin, and Halliwell (1986b) study showed that this conclusion also applies to 10- to 12-year-old children who engaged in a balancing task (i.e., the stabilometer). Winning or losing a competition represents another potent social determinant of motivation. Research in sport reveals that winners (e.g., Vallerand, Gauvin, & Halliwell, 1986a; Weinberg & Ragan, 1979) and those who subjectively feel that they have done well in competition (McAuley & Tammen, 1989) display higher levels of intrinsic motivation than losers and those who feel that they have not done well. A recent series of four studies on basketball by Tauer and Harackiewicz (2004) assessed the effects of competition, cooperation, and intergroup competition on children's enjoyment on a basketball free-throw task. Three findings of interest were found. First, they replicated the findings on success and failure of competition mentioned earlier. Second, cooperation and competition did not differ across studies. And third, intergroup competition consistently led to the highest levels of enjoyment. The authors posit that engaging in intergroup competition leads individuals to derive the best of both worlds: They experience the excitement of competition as well as the interpersonal enthusiasm derived from having a teammate.

The fact that the competition and intergroup competition conditions did not lead to lower levels of enjoyment than the cooperation condition is surprising. These findings could be due to measurement and methodological issues (a no-feedback, no-competition control group was not included, and, though related, enjoyment and intrinsic motivation are nevertheless different constructs). In addition, because the focus in the Tauer and Harackiewicz (2004) studies was on trying to do well and not necessarily on beating others at all cost (as in past competition research), the controlling dimension of competition may have been downplayed in favor of the informational dimension of competition (see Deci, Betley, et al., 1981), thereby eliminating the negative effects of competition typically found in most studies. Clearly, future research on the effects of competition on intrinsic motivation is needed.

Positive and Negative Feedback

By providing athletes with feedback about their strengths and weaknesses, coaches, fitness instructors, and physical education teachers may influence athletes' situational intrinsic motivation. Past research has indeed shown that positive feedback enhances and negative feedback decreases situational intrinsic motivation (Vallerand & Reid, 1984, 1988). For example, Thill and Mouanda (1990) showed that team handball players receiving bogus negative verbal feedback (indicating failure) after shooting at targets report lower levels of situational intrinsic motivation than players receiving bogus positive verbal feedback (indicating success).

However, other dimensions of the feedback in addition to its valence (positive or negative) are important to consider. For instance, a review of the literature by Henderlong and Lepper (2002) underscored that praise must be used with caution as it can increase, decrease, or have no effects on children's intrinsic motivation. To the extent that the message is believed, an increase in intrinsic motivation will follow. However, if the feedback is not perceived as sincere, negative effects can occur. In addition, much research also reveals that the style of feedback delivery is important. Specifically, when the message is presented in an autonomy-supportive fashion (e.g., "It is important for your own good to do this"), athletes feel as if they are in control and can make choices within reasonable limits (Deci, Schwartz, Sheinman, & Ryan, 1981). On the other hand, messages are controlling when they force or coerce athletes to behave in a certain way (e.g., "You must do this. You have no choice"). Controlling statements typically undermine intrinsic motivation, whereas autonomy-supportive statements preserve it or even enhance it (see Mageau & Vallerand, 2003, for a review of such research).

Choice

Research in sport and exercise reveals that choice facilitates intrinsic motivation with respect to physical activity. For example, Dwyer (1995) showed that having the opportunity to choose the songs they wanted to hear while exercising increases feelings of choice and intrinsic motivation relative to participants in a control condition, even though both groups heard the same songs. Similar findings have also been reported with respect to physical education classes (e.g., Goudas, Biddle, Fox, & Underwood, 1995). Thus, it appears that choice represents an important factor to consider with respect to situational motivation.

Mediational Evidence

Because individuals need to feel competent, autonomous, and connected to significant others in their interaction with their environment, activities that allow them to satisfy these needs will be engaged in by choice out of intrinsic motivation or identified regulation when they have the opportunity to do so. Thus, need satisfaction is hypothesized to mediate the impact of social factors on motivation. Research has found support for this hypothesis. For instance, in a study with master swimmers, Kowal and Fortier (2000) showed that perceptions of competence, autonomy, and relatedness mediate the relationship between social factors (perceived success and motivational climate) and situational motivation following a meet. In another study, Guay et al. (2000, Study 4) looked at the role of the three psychological mediators in the *changes* in situational motivation over two subsequent collegiate basketball games. Results revealed a differentiated picture for each type of situational motivation. Athletes who experienced perceptions of relatedness, autonomy, and collective competence displayed an increase in intrinsic motivation from game 1 to game 2. Increases in identified regulation were predicted by perceptions of autonomy and relatedness, whereas increases in amotivation were negatively predicted only by perceptions of relatedness. Finally, changes in external regulation were not significantly predicted by any of the predictors. These findings are interesting in that they reveal that with respect to team sports, collective competence represents an important mediator that needs to be looked at more closely in future research. More generally, these findings underscore the fact that the hypothesized psychological mediators need to be taken into account to better understand changes that occur at the situational level over time.

Corollary 3.3 posits that there is a top-down effect from motivation at the contextual level on motivation at the situational level. For instance, an athlete who usually plays her favorite sport, tennis, because of high contextual intrinsic motivation should be predisposed to display high levels of intrinsic motivation at a given moment (high level of situational intrinsic motivation) while playing tennis. Research supports the top-down effect. For instance, Gagné et al. (2003) measured gymnasts' contextual motivation toward gymnastics at Time 1 and their situational motivation at the beginning of practice each day for 15 days. In line with the top-down effect posited by the HMIEM, correlations between contextual motivation and situational motivation were always positive and varied from .22 to .50. These findings also suggest that although the top-down effect was present each day for 15 consecutive days, its impact varied daily, presumably due to the presence of situational factors that differed in importance on a given day.

Other studies have tested the validity of the top-down effect in physical education settings. For instance, Ntoumanis and Blaymires (2003) had participants complete the contextual measures of motivation toward physical activity (the Perceived Locus of Causality [PLOC] Scale of Goudas et al., 1994) and toward education (the AMS; Vallerand et al., 1992, 1993). One month later, students engaged in a typical science class in the classroom and a typical physical education class in the gymnasium, and situational motivation toward each was assessed with the SIMS. Ntoumanis and Blaymires found that students' situational motivation during the science class was positively predicted by their contextual motivation toward education, and their situational motivation toward physical activity in the gymnasium was predicted by their contextual motivation toward physical activity. These findings provide support for the HMIEM's position that it is not simply any motivation at the contextual level that will influence situational motivation, but rather the contextual motivation that is pertinent to the activity being performed.

The HMIEM posits that life contexts can be seen as schemas that serve to store contextual cues in addition to the relevant contextual motivation. If this is so, then presenting relevant contextual cues should be sufficient to trigger the appropriate contextual motivation stored with the cues, thereby setting in motion the top-down effect on situational motivation. Furthermore, such a triggering can take place outside of awareness (see Bargh, 2005). Recent research by Ratelle, Baldwin, and Vallerand (2005) has supported this hypothesis. In two studies, Ratelle et al. showed that simply hearing a sound (in the background and out of awareness) initially paired with a controlling message on a first task was sufficient to produce a decrease in situational motivation on a second task. Why? Because according to the HMIEM, working on a new type of task (the first one) creates a new context in which cues inherent to that new context such as the sound paired with the task were stored with the contextual motivation related to such types of task. So, when a task relevant to that context is later available (the second task), the mere sound triggers the relevant contextual motivation stored in the schema along with the cue, and the top-down effect takes place. These findings provide support for the top-down effect and show that such an effect can be triggered nonconsciously.

A final note on the top-down effect is in order. In a study on leisure, Iwasaki and Mannell (1999) obtained an interaction between the relevant contextual motivation and the actual situational factor that was manipulated (choice versus being controlled). More specifically, it was found that the top-down effect took place only in the choice condition where participants experienced some autonomy. It is thus possible that some situational conditions are more conducive to the top-down effect than others. Research on this issue in sport would appear to be in order.

Summary

In summary, the studies reviewed show that social factors such as rewards, competition, verbal feedback, and choice can influence individuals' situational motivation. Moreover, perceived competence, autonomy, and relatedness have been shown to mediate the impact of social factors on situational motivation. Finally, support for Corollary 3.3 on the top-down effect has been found to support the impact of contextual motivation on situational motivation.

Consequences

According to the hierarchical model, situational motivation leads to situational consequences (outcomes that are experienced at one specific point in time and with respect to a specific activity) that can be affective, cognitive, and behavioral in nature (Vallerand, 1997). In addition, the most positive consequences should be produced by the most self-determined forms of motivation (i.e., intrinsic motivation and identified regulation), and the least self-determined forms of motivation (i.e., external regulation and especially amotivation) should lead to the most negative consequences (Corollary 5.1). Introjection should lead to intermediate effects.

Affective Outcomes

In line with the hierarchical model and SDT, several studies in sport and exercise have shown that intrinsic motivation predicts the occurrence of positive affect in sports (e.g., McAuley & Tammen, 1989; Scanlan & Lewthwaite, 1986). Other research by Kowal and Fortier (1999) showed that swimming for intrinsic reasons was associated with the highest levels of flow during practice, followed decreasingly by identified regulation, external regulation, and amotivation (the last two scales yielded mostly negative correlations). Similar findings were obtained with gymnasts (Gagné et al., 2003), with a number of affective variables (positive and negative affect, vitality, and self-esteem) experienced before practice over a period of 15 consecutive days.

Experimental conditions known to induce intrinsic motivation and identified regulation have also been found to lead to positive affective outcomes. For instance, in an exercise setting, Parfitt and Gledhill (2004) showed that low-active individuals who engaged in a 20-minute exercise bout under a choice condition (deciding which types of exercise to do) reported less fatigue, psychological distress, and perceived exertion than those in a no-choice condition even though the total output as measured by heart rate was similar. Furthermore, these benefits seemed to increase over time. In another study, it was found that college students who engaged in a basketball dribbling task as part of a physical education course under conditions of personal relevance and instrumentality (the task is personally beneficial and will be directly useful in the course) experienced higher levels of intrinsic motivation and enjoyment than students who saw no relevance or instrumentality in that particular task (Simons, Dewitte, & Lens, 2003). In line with Deci, Eghrari, Patrick, and Leone (1994), it appears that choice and personal relevance may represent important motivational catalysts for tasks that may not be initially interesting.

Cognitive Outcomes

In the Kowal and Fortier (1999) study with master swimmers described earlier, higher levels of self-determined motivation predicted better concentration on the task at hand. These results may be explained by the fact that when intrinsically motivated, individuals focus more on the task and may become more impervious to external distractions (e.g., behaviors from the coach, teammates, or the crowd), and thus can devote all their attention and concentration to the task. These hypothesized mediating processes nevertheless remain to be empirically tested in future research.

Behavioral Outcomes

Finally, the HMIEM also posits that higher levels of self-determined situational motivation should result in positive behavioral consequences at a specific moment in time. Research is supportive of the hypothesis. For instance, in their study with gymnasts, Gagné et al. (2003) found that intrinsic motivation predicted attendance at practice each day over a 15-day period. In addition, the results from the Simons et al. (2003) study revealed that physical education students who saw a basketball dribbling task as personally relevant and instrumental were more intrinsically motivated, expended more effort and time on the task, and also displayed higher levels of objective performance than those in less self-determined conditions.

Summary

Research shows that situational motivation leads to several affective, cognitive, and behavioral outcomes. Furthermore, higher levels of self-determined motivation result in more positive situational outcomes, whereas lower levels of self-determined motivation result in less positive situational outcomes (Corollary 5.1). Although additional research is needed, especially with respect to cognitive outcomes, extant findings on consequences at the situational level provide support for the HMIEM as well as SDT.

RESEARCH ON MOTIVATION AT THE CONTEXTUAL LEVEL

Contextual motivation refers to one's generalized motivation toward a specific life context. In the present section, studies on the determinants and consequences of contextual intrinsic and extrinsic motivation in sport and physical activity are reviewed.

Determinants

Several contextual factors have been found to influence athletes' contextual motivation toward sport, including the coach, the motivational climate, scholarships, and the sport structures. This research is reviewed next.

The Coach

The coach represents one of the most important sources of influence on athletes' motivation and quality of involvement in sport (Pensgaard & Roberts, 2002). Mageau and Vallerand (2003) have proposed a model that posits that coaches' influence on their athletes' motivation takes place mainly through the coaches' interactional behavior with them. Such behavior can convey varying degrees of autonomy-support, structure, and involvement and caring toward the athletes, which are hypothesized to influence athletes' perceptions of autonomy, competence, and relatedness. In turn, these perceptions facilitate athletes' self-determined motivation. Of particular interest is the fact that Mageau and Vallerand have identified some of the determinants of coaches' behavior toward athletes. These include their personal orientations toward coaching (i.e., a natural tendency to be controlling or autonomy-supportive), the context within which coaches work (e.g., a pressure cooker), and the perception coaches may have of their athletes' behavior and motivation. This model is presented in Figure 3.2.

With respect to the effects of autonomy-supportive behavior on motivation, much research has shown that athletes who feel that their coaches are controlling tend to report lower levels of contextual intrinsic motivation and identified regulation and higher levels of amotivation and external regulation than those who feel that their coaches and instructors are autonomy-supportive (e.g., Amorose &

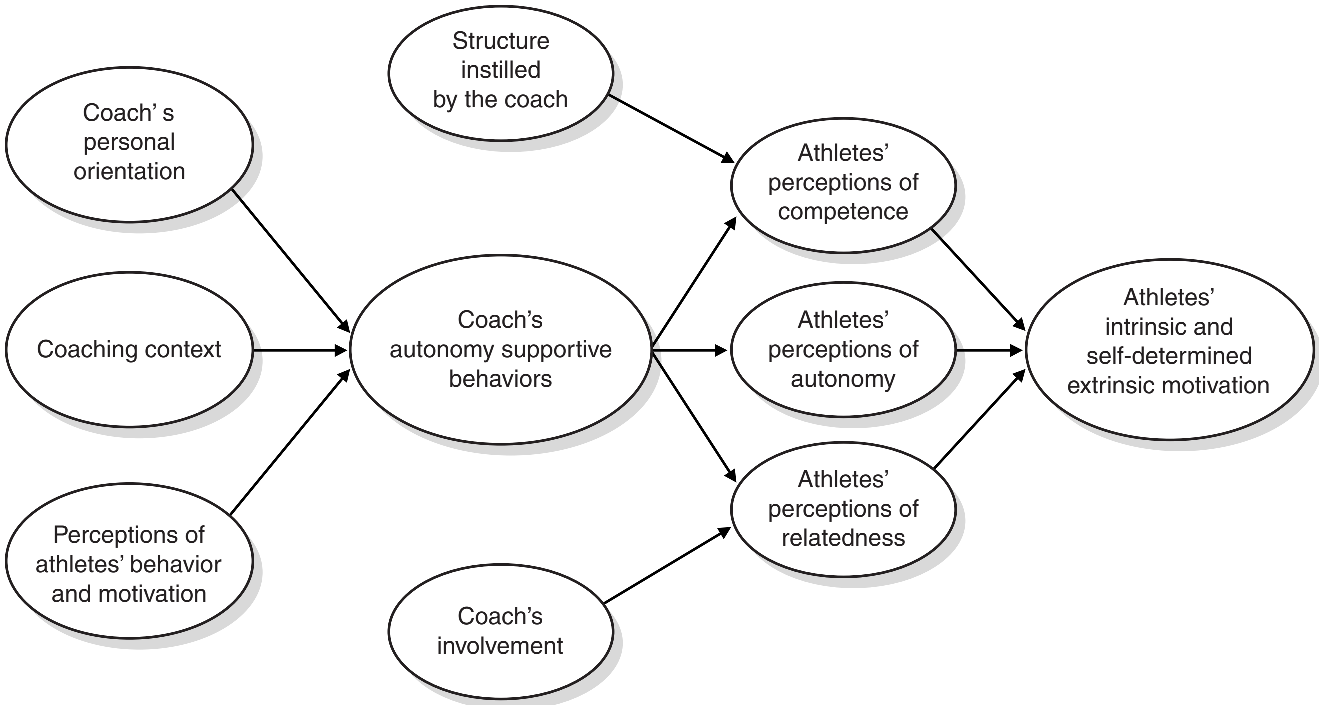


Figure 3.2 The coach-athlete model of motivation. *Source:* "The Coach-Athlete Relationship: A Motivational Model," by G. A. Mageau and R. J. Vallerand, 2003, *Journal of Sports Sciences, 21,* pp. 883–904. Reprinted with permission.

Horn, 2000, 2001; Hollembeak & Amorose, 2005; Pelletier, Fortier, Vallerand, & Brière, 2001; Pelletier et al., 1995; Reinboth, Duda, & Ntoumanis, 2004). Similar findings have been obtained in physical activity settings where a controlling teacher contributes to amotivation toward physical activity (Ntoumanis, Pensgaard, Martin, & Pipe, 2004), whereas autonomy support from important people in one's life facilitates self-determined motivation toward exercise (Wilson & Rodgers, 2004).

To the best of my knowledge, only one study has looked at the role of the coach in athletes' *changes* in motivation at the contextual level (Amorose & Horn, 2001). In this study, it was found that increases in Division 1 athletes' intrinsic motivation over the season was predicted by their perceptions that their coaches provided high-level training and instruction behavior and low frequencies of autocratic (or controlling) behavior. These findings thus underscore the fact that controlling behavior from the coach will undermine athletes' intrinsic motivation, whereas providing time and instruction is likely to facilitate its development.

Very little research has looked at the *determinants* of the coach's autonomy-supportive versus controlling behavior in sport and physical activity. However, some research has started to assess some of these relationships in the field of education (see Mageau & Vallerand, 2003, for a more complete review). For instance, research by Pelletier, Séguin-Lévesque, and Legault (2002) has shown that teachers who experience a lot of pressure from the administration to teach in a specific way or to have their students perform at a high level (pressure from above) and who have unruly and/or amotivated students (pressure from below) end up using controlling behavior toward their students (see also Pelletier & Vallerand, 1996, on this issue). Furthermore, research reveals that teachers who have a personal disposition to be controlling rather than autonomy-supportive as assessed by the Problem in School Questionnaire display more controlling behavior toward their students, who in turn display lower levels of intrinsic motivation (see Deci, Schwartz, et al., 1981). In light of the importance of coaches' behavior for their athletes' motivation, it is important to conduct future research on the determinants and consequences of such behavior. The Mageau and Vallerand model represents an appropriate point of departure for such research.

Motivational Climate

Coaches may also influence their athletes indirectly through the type of motivational climate they help to create. The motivational climate refers to the general ambience that exists in a team or club and the message it conveys to athletes. There are two main types of motivational climate: task-involved (or mastery) and ego-involved (or performance; see Duda & Hall, 2001). A task-oriented climate encourages participants to perform an activity in order to improve their skills; an ego-involved climate leads athletes to believe that they must outperform other athletes, including their teammates. Research reveals that a task climate is more conducive to the growth of self-determined forms of motivation (intrinsic motivation and identified regulation), whereas the opposite takes place with an ego-involved climate with respect to a variety of sports (Kavussanu & Roberts, 1996; Sarrazin, Vallerand, Guillet, Pelletier, & Curry, 2002) and physical activity (Brunel, 1999; Ferrer-Caja & Weiss, 2000; Kowal & Fortier, 2000; Ntoumanis, 2001a; Standage, Duda, & Ntoumanis, 2003).

Scholarships and Sport Structures

Scholarships qualify as a contextual factor because they represent a type of reward that will remain present for the duration of the athlete's collegiate career. The purpose of scholarships is typically to provide athletes with more time for training and studying. Unfortunately, scholarship recipients may come to feel that they play more to justify the scholarship they have received than for the pleasure of the game. As a result, they may feel controlled (feel that they must perform) and become less intrinsically motivated. Early research provided support for this hypothesis (E. D. Ryan, 1977; Wagner, Lounsbury, & Fitzgerald, 1989), although E. D. Ryan (1980) subsequently found that the negative effects were only true for football players and not for male wrestlers and female athletes from a variety of sports. More recently, using the Intrinsic Motivation Inventory (IMI; McAuley, Duncan, & Tammen, 1989), Amorose and Horn (2000) found that scholarship athletes felt more competent and less pressured than nonscholarship athletes (which is not surprising, as they're supposed to be better!), although in a subsequent study (Amorose & Horn, 2001), they didn't find any differences. Because the IMI displays some conceptual problems (see Vallerand & Fortier, 1998), future research using other scales such as the SMS is needed to more clearly determine the motivational effect of scholarships.

Another contextual factor of interest pertains to the sport structures. These refer to the organizational pattern that is inherent in athletic leagues. For instance, certain leagues may foster competitive structures, whereas others may instill a more relaxed climate where self-improvement is the goal. Sport structures are important because they convey an implicit message that may affect athletes' motivational processes. If the message conveyed to athletes is that winning is the only thing, then athletes will probably experience lower levels of intrinsic motivation and have less fun. However, if structures lead athletes to predominantly focus on self-improvement, they are likely to experience higher levels of intrinsic and identified regulation, and consequently more enjoyment. Research supports this hypothesis (Fortier, Vallerand, Brière, & Provencher, 1995; Frederick, Morrison, & Manning, 1996).

Mediational Evidence

Several studies have now provided support for mediational effects at the contextual level (Hollembeak & Amorose, 2005; Ntoumanis, 2001a, in press; Reinboth et al., 2004; Sarrazin et al., 2002), both in sports and in physical activity settings. Perhaps one of the most impressive studies is that of Ntoumanis (2001b), who attempted to link specific social factors (cooperative learning, emphasis on improvement, and perceived choice) prevalent in British physical education classes to physical education students' perceptions of autonomy, competence, and relatedness, and in turn to their contextual motivation toward exercise. Results from a path analysis revealed that a classroom in which emphasis was on improvement led to perceptions of competence, whereas cooperative learning and perceived choice led, respectively, to perceptions of relatedness and autonomy. In addition, although all three mediators were related as hypothesized to the different types of motivation, the most important predictor was perceived competence. This is in line with past research in sports (see Chatzisarantis, Hagger, Biddle, Smith, & Wang, 2003; Vallerand & Reid, 1984) but not in education, where perceived autonomy has been found to have the most important mediating effects (e.g., Vallerand, Fortier, et al., 1997). Future research is needed on the relative mediating impact of the three needs as a function of life contexts.

A final type of motivational determinant comes from the top-down effect (Corollary 3.3), where an individual who has a predisposition to do things out of intrinsic motivation (e.g., a high level of global intrinsic motivation) should display high levels of intrinsic motivation toward, for instance, basketball in general (e.g., a high level of contextual intrinsic motivation). Research using longitudinal and prospective designs has found support for the top-down effect with respect to the contexts of education (Guay et al., 2003) and physical activity (Vallerand, Guay, Mageau, Blanchard, &

Cadorette, 2005, Study 3) over extended periods of time up to 5 years, and with a variety of participants, including some from the general population.

Noteworthy is that researchers have started to look at the role of personality variables, other than global motivation, and how these predict contextual motivation. For instance, Ingledew, Markland, and Sheppard (2003) related the personality dimensions of the Big 5 (Costa & McRae, 1992) to contextual motivation toward exercise using the BREQ. It was found that contextual intrinsic motivation was predicted by extraversion and conscientiousness; identified regulation by extraversion; introjected regulation by neuroticism; and external regulation by less conscientiousness and less openness to experience (amotivation was not assessed). Other researchers (Miquelon, Vallerand, Grouzet, & Cardinal, 2005) have shown that adaptive forms of perfectionism (Hewitt & Flett, 2002) are conducive to self-determined forms of motivation toward education, whereas maladaptive perfectionism leads to non-self-determined motivation. Overall, these two sets of findings are important because they suggest that motivation at the contextual level may be influenced to some extent by personality variables other than global motivation. Future research is needed to pursue these initial efforts.

Summary

Studies reviewed in this section indicate that contextual self-determined motivation toward sport is influenced by several social factors: such as coaches' behavior, sport structures, scholarships, and the team's climate (or fitness center ambience). Furthermore, the relationships between those social factors and contextual self-determined motivation toward sport or exercise are mediated by individuals' general sense of competence, autonomy, and relatedness toward sport or exercise. Finally, global motivation and other personality variables have been found to predict contextual motivation.

Consequences

Several types of motivational outcomes have been studied at the contextual level. Next, we review empirical research on the affective, cognitive, and behavioral outcomes.

Affective Outcomes

Much research in sport has been designed to examine the positive relationship between contextual intrinsic motivation and affective consequences such as satisfaction, interest, and enjoyment (e.g., Brière et al., 1995; Pelletier et al., 1995) and the negative relationship with burnout (Raedeke, 1997). More recent research (Cresswell & Eklund, 2005) has extended such work by showing, in line with Corollary 5.1, the presence of the hypothesized continuum where intrinsic motivation (especially intrinsic motivation toward stimulation and intrinsic motivation toward accomplishment) was negatively associated with burnout and amotivation was strongly and positively associated with it. Along the same lines, Lemyre, Treasure, and Roberts (in press), showed that decreases in the self-determined motivation of top Division 1 swimmers over the course of the season predicted increases in burnout at season's end.

Similar findings have been obtained in physical activity settings with other types of affective outcomes. For instance, a study by Ntoumanis (2001a) has shown that boredom in physical education classes was negatively predicted by intrinsic motivation but positively by amotivation and external regulation. Using the BREQ, Karageorghis and Vlachopoulos (2002) have also shown that contextual introjected regulation toward exercise predicted exercise dependence. Finally, Wilson and Rodgers (2002) found that identified regulation and intrinsic motivation contributed to physical self-esteem but that external and introjected regulation did not.

Cognitive Outcomes

Optimal concentration may represent one of the most important predictors of performance. In line with Corollary 5.1 of the hierarchical model, research with athletes from a variety of sports (Brière et al., 1995; Pelletier et al., 1995) as well as with physical education students (Ntoumanis, 2001a) and adult exercisers (Vallerand et al., 2005, Study 3) has shown that the highest levels of concentration result from the self-determined forms of motivation. Wilson, Rodgers, Hall, and Gammage (2003) have also shown that not only the level of concentration but also its quality is affected by motivation. Specifically, adults who mainly exercise out of non-self-determined motivation display an imagery style much more oriented toward the image they project to others than those who engage in exercise out of self-determined motivation. Such an imagery style is far from ideal when performing a demanding task.

In sum, the proposed link between the various forms of motivation and cognitive outcomes has been obtained with various populations in both sport and physical activity settings. However, there is a need to look at other types of cognitive outcomes (learning, memory, recall of broken plays, etc.) to more fully probe the relationship between motivation and cognitive outcomes. For instance, higher levels of contextual self-determined motivation should lead top-level athletes to be more proactive and secure (Hodgins & Knee, 2002), thereby leading them to recall more errors they may have committed in game situations, and eventually to work on these mistakes and thus improve.

Behavioral Outcomes

Increased attention has been given to the role of contextual motivation in behavioral types of outcomes such as intentions to pursue engagement in sport or physical activity. Such research provides support for the adaptive role of self-determined motivation in both sports (Chatzisarantis et al., 2003; Sarrazin et al., 2002), and exercise (Ingledew, Markland, & Medley, 1998; Ntoumanis, 2001a; Thøgersen-Ntoumani & Ntoumanis, in press; Wilson & Rodgers, 2004; Wilson, Rodgers, Fraser, & Murray, 2004). Of particular interest is the research of Ferrer-Caja and Weiss (2000) showing that intrinsic motivation positively predicts effort and persistence as assessed by the physical education teacher. It thus appears that more objective forms of outcomes assessment (such as teacher reports) yield findings similar to those obtained with participants' own reports (Fortier & Grenier, 1999; Li, 1999), thereby providing further validity to research in this area.

Results from this research reveal that, typically, the more self-determined the motivation, the more one intends to continue engagement in the activity. However, a major difference seems to emerge between the exercise and the sport studies. Specifically, although all studies reveal the presence of the hypothesized continuum, there is a difference with the main positive predictor of intentions. The results of a meta-analysis conducted mainly with sport studies (Chatzisarantis et al., 2003) reveal that intrinsic motivation is the main predictor. On the other hand, in exercise studies, identified regulation appears to be the main predictor (see Wilson & Rodgers, in press). One possible explanation for this discrepancy proposed by Vallerand (1997) deals with the nature of the activity. When the task is perceived as interesting, as in most sports, intrinsic motivation should lead to the most positive outcomes, as intrinsic motivation is then the optimal type of motivation. However, when the task is uninteresting, as is often the case with exercise, at least in the initial stages, then identified regulation may become a more important determinant of positive consequences than intrinsic motivation. Indeed, if a task is relatively dull and unappealing, intrinsic motivation may be insufficient to engage in it. Rather, what is needed is a motivational force leading the person to choose to engage in the activity despite the fact that it is not interesting. Identified regulation can provide such a force. This hypothesis makes sense and is in line with data from various studies, but additional research is needed to empirically test this hypothesis using a controlled design within the confines of the same study.

Research has also looked at the role of contextual motivation in persisting in sport. In a longitudinal study of over 22 months with Canadian teen swimmers, Pelletier et al. (2001) found support for the presence of a continuum, with the most important positive predictor of persistence being intrinsic motivation and the most important negative predictor being amotivation. Similar findings have been obtained in a study with French handball players over 21 months (Sarrazin et al., 2002) and with adult exercisers (Fortier & Grenier, 1999; Ryan, Frederick, Lepes, Rubio, & Sheldon, 1997). Of additional interest is the fact that Pelletier et al. found that the relationships between motivation at Time 1 and persistence changed over time. Specifically, although the link to external regulation was not significant at 10 months, it became significant and negative at 22 months. Conversely, the link between introjection and behavior, which was slightly positive initially, became null at 22 months. These findings suggest that the negative effects of external and introjected regulation may take place further down the road, perhaps when it is clear that the extrinsic payoffs (e.g., awards, fame) are no longer forthcoming. Future research on this issue appears important.

More recently, researchers have started to focus on specific types of motivations to better understand the intricacies of continued behavioral engagement in exercise. For instance, Hein et al. (2004) looked at the predictive role of the three types of intrinsic motivation with respect to British teenagers' intentions to engage in sport and exercise after high school. The results revealed that intrinsic motivation to experience stimulation was the best predictor, followed by intrinsic motivation to accomplish things. The contribution of intrinsic motivation to know was not significant. The two predictors accounted for a total of 65% of the variance in intentions to exercise. These findings are in line with those of Jackson, Kimiecik, Ford, and Marsh (1998), who found that the best predictor of flow was intrinsic motivation to experience stimulation. It is thus possible that the pleasant experience of stimulation is what people seek from their exercise participation, and not necessarily the pleasure to learn or accomplish something. These results would seem to have some applied importance.

Other research (Vallerand & Losier, 1994) has shown that, over the course of a hockey season, a self-determined motivational profile led to an increase in the tendency to show respect and concern for others (a positive sportspersonship orientation; see Vallerand, Brière, et al., 1997; Vallerand, Deshaies, Cuerrier, Brière, & Pelletier, 1996). Athletes who are self-determined toward their sport focus on the activity itself and not the end result. Winning is not a matter of life or death for them. Rather, respect and concern for the rules and participants is more important because it ensures the creation of a pleasant environment for all participants. The Vallerand and Losier findings have been replicated with physical education students over a 1-year period (Chantal & Bernache-Assollant, 2003). Subsequent research by Chantal, Robin, Vernat, and Bernache-Assollant (2005) extended these findings by distinguishing between reactive (wanting to hurt someone) and instrumental (displaying energy toward the game and not the opponent) aggression and showing that self-determined motivation toward sport facilitates sportspersonship orientations, which in turn leads to instrumental but not reactive aggression.

A final motivational outcome of interest is performance. Because self-determined forms of contextual motivation have been found to facilitate persistence at a specific activity, given equal ability and coaching, additional practice should lead to increased performance. There is a lot of evidence to support the role of self-determined motivation in performance on nonsport tasks (see Vallerand, 1997, for a review). Limited evidence exists for this hypothesis in sport and physical activity, where it has been found that inducing intrinsic motivation was conducive to better performance in putting (Beauchamp, Halliwell, Fournier, & Koestner, 1996) as well as swimming (Pelletier, Vallerand, Brière, & Blais, 2006). However, because neither study contained a true experimental design, alternative hypotheses exist.

Summary

The studies reviewed in this section provide strong support for the hierarchical model, with respect to the determinants and outcomes associated with contextual self-determined forms of motivation. However, future research using prospective, longitudinal, and experimental designs is necessary to more fully document the role of motivation in long-term outcomes, especially performance.

RESEARCH ON MOTIVATION AT THE GLOBAL LEVEL

Very little research has focused on motivation and determinants and consequences at the global level. However, as we see below, the available research underscores the importance of such research.

Determinants

No research appears to have examined how global social factors may affect global motivation. However, research by Vallerand and O'Connor (1991) with elderly individuals has revealed that the type of residence they live in seems to impact their global motivation. Elderly people living in residences that provided autonomy support (as assessed by observers) reported higher levels of contextual self-determined motivation toward most aspects of their lives (across six life contexts) compared to those living in controlling residences. Thus, although Vallerand and O'Connor did not measure global motivation per se, it does appear that spending most of one's life in a controlling or autonomy-supportive residence may represent a global social factor likely to influence global motivation. Similar research could be conducted on the impact on global motivation of living in sports boarding schools (see Riordan, 1977).

Another global factor that would appear relevant for children is parents. Indeed, parents are a constant presence in all aspects of their children's life. They are thus in a prime position to influence the development of their personality (Eccles & Wigfield, 2002), including global motivation. Assor, Roth, and Deci (2004) have conducted very informative research that partly addresses this issue. In two studies, these authors found that children who perceived their parents to be providing conditional regard (a form of control where love is provided conditionally to children upon certain behaviors on their part) display high levels of introjection uniformly across four life contexts (e.g., prosocial behavior, sports). The picture was partly supportive with identified regulation, where parental conditional regard was negatively correlated with identified regulation in some contexts (i.e., emotional control and academic domains) but not in the other two. It is hypothesized that if parental behavior can affect individual functioning and motivation in four life contexts largely in the same direction, global motivation is likely to be affected as well. Future research is needed to test this hypothesis.

Consequences

There are at least three ways through which global motivation can affect outcomes. A first influence comes from the influence of global motivation on global psychological adjustment. Because global self-determined motivation reflects a proactive way of interacting with one's environment, it would be predicted that having such a motivation should lead to better adaptive functioning and psychological adjustment. Empirical support exists for this hypothesis. For instance, Ratelle, Vallerand, Chantal, and Provencher (2004) showed that global self-determined motivation positively predicted increases in psychological adjustment that took place over a 1-year period with adults from the general population. Because experiencing positive psychological adjustment at the global level may provide additional strength to face demanding situations and failure experiences in sport, this first function of global motivation deserves attention in sport and physical activity.

A second way through which global motivation has been found to affect functioning is the protective function it may serve. A recent study by Pelletier et al. (2004) has shown that global motivation plays a protective function, leading women to perceive less pressure from society to have a thin body and to internalize to a lesser degree society's stereotypes regarding thinness. Global self-determined motivation also had a direct negative effect on bulimic symptomatology. Because bulimic symptomatology does take place in sports, research on the protective function of global motivation with athletes is important.

Finally, global motivation can also serve an integrative function among life contexts. For instance, Koestner et al. (1992) have shown that adults with a predominant autonomy-causality orientation (the equivalent of a self-determined global motivation) display behavior that is more in line with their attitudes and inner values than individuals with a control (or non-self-determined) orientation. Similar findings have been obtained with children (Joussemet, Koestner, Lekes, & Houlfort, 2004). Thus, athletes with global self-determined motivation would be expected to have a sport-contextual motivation better integrated with other contextual motivations in their life. They would therefore be expected to experience fewer conflicts among life contexts and in turn to display a more focused involvement in sport and other life activities.

Summary

Very little research has been done at the global level with athletes or individuals engaged in physical activity. Future research with athletes could examine the role of parents and coaches in the development of global motivation and, in turn, how global motivation leads to different outcomes through the various functions it serves.

RESEARCH ON INTEGRATIVE STUDIES

Certain studies have looked at motivation and outcomes in a more integrated fashion either within the confines of an integrated sequence or by looking at how various motivations at two and three levels of generality are connected. Such research is reviewed in this section.

A Social Factors → Psychological Mediators → Motivation → Consequences Sequence

One of the key hypotheses of the HMIEM is that the impact of the environment on individuals takes place through a causal chain of processes which can be presented as follows: Social Factors → Psychological Mediators → Motivation → Consequences (see Vallerand, 1997; Vallerand & Losier, 1999). This sequence can take place at all three levels of the hierarchy. Following the lead of research on high school dropout (Vallerand & Bissonnette, 1992; Vallerand, Fortier, et al., 1997), some studies have provided support for this causal sequence with respect to sport dropouts at the *contextual* level (Pelletier et al., 2001; Sarrazin et al., 2002). For instance, in the Sarrazin et al. study, task- and ego-involving climates were found, respectively, to positively and negatively predict perceptions of competence, autonomy, and relatedness, which positively predicted self-determined motivation. In turn, self-determined motivation predicted intention to persist in handball, which led to actual persistence 21 months later. Pelletier et al. obtained similar results showing that coaches' autonomy-supportive behavior influenced self-determined motivation, which prevented dropout in swimming over 22 months.

Research on the integrated causal sequence at the contextual level has also been tested in exercise settings. Such research reveals that different learning structures (Ntoumanis, 2001a), motivational climates (Ferrer-Caja & Weiss, 2000; Standage, Duda, et al., 2003), autonomy support from friends (Wilson & Rodgers, 2004), and the physical education teacher (Ntoumanis, in press) positively influence self-determined motivation through their impact on perceptions of competence, autonomy, and relatedness. Finally, self-determined motivation positively predicts a variety of contextual cognitive, affective, and behavioral outcomes, including teacher-rated assessment of behavior (Ferrer-Caja & Weiss, 2000; Ntoumanis, in press).

It appears that only one study has provided support for the proposed sequence at the situational level in sport. In this study with master swimmers (Kowal & Fortier, 2000), it was shown that motivational climates predicted perceptions of competence, autonomy, and relatedness, which in turn led to self-determined situational motivation, which finally led to the experience of flow. Clearly, additional research is needed to test the validity of the integrated sequence in sports and physical activity settings at the situational level.

The results of these studies provide strong support for the proposed sequence in a variety of settings and activities. Future research is needed, however, with prospective or longitudinal designs at the contextual level, and experimental designs at the situational level, to provide more clarity regarding the direction of causality among the various variables of the causal sequence (see Grouzet, Vallerand, Thill, & Provencher, 2004, for such a test using an experimental design at the situational level with a cognitive task). There is also a need to look at other types of consequences, such as creativity and learning, as well as interpersonal outcomes such as quality of relationships and friendships.

Motivation at Two or Three Levels of Generality

A key aspect of the HMIEM is that motivation at a given level of generality reflects the relative influence of individual differences through the top-down effect and that of social factors. Brunel and Vallerand (2005) tested the relative influence of the top-down effect from contextual motivation and the impact of situational factors on situational motivation over time. These authors reasoned that when put in a new situation (practicing their sport on university premises with new coaches), athletes who usually practice in civic clubs should see their contextual motivation provide the main influence on their situational motivation toward practice because participants are not used to the social factors conveyed in such new settings. However, months later, when the meaning conveyed by situational factors is clearer, the latter should have a more potent influence on situational motivation than contextual motivation. Results of a study (Brunel & Vallerand, 2005) with French athletes provided support for the hypothesis.

Research has also started to look at how contextual motivation sets things in motion at the situational level so that affective outcomes can be experienced at that level. For instance, Amiot, Gaudreau, and Blanchard (2004) showed that self-determined contextual motivation toward sport led to the use of situational adaptive cognitive skills, which, in turn, facilitated reaching goals during a game. Finally, reaching one's goals led to an increase of positive affect after the game. The opposite picture emerged for athletes with a non-self-determined motivation, as it led to the use of poor coping skills and failing to reach one's goals and to experience less positive effect. Future research is needed to determine if the impact of contextual motivation on situational-level coping skills takes place through the top-down effect from contextual to situational motivation.

Another dimension of the HMIEM that has attracted attention is the bottom-up effect (Postulate 4). More specifically, motivation experienced at a lower level (e.g., the situational level) can produce over time a recursive effect on motivation at the next higher level (e.g., contextual motivation toward sport). Blanchard, Amiot, Saint-Laurent, Vallerand, and Provencher (2005) conducted a study to test this interplay between the contextual and situational levels leading to changes in contextual motivation toward basketball over time. Measures of contextual motivation toward basketball were obtained before the first and second games of the tournament and 10 days after the tournament. Moreover, measures of situational motivation (using the SIMS) were obtained immediately after the two games of a tournament. Finally, players' assessment of personal and team performance as well as objective results of the games were collected to test the role of situational factors in the prediction of situational motivation. Results from a path analysis showed that contextual motivation for basketball predicted situational motivation during each of the two basketball games during the tournament (the top-down effect). Moreover, situational motivation for both basketball games was also predicted by team and personal performance (the situational factors). In turn, situational motivation influenced contextual motivation subsequent to each game, as well as 10 days after the tournament (the recursive bottom-up effect). In sum, Blanchard et al. tracked down the flow of psychological processes through which changes in motivation at the contextual level take place over time while providing support for several of the corollaries proposed by the HMIEM. Future research on Postulate 4, especially over the course of a whole season, would be fruitful.

Other studies have looked at the interplay between the motivations stemming from two life contexts and the outcomes that may be derived from such an interface. For instance, research has shown that conflicts between two life contexts, such as work and family for working adults (Senécal, Vallerand, & Guay, 2001) or education and leisure for students (Ratelle, Senécal, Vallerand, & Provencher, in press), lead to poor psychological adjustment. In exercise settings, Hagger and Chatzisarantis and their colleagues (e.g., Hagger, Chatzisarantis, Barkoukis, Wang, & Baranowski, in press; Hagger, Chatzisarantis, Culverhouse, & Biddle, 2003) have shown that having a self-determined motivation toward physical activity at school facilitates self-determined motivation toward physical activity during one's leisure time. Future research is needed to pursue this line of scientific inquiry to determine when facilitative and conflicting motivational effects will be obtained between two life contexts and determine the types of outcomes that will be experienced by elite athletes and adult exercisers as a result.

Finally, to the best of my knowledge, only one study has integrated motivation at the three levels of the hierarchy in the context of sport and physical activity. In this study, Vallerand et al. (2005, Study 3) tested the interplay among motivations at the three levels of the hierarchy with participants in a fitness program. Results from a path analysis revealed that global motivation at the beginning of the fitness program influenced contextual motivation toward exercise 4 weeks later. In turn, contextual motivation toward exercise influenced situational motivation, which determined situational consequences of concentration and enjoyment while exercising.

Summary

Research in this section highlights the dynamic relationships that can take place between motivation at different levels of generality, as well as among different life contexts. Future research along those lines in sport and physical activity could provide not only a deeper understanding of the motivational processes at play, but also a better prediction of different outcomes experienced by athletes and physical activity participants.

INTERVENTION STRATEGIES

At least two major types of intervention have been conducted within the intrinsic/extrinsic motivation paradigm. One seeks to increase the autonomy-supportive behavior displayed by coaches toward the athletes. Based on the findings that an autonomy-supportive style is teachable (Reeve, 1998), Pelletier and his colleagues (2006) developed an intervention program to help swim coaches become more autonomy-supportive and consequently facilitate their athletes' motivation. Results from this 18-month intervention program revealed that the program was highly effective in leading athletes to perceive their coach as less controlling and more autonomy-supportive and to experience higher levels of perceived competence and intrinsic motivation. Of major interest is the fact that attendance at practice increased markedly and dropout was reduced significantly. A recent intervention study with adult exercisers has shown similar results with respect to the important role of autonomy support from the fitness leader in exercisers' motivation (see Edmunds, Ntoumanis, & Duda, in press).

A second line of intervention studies takes into consideration the fact that some activities may not be inherently interesting and focuses on providing individuals with a rationale to engage in a specific behavior. However, how the rationale is presented is crucial. To be effective, the rationale must be presented in a noncontrolling way, while providing some form of choice and acknowledging the person's feelings (Deci et al., 1994; Koestner et al., 1984). For instance, the fitness instructor may say something like "The reason we're focusing on these exercises is because they're the ones that will lead you to gain the most from your training (rationale). I know that it may feel uncomfortable at first (acknowledgment of the person's feelings). However, it is entirely up to you if you want to do some or all of them today (choice)." Such instructions lead the person to "*wanting* to do what *should* be done" (Berg, Janoff-Bulman, & Cotter, 2001, p. .982). Research by Simons et al. (2003) in physical education settings has shown that similar instructions regarding rationale on a basketball task led to higher levels of intrinsic motivation, enjoyment, effort, time on task, and performance than conditions where students are told that they have to engage in the task simply because they will be tested on it.

In sum, advances have taken place recently with respect to interventions oriented at improving intrinsic motivation and self-determined motivation and creating positive consequences in athletes and exercisers. Future research is needed to determine if such interventions are applicable to a variety of tasks and situations, some interesting (e.g., playing games) and some less so (e.g., running suicide drills in practice; to this end, see Green-Demers, Pelletier, Stewart, & Gushue, 1998; Reeve, Jang, Hardre, & Omura, 2002).

CURRENT TRENDS AND FUTURE DIRECTIONS

Several trends have started to emerge in the literature. One pertains to the testing of different postulates and propositions of the HMIEM. Of these, the one that has received the most attention is the Social Factors → Psychological Mediators → Motivation → Consequences causal sequence. As presented earlier, much support has been garnered for this sequence, especially at the contextual level. Much research remains to be done with respect to a number of other aspects of the HMIEM, including the interplay of motivation at different levels of generality, the conflict versus facilitative effects of different contextual motivations on situational motivation and outcomes, and the different functions of global motivation in athletes' and exercisers' contextual and situational motivations and ensuing outcomes. Future research on these issues would appear promising.

A second area where much action has taken place is the integration of different theories in leading to a better understanding of motivational processes. For instance, following the lead of Duda, Chi, Newton, Walling, and Catley (1995) and Brunel (1999), researchers have started to explore the relationships between elements of achievement goal theory (Nicholls, 1984) and those from SDT (Deci & Ryan, 2000; see also Ntoumanis, 2001b). Typically, researchers have looked at the motivational impact of different learning structures (Ntoumanis, 2001a) and motivational climates (Ferrer-Caja & Weiss, 2000; Kowal & Fortier, 2000; Standage, Duda, et al., 2003) and have shown that mastery (or learning, or task) climates and structures facilitate the satisfaction of participants' needs for competence, autonomy, and relatedness, which in turn lead to self-determined motivation and adaptive outcomes. On the other hand, performance (or ego) climates have been found to trigger a maladaptive motivational sequence.

Another integrative attempt has been conducted by Hagger et al. (in press), who have integrated SDT, the theory of planned behavior, and the HMIEM to better understand how the constructs and processes of each model can better predict the generalization of physical activity from formal to informal settings (for a review, see Hagger & Chatzisarantis, in press). Basically, the transcontextual model posits that autonomy support from the physical education teacher facilitates self-determined motivation toward physical activity at school. Such motivation (especially intrinsic motivation and identified regulation) generalizes to leisure contextual motivation, which in turn influences attitude and perceived behavioral control toward exercise. Finally, attitude and control lead to the intention to exercise during leisure time, which leads to actual exercise behavior.

These two integrative efforts are important from both theoretical and applied standpoints. Clearly, such research must continue, as it can lead to theoretical advances with respect to a better understanding of the contribution and limits of each theory as well as a better prediction of outcomes promoted in sport and physical activity settings.

Another area of active interest has been the use of cluster analyses to look at how the different types of motivation can be best integrated in both sport and physical activity settings (Matsumoto & Takenaka, 2004; Ntoumanis, 2002; Vlachopoulos, Karageorghis, & Terry, 2000; Wang & Biddle, 2001; Wang, Chatzisarantis, Spray, & Biddle, 2002; Weiss & Amorose, 2005). Research so far reveals the presence of different numbers of clusters in different studies, presumably because of methodological differences. However, a constant across the various studies is the presence of a high-self determined motivation cluster and the positive outcomes associated with it. Future research is needed to systematically compare clusters within sports and physical activity settings and determine which ones are predictive of positive outcomes in each type of setting.

Two other issues deserve mention, as they represent important research agendas for the future. The first is the role of unconscious (or implicit) motivational processes. Much research in social cognition has now shown that behavior can be influenced by factors outside of our awareness (see Bargh, 2005). Along these lines, Lévesque and Pelletier (2003) showed that presenting primes dealing with intrinsic or extrinsic motivation out of awareness is sufficient to induce the situational motivation implied by the primes. In an even more provocative study, Hodgins, Yacko, and Gottlieb (2005, Study 3) showed that priming members of a university rowing team with self-determined words (e.g., "choose," "freedom") led to faster times on a rowing machine than priming members with non-self-determined (e.g., "must," "should") and amotivational (e.g., "passive," "uncontrollable") words. In other words, priming self-determined motivation outside of awareness increases performance! Finally, as described earlier in the Ratelle et al. (2005) study, it may not be necessary to use primes related to motivation to induce the actual motivation. Priming certain environmental cues associated with aspects of the activity (e.g., sounds) can trigger by their mere unnoticed presence certain types of contextual motivation, which, in turn, will subsequently influence situational motivation. For obvious theoretical and practical reasons, it is believed that sport psychologists would do well to start exploring the role of such unconscious motivational processes.

A final issue pertains to the effect of culture on motivational processes. The role of culture in human behavior has attracted a lot of attention lately (see Kitayama, Markus, & Kurokawa, 2000; Nisbett, 2003). Among other perspectives, it has been hypothesized that cultures that are more individualistic (e.g., Western society) promote the development of an independent self, whereas collectivistic cultures (e.g., East Asia) facilitate an interdependent self. This has led to some interesting motivation research by Iyengar and Lepper (1999), who have shown in two studies that Asian American children (with an interdependent self) displayed higher levels of situational intrinsic motivation on tasks that were chosen by their mother than on those chosen by themselves, whereas the opposite took place for Anglo-American children. These results are puzzling because much research has shown that variables related to autonomy and choice posited by SDT do operate in various cultures, including collectivistic ones (e.g., Chirkov, Ryan, Kim, & Kaplan, 2003). Because sport and physical activity are engaged in most, if not all, cultures, it is imperative to determine if culture affects motivation in sport and physical activity settings. And if so, what are the processes through which such effects take place? Sport psychology has typically neglected cultural issues (Duda & Hayashi, 1998). The time has come to move forward and to correct this important oversight.

CONCLUSION

The purpose of this chapter was to review the extant literature on intrinsic and extrinsic motivation in sport and physical activity using the HMIEM as an organizing framework. The present review has shown that such research is vibrant, as it deals with a variety of issues at different levels of generality. A number of future research directions have also been proposed. To this end, it is important to reiterate that the hierarchical model proposes that it is desirable to progress from the mere study of athletes (or exercise participants) to that of whole individuals who, in addition to being athletes (or exercise participants), are also students (or workers) and part of a social matrix (see Vallerand, 1997; Vallerand & Grouzet, 2001). Specifically, this means that if we are to better understand an individual's motivation toward sport or exercise and ensuing outcomes, we need to know more about his or her motivations in other life contexts as well as his or her motivational orientation at the global level. Furthermore, we need to pay attention to factors that may operate out of the person's level of awareness and those that may affect motivation differently as a function of culture. It is believed that future research framed in line with the HMIEM should lead to a more comprehensive understanding of the psychological processes underlying motivational phenomena taking place in sport and physical activity settings, eventually contributing to the development of a more adaptive environment for all participants.

REFERENCES

Amiot, C. E., Gaudreau, P., & Blanchard, C. M. (2004). Self-determination, coping, and goal attainment in sport. *Journal of Sport and Exercise Psychology, 26,* 396–411.

Amorose, A. J., & Horn, T. S. (2000). Intrinsic motivation: Relationships with collegiate athletes' gender, scholarship status, and perceptions of their coaches' behavior. *Journal of Sport and Exercise Psychology, 22,* 63–84.

Amorose, A. J., & Horn, T. S. (2001). Pre- to post-season changes in the intrinsic motivation of first year college athletes: Relationships with coaching behavior and scholarship status. *Journal of Applied Sport Psychology, 13,* 355–373.

Angyal, A. (1941). *Foundation for a science of personality.* New York: Commonwealth Fund.

Assor, A., Roth, G., & Deci, E. L. (2004). The emotional costs of parents' conditional regard: A self-determination theory analysis. *Journal of Personality, 72,* 47–88.

Bargh, J. A. (2005). Bypassing the will: Toward demystifying the nonconscious control of social behavior. In R. R. Hassin, J. S. Uleman, & J. A. Bargh (Eds.), *The new unconscious* (pp. 37–58). New York: Oxford University Press.

Beauchamp, P. H., Halliwell, W. R., Fournier, J. F., & Koestner, R. (1996). Effects of cognitive-behavioral psychological skills training on the motivation, preparation, and putting performance of novice golfers. *Sport Psychologist, 10,* 157–170.

Berg, M. B., Janoff-Bulman, R., & Cotter, J. (2001). Perceiving value in obligations and goals: Wanting to do what should be done. *Personality and Social Psychology, 27,* 982–995.

Blais, M. R., Vallerand, R. J., Gagnon, A., Brière, N. M., & Pelletier, L. G. (1990). Significance, structure, and gender differences in life domains of college students. *Sex Roles, 22,* 199–212.

Blais, M. R., Vallerand, R. J., Pelletier, L. G., & Brière, N. M. (1994). *Construction et validation de l'Inventaire des Motivations Interpersonnelles* [Construction and validation of the Interpersonal Motivations Inventory]. Unpublished manuscript, Université du Québec, Montréal.

Blanchard, C., Amiot, C., Saint-Laurent, E., Vallerand, R. J., & Provencher, P. (2005). *An analysis of the bi-directional effects between contextual and situational motivation in a natural setting.* Manuscript submitted for publication.

Brière, N. M., Vallerand, R. J., Blais, M. R., & Pelletier, L. G. (1995). Développement et validation d'une mesure de motivation intrinsèque, extrinsèque et d'amotivation en contexte sportif: L'échelle de Motivation dans les Sports (ÉMS) *[On the development and validation of the French form of the Sport Motivation Scale]. International Journal of Sport Psychology, 26,* 465–489.

Brunel, P. C. (1999). Relationship between achievement goal orientations and perceived motivational climate on intrinsic motivation. *Scandinavian Journal of Medicine and Science in Sports, 9,* 365–374.

Brunel, P., & Vallerand, R. J. (2005). *On the relative effects of contextual motivation and situational factors on situational motivation as a function of time.* Manuscript submitted for publication.

Chantal, Y., & Bernache-Assollant, I. (2003). A prospective analysis of self-determined sport motivation and sportspersonship orientations. *Athletic Insight: The Online Journal of Sport Psychology.* Retrieved March 23, 2006, from http://www.athleticinsight.com/Vol5Iss4/Sportspersonship.htm.

Chantal, Y., Robin, P., Vernat, J.-P., & Bernache-Assollant, I. (2005). Motivation, sportspersonship, and athletic aggression: A mediational analysis. *Psychology of Sport and Exercise, 6,* 233–249.

Chatzisarantis, N. L. D., Hagger, M. S., Biddle, S. J. H., Smith, B., & Wang, J. C. K. (2003). A meta-analysis of perceived locus of causality in exercise, sport, and physical education contexts. *Journal of Sport and Exercise Psychology, 25,* 284–306.

Chirkov, V., Ryan, R. M., Kim, Y., & Kaplan, U. (2003). Differentiating autonomy from individualism and independence: A self-determination theory perspective on internalization of cultural orientations and well-being. *Journal of Personality and Social Psychology, 84,* 97–110.

Costa, P. T., & McCrae, R. R. (1992). *Revised NEO Personality Inventory (NEO-PI-R) professional manual.* Odessa, FL: Psychological Assessment Resources.

Cresswell, S. L., & Eklund, R. C. (2005). Motivation and burnout among top amateur rugby players. *Medicine and Science in Sports and Exercise, 37,* 469–477.

deCharms, R. C. (1968). *Personal causation: The internal affective determinants of behavior.* New York: Academic Press.

Deci, E. L. (1971). Effects of externally mediated rewards on intrinsic motivation. *Journal of Personality and Social Psychology, 18,* 105–115.

Deci, E. L., Betley, G., Kahle, J., Abrams, L., & Porac, J. (1981). When trying to win: Competition and intrinsic motivation. *Personality and Social Psychology Bulletin, 7,* 79–83.

Deci, E. L., Eghrari, H., Patrick, B. C., & Leone, D. R. (1994). Facilitating internalization: The self-determination theory perspective. *Journal of Personality, 62,* 119–142.

Deci, E. L., Koestner, R., & Ryan, R. M. (1999). A meta-analysis review of experiments examining the effects of extrinsic rewards on intrinsic motivation. *Psychological Bulletin, 125,* 627–668.

Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic rewards and intrinsic motivation in education: Reconsidered once again. *Review of Educational Research, 71,* 1–27.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior.* New York: Plenum Press.

Deci, E. L., & Ryan, R. M. (1994). Promoting self-determined education. *Scandinavian Journal of Educational Research, 38,* 3–14.

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 11,* 227–268.

Deci, E. L., Schwartz, A. J., Sheinman, L., & Ryan, R. M. (1981). An instrument to assess adults' orientations toward control versus autonomy with children: Reflections on intrinsic motivation and competence. *Journal of Educational Psychology, 83,* 642–650.

Duda, J. L., Chi, L., Newton, M. L., Walling, M. D., & Catley, D. (1995). Task and ego orientation and intrinsic motivation in sport. *International Journal of Sport Psychology, 26,* 40–63.

Duda, J. L., & Hall, H. (2001). Achievement goal theory in sport: Recent extensions and future directions. In R. N. Singer, H. A. Hausenblas, & C. M. Janelle (Eds.), *Handbook of sport psychology* (2nd ed., pp. 417–443). New York: Wiley.

Duda, J. L., & Hayashi, C. T. (1998). Measurement issues in cross-cultural research within sport and exercise psychology. In J. L. Duda (Ed.), *Advances in sport and exercise psychology measurement* (pp. 471–483). Morgantown, WV: Fitness Information Technology.

Dwyer, J. J. M. (1995). Effect of perceived choice of music on exercise intrinsic motivation. *Health Values, 19,* 18–26.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology, 53,* 109–132.

Edmunds, J., Ntoumanis, N., & Duda, J. L. (in press). The application of self-determination theory to the exercise domain: New methodological and conceptual directions. In M. Hagger & N. L. D. Chatzisarantis (Eds.), *Self-determination in exercise and sport.* Champaign, IL: Human Kinetics.

Edwards, Y. V., Portman, T. A. A., & Bethea, J. (2002). Counseling student computer competency skills: Effects of technology course in training. *Journal of Technology in Counseling, 2*(2). Available from http://jtc.colstate.edu/issues.htm.

Fairchild, A. J., Horst, S. J., Finney, S. J., & Barron, K. E. (2005). Evaluation existing and new validity evidence for the Academic Motivation Scale. *Contemporary Educational Psychology, 30,* 331–358.

Ferrer-Caja, E., & Weiss, M. R. (2000). Predictors of intrinsic motivation among adolescent students in physical education. *Research Quarterly for Exercise and Sport, 71,* 267–279.

Fortier, M. S., & Grenier, M. N. (1999). Les déterminants personnels et situationnels de l'adhérence à l'exercise: Une étude prospective [Personal and situational determinants of exercise adherence]. *STAPS, 48,* 25–37.

Fortier, M. S., Vallerand, R. J., Brière, N. M., & Provencher, P. J. (1995). Competitive and recreational sport structures and gender: A test of their relationship with sport motivation. *International Journal of Sport Psychology, 26,* 24–39.

Frederick, C. M., Morrison, C., & Manning, T. (1996). Motivation to participate, exercise affect, and outcome behaviors toward physical activity. *Perceptual and Motor Skills, 82,* 691–701.

Gagné, M., Ryan, R. M., & Bargmann, K. (2003). Autonomy support and need satisfaction in the motivation and well-being of gymnasts. *Journal of Applied Sport Psychology, 15,* 372–390.

Goudas, M., Biddle, S. J. H., & Fox, K. (1994). Achievement goal orientations and intrinsic motivation in physical fitness testing with children. *Pediatric Exercise Science, 6,* 159–167.

Goudas, M., Biddle, S. J. H., Fox, K., & Underwood, M. (1995). It ain't what you do, it's the way that you do it! Teaching style affects children's motivation in track and field lessons. *Sport Psychologist, 9,* 254–264.

Gould, D., Dieffenbach, K., & Moffett, A. (2002). Psychological characteristics and their development of Olympic champions. *Journal of Applied Sport Psychology, 14,* 172–204.

Green-Demers, I., Pelletier, L. G., Stewart, D. G., & Gushue, N. R. (1998). Coping with the less interesting aspects of training: Toward a model of interest and motivation enhancement in individual sports. *Basic and Applied Social Psychology, 20,* 251–261.

Grouzet, F. M. E., Vallerand, R. J., Thill, E. E., & Provencher, P. J. (2004). From environmental factors to outcomes: A test of a motivational causal sequence. *Motivation and Emotion, 28,* 331–346.

Guay, F., Mageau, G. A., & Vallerand, R. J. (2003). On the hierarchical structure of self-determined motivation: A test of top-down, bottom-up, reciprocal, and horizontal effects. *Personality and Social Psychology Bulletin, 29,* 992–1004.

Guay, F., Vallerand, R. J., & Blanchard, C. (2000). On the assessment of situational intrinsic and extrinsic motivation: The Situational Motivation Scale (SIMS). *Motivation and Emotion, 24,* 175–213.

Guay, F., Vallerand, R. J., Pelletier, L. G., & Blais, M. R. (1999). *The Global Motivation Scale.* Unpublished manuscript, Université Laval, Ste-Foy, Quebec, Canada.

Hagger, M. S., & Chatzisarantis, N. L. D. (in press). A trans-contextual model of self-determined motivation in physical education and leisure contexts. In M. S. Hagger & N. L. Chatzisarantis (Eds.), *Self-determination theory in exercise and sport.* Champaign, IL: Human Kinetics.

Hagger, M. S., Chatzisarantis, N., Barkoukis, V., Wang, C. K. J., & Baranowski, J. (in press). Perceived autonomy support in physical education and leisure-time physical activity: A cross-cultural evaluation of the trans-contextual model. *Journal of Educational Psychology.*

Hagger, M. S., Chatzisarantis, N., Culverhouse, T., & Biddle, S. J. H. (2003). The processes by which perceived autonomy support in physical education promotes leisure-time physical activity intentions and behavior: A trans-contextual model. *Journal of Educational Psychology, 95,* 784–795.

Harlow, H. F. (1958). The nature of love. *American Psychologist, 13,* 673–685.

Hein, V., Müür, M., & Koka, A. (2004). Intention to be physically active after school graduation and its relationship to three types of intrinsic motivation. *European Physical Education Review, 10,* 5–19.

Henderlong, J., & Lepper, M. R. (2002). The effects of praise on children's intrinsic motivation: A review and synthesis. *Psychological Bulletin, 128,* 774–795.

Hewitt, P. L., & Flett, G. L. (2002). Perfectionism and stress enhancement, perpetuation, anticipation, and generation in psychopathology. In G. L. Flett & P. L. Hewitt (Eds.), *Perfectionism: Theory, research, and treatment* (pp. 742–775). Washington, DC: American Psychological Association.

Hodgins, H., & Knee, C. R. (2002). The integrating self and conscious experience. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (pp. 87–100). Rochester, NY: University of Rochester Press.

Hodgins, H., Yacko, I., & Gottlieb, E. (2005). *Autonomy and nondefensiveness.* Manuscript submitted for publication.

Hollembeak, J., & Amorose, A. J. (2005). Perceived coaching behaviors and college athletes' intrinsic motivation: A test of self-determination theory. *Journal of Applied Sport Psychology, 17,* 20–36.

Ingledew, D. K., Markland, D., & Medley, A. (1998). Exercise motives and stages of change. *Journal of Health Psychology, 3,* 477–489.

Ingledew, D. K., Markland, D., & Sheppard, K. E. (2003). Personality and self-determination of exercise behavior. *Personality and Individual Differences, 26,* 1921–1932.

Iwasaki, Y., & Mannell, R. C. (1999). Situational and personality influences on intrinsically motivated leisure behavior: Interaction effects and cognitive processes. *Leisure Sciences, 21,* 287–306.

Iyengar, S. S., & Lepper, M. R. (1999). Rethinking the value of choice: A cultural perspective on intrinsic motivation. *Journal of Personality and Social Psychology, 76,* 349–366.

Jackson, S. A., Kimiecik, J. C., Ford, S. K., & Marsh, H. W. (1998). Psychological correlates of flow in sport. *Journal of Sport and Exercise Psychology, 20,* 358–378.

Joussemet, M., Koestner, R., Lekes, N., & Houlfort, N. (2004). Introducing uninteresting tasks to children: A comparison of the effects of rewards and autonomy support. *Journal of Personality, 72,* 139–166.

Karageorghis, H. M., & Vlachopoulos, S. P. (2002). Motives for exercise participation as predictors of exercise dependence among endurance athletes. *Journal of Sports and Medicine Physical Fitness, 42,* 233–238.

Kavussanu, M., & Roberts, G. C. (1996). Motivation in physical activity contexts: The relationship of perceived motivational climate to intrinsic motivation and self-efficacy. *Journal of Sport and Exercise Psychology, 18,* 264–280.

Kitayama, S., Markus, H. R., & Kurokawa, M. (2000). Culture, emotion, and well-being: Good feelings in Japan and the United States. *Cognition and Emotion, 14,* 93–124.

Koestner, R., Bernieri, F., & Zuckerman, M. (1992). Self-determination and consistency between attitudes, traits, and behaviors. *Personality and Social Psychology Bulletin, 18,* 52–59.

Koestner, R., Ryan, R. M., Bernieri, F., & Holt, K. (1984). Setting limits in children's behavior: The differential effects of controlling versus informational styles on intrinsic motivation and creativity. *Journal of Personality, 52,* 233–248.

Kowal, J., & Fortier, M. S. (1999). Motivational determinants of flow: Contributions from self-determination theory. *Journal of Social Psychology, 139,* 355–368.

Kowal, J., & Fortier, M. S. (2000). Testing relationships from the hierarchical model of intrinsic and extrinsic motivation using flow as a motivational consequence. *Research Quarterly for Exercise and Sport, 71,* 171–181.

Lemyre, P.-N., Treasure, D. C., & Roberts, G. C. (2006). Influence of variability in motivation and affect on elite athlete burnout susceptibility. *Journal of Sport and Exercise Psychology.*

Lévesque, C., & Pelletier, L. G. (2003). On the investigation of primed and chronic autonomous and heteronomous motivational orientations. *Personality and Social Psychology Bulletin, 29,* 1570–1584.

Li, F. (1999). The Exercise Motivation Scale: Its multifaceted structure and construct validity. *Journal of Applied Sport Psychology, 11,* 97–115.

Mageau, G. A., & Vallerand, R. J. (2003). The coach-athlete relationship: A motivational model. *Journal of Sports Sciences, 21,* 883–904.

Markland, D., & Tobin, V. (2004). A modification of the Behavioral Regulation in Exercise Questionnaire to include an assessment of amotivation. *Journal of Sport and Exercise Psychology, 26,* 191–196.

Matsumoto, H., & Takenaka, K. (2004). Motivational profiles and stages of exercise behavior change. *International Journal of Sport and Health Science, 2,* 89–96.

McAuley, E., Duncan, T., & Tammen, V. V. (1989). Psychometric properties of the Intrinsic Motivation Inventory in a competitive sport setting: A confirmatory factor analysis. *Research Quarterly for Exercise and Sport, 60,* 48–58.

McAuley, E., & Tammen, V. V. (1989). The effects of subjective and objective competitive outcomes on intrinsic motivation. *Journal of Sport and Exercise Psychology, 11,* 84–93.

Miquelon, P., Vallerand, R. J., Grouzet, F. M. E., & Cardinal, G. (2005). Perfectionism, academic motivation, and psychological adjustment: An integrative model. *Personality and Social Psychology Bulletin, 31,* 913–924.

Mullan, E., Markland, D., & Ingledew, D. K. (1997). A graded conceptualization of self-determination in the regulation of exercise behavior: Development of a measure using confirmatory factor analytic procedures. *Personality and Individual Differences, 23,* 745–752.

Nicholls, J. G. (1984). Achievement motivation: Conceptions of ability, subjective experience, task choice, and performance. *Psychological Review, 91,* 328–346.

Nisbett, R. E. (2003). *The geography of thought: How Asians and Westerners think differently and why.* New York: Free Press.

Ntoumanis, N. (2001a). A self-determination approach to understanding motivation in physical education. *British Journal of Educational Psychology, 7,* 225–242.

Ntoumanis, N. (2001b). Empirical links between achievement goal theory and self-determination theory in sport. *Journal of Sports Sciences, 19,* 397–409.

Ntoumanis, N. (2002). Motivational clusters in a sample of British physical education classes. *Psychology of Sport and Exercise, 3,* 177–194.

Ntoumanis, N. (in press). A prospective study of participation in optional school physical education using a self-determination theory approach. *Journal of Educational Psychology.*

Ntoumanis, N., & Blaymires, G. (2003). Contextual and situational motivation in education: A test of the specificity hypothesis. *European Physical Education Review, 9,* 5–21.

Ntoumanis, N., Pensgaard, A.-M., Martin, C., & Pipe, K. (2004). An idiographic analysis of amotivation in compulsory school physical education. *Journal of Sport and Exercise Psychology, 26,* 197–214.

Orlick, T. D., & Mosher, R. (1978). Extrinsic awards and participant motivation in a sport related task. *International Journal of Sport Psychology, 9,* 27–39.

Parfitt, G., & Gledhill, C. (2004). The effect of choice of exercise mode on psychological responses. *Psychology of Sport and Exercise, 5,* 111–117.

Pelletier, L. G., Dion, S., & Lévesque, C. (2004). Can self-determination help protect women against sociocultural influences about body image and reduce their risk of experiencing bulimic symptoms? *Journal of Social and Clinical Psychology, 23,* 61–88.

Pelletier, L. G., Fortier, M. S., Vallerand, R. J., & Brière, N. M. (2001). Associations among perceived autonomy support, forms of self-regulation, and persistence: A prospective study. *Motivation and Emotion, 25,* 279–306.

Pelletier, L. G., Fortier, M. S., Vallerand, R. J., Tuson, K. M., Brière, N. M., & Blais, M. R. (1995). Toward a new measure of intrinsic motivation, extrinsic motivation, and amotivation in sports: The Sport Motivation Scale (SMS). *Journal of Sport and Exercise Psychology, 17,* 35–53.

Pelletier, L. G., & Sarrazin, P. (in press). Measurement issues in self-determination theory and sport. In M. S. Hagger & N. L. Chatzisarantis (Eds.), *Self-determination theory in exercise and sport.* Champaign, IL: Human Kinetics.

Pelletier, L. G., Séguin-Lévesque, C., & Legault, L. (2002). Pressure from above and pressure from below as determinants of teachers' motivation and teaching behaviors. *Journal of Educational Psychology, 94,* 186–196.

Pelletier, L. G., & Vallerand, R. J. (1996). Supervisors' beliefs and subordinates' intrinsic motivation: A behavioral confirmation analysis. *Journal of Personality and Social Psychology, 71,* 331–340.

Pelletier, L. G., Vallerand, R. J., Brière, N. M., & Blais, M. R. (2006). *When coaches become autonomy-supportive: Effects on intrinsic motivation, persistence, and performance.* Unpublished manuscript, University of Ottawa, Ontario, Canada.

Pelletier, L. G., Vallerand, R. J., Green-Demers, I., Blais, M. R., & Brière, N. M. (1996). Vers une conceptualisation motivationnelle multidimensionnelle du loisir: Construction et validation de l'Échelle de Motivation vis-à-vis des Loisirs (EML) [Toward a multidimensional motivational conceptualization of leisure: Construction and validation of the Leisure Motivation Scale]. *Loisir et Société, 19,* 559–585.

Pensgaard, A. M., & Roberts, G. C. (2002). Elite athletes' experiences of the motivational climate: The coach matters. *Scandinavian Journal of Medicine and Science in Sports, 12,* 54–59.

Raedeke, T. D. (1997). Is athlete burnout more than just stress? A sport commitment perspective. *Journal of Sport and Exercise Psychology, 19,* 369–417.

Ratelle, C. F., Baldwin, M., & Vallerand, R. J. (2005). On the cued activation of situational motivation. *Journal of Experimental Social Psychology, 41,* 482–487.

Ratelle, C. F., Senécal, C., Vallerand, R. J., & Provencher, P. J. (in press). The relationship between school-leisure conflict and poor educational and mental health indices: A motivational analysis. *Journal of Applied Social Psychology.*

Ratelle, C. F., Vallerand, R. J., Chantal, Y., & Provencher, P. (2004). Cognitive adaptation and mental health: A motivational analysis. *European Journal of Social Psychology, 34,* 459–476.

Reeve, J. (1998). Autonomy support as an interpersonal motivating style: Is it teachable? *Contemporary Educational Psychology, 23,* 312–330.

Reeve, J., Jang, H., Hardre, P., & Omura, M. (2002). Providing a rationale in an autonomy-supportive way as a strategy to motivate others during an uninteresting activity. *Motivation and Emotion, 26,* 183–297.

Reinboth, M., Duda, J. L., & Ntoumanis, N. (2004). Dimensions of coaching behavior, need satisfaction, and the psychological and physical welfare of young athletes. *Motivation and Emotion, 28,* 297–313.

Reis, H. T., Sheldon, K. M., Gable, S. L., Roscoe, R., & Ryan, R. M. (2000). Daily well-being: The role of autonomy, competence, and relatedness. *Personality and Social Psychology Bulletin, 26,* 419–435.

Riordan, J. (1977). *Sport in Soviet society.* Cambridge, England: Cambridge University Press.

Ryan, E. D. (1977). Attribution, intrinsic motivation, and athletics. In L. I. Gedvilas & M. E. Kneer (Eds.), *Proceedings of the National College of Physical Education Association for Men/National Association for Physical Education of College Women national conference* (pp. 346–353). Chicago: University of Illinois at Chicago Circle Press, Office of Publications Services.

Ryan, E. D. (1980). Attribution, intrinsic motivation, and athletics: A replication and extension. In C. H. Nadeau, W. R. Halliwell, K. M. Newell, & G. C. Roberts (Eds.), *Psychology of motor behavior and sport—1979* (pp. 19–26). Champaign, IL: Human Kinetics.

Ryan, R. M., Frederick, C. M., Lepes, D., Rubio, N., & Sheldon, K. M. (1997). Intrinsic motivation and exercise adherence. *International Journal of Sport Psychology, 28,* 335–354.

Sarrazin, P., Vallerand, R. J., Guillet, E., Pelletier, L. G., & Curry, F. (2002). Motivation and dropout in female handballers: A 21-month prospective study. *European Journal of Social Psychology, 57,* 749–761.

Scanlan, T. K., & Lewthwaite, R. (1986). Social psychological aspects of competition for male youth sport participants: Pt. IV. Predictors of enjoyment. *Journal of Sport Psychology, 8,* 25–35.

Senécal, C., Vallerand, R. J., & Guay, F. (2001). Antecedents and outcomes of work-family conflicts: Toward a motivational model. *Personality and Social Psychology Bulletin, 27,* 176–186.

Sheldon, K. M., Elliot, A. J., Kim, Y., & Kasser, T. (2001). What is satisfying about satisfying events? Testing 10 candidate psychological needs. *Journal of Personality and Social Psychology, 80,* 325–339.

Simons, J., Dewitte, S., & Lens, W. (2003). Don't do it for me. Do it for yourself! Stressing the personal relevance enhances motivation in physical education. *Journal of Sport and Exercise Psychology, 25,* 145–160.

Standage, M., Duda, J. L., & Ntoumanis, N. (2003). Predicting motivation regulations in physical education: The interplay between dispositional goal orientations, motivational climate and perceived competence. *Journal of Sports Sciences, 21,* 631–647.

Standage, M., & Treasure, D. C. (2002). Relationship among achievement goal orientations and multidimensional situational motivation in physical education. *British Journal of Educational Psychology, 72,* 87–103.

Standage, M., Treasure, D. C., Duda, J. L., & Prusak, K. A. (2003). Validity, reliability, and invariance of the Situational Motivation Scale (SIMS) across diverse physical activity contexts. *Journal of Sport and Exercise Psychology, 25,* 19–43.

Tauer, J. M., & Harackiewicz, J. M. (2004). The effects of cooperation and competition on intrinsic motivation and performance. *Journal of Personality and Social Psychology, 86,* 849–861.

Thill, E., & Mouanda, J. (1990). Autonomy or control in the sports context: Validity of cognitive evaluation theory. *International Journal of Sport Psychology, 21,* 1–20.

Thøgersen-Ntoumani, C., & Ntoumanis, N. (in press). The role of self-determined motivation to the understanding of exercise-related behaviors, cognitions, and physical self-evaluation. *Journal of Sports Sciences.*

Thomas, J. R., & Tennant, L. K. (1978). Effects of rewards on children's motivation for an athletic task. In F. L. Smoll & R. E. Smith. *Psychological perspectives in youth sports* (pp. 123–144). Washington, DC: Hemisphere.

Vallerand, R. J. (1997). Toward a hierarchical model of intrinsic and extrinsic motivation. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 29, pp. 271–360). New York: Academic Press.

Vallerand, R. J. (2001). A hierarchical model of intrinsic and extrinsic motivation in sport and exercise. In G. Roberts (Ed.), *Advances in motivation in sport and exercise* (2nd ed., pp. 263–319). Champaign, IL: Human Kinetics.

Vallerand, R. J. (in press). The hierarchical model of intrinsic and extrinsic motivation in sport and physical activity. In M. S. Hagger & N. L. D. Chatzisarantis (Eds.), *Self-determination theory in exercise and sport.* Champaign, IL: Human Kinetics.

Vallerand, R. J., & Bissonnette, R. (1992). Intrinsic, extrinsic, and amotivational styles as predictors of behavior: A prospective study. *Journal of Personality, 60,* 599–620.

Vallerand, R. J., Blais, M. R., Brière, N. M., & Pelletier, L. G. (1989). Construction et validation de l'Échelle de motivation en éducation (EME) [On the construction and validation of the French form of the Academic Motivation Scale]. *Canadian Journal of Behavioral Science, 21,* 323–349.

Vallerand, R. J., Brière, N. M., Blanchard, C., & Provencher, P. (1997). Development and validation of the Multidimensional Sportspersonship Orientations Scale. *Journal of Sport and Exercise Psychology, 19,* 197–206.

Vallerand, R. J., Deci, E. L., & Ryan, R. M. (1987). Intrinsic motivation in sport. In K. Pandolf (Ed.), *Exercise and sport science reviews* (Vol. 15, pp. 389–425). New York: Macmillan.

Vallerand, R. J., Deshaies, P., Cuerrier, J.-P., Brière, N. M., & Pelletier, L. G. (1996). Toward a multidimensional definition of sportsmanship. *Journal of Applied Sport Psychology, 8,* 89–101.

Vallerand, R. J., & Fortier, M. S. (1998). Measures of intrinsic and extrinsic motivation in sport and physical activity: A review and critique. In J. Duda (Ed.), *Advancements in sport and exercise psychology measurement* (pp. 83–100). Morgantown, WV: Fitness Information Technology.

Vallerand, R. J., Fortier, M. S., & Guay, F. (1997). Self-determination and persistence in a real-life setting: Toward a motivational model of high school dropout. *Journal of Personality and Social Psychology, 72,* 1161–1176.

Vallerand, R. J., Gauvin, L., & Halliwell, W. R. (1986a). Effects of zero-sum competition on children's intrinsic motivation and perceived competence. *Journal of Social Psychology, 126,* 465–472.

Vallerand, R. J., Gauvin, L., & Halliwell, W. R. (1986b). Negative effects of competition on children's intrinsic motivation. *Journal of Social Psychology, 126,* 649–657.

Vallerand, R. J., & Grouzet, F. M. E. (2001). Pour un modèle hiérarchique de la motivation intrinsèque et extrinsèque dans les pratiques sportives et l'activité physique [For a hierarchical model of intrinsic and extrinsic motivation in sport and physical activity]. In F. Curry, P. Sarrazin, & J. P. Famose (Eds.), *Théories de la motivation et pratiques sportives* (pp. 57–95). Paris: Presses Universitaires de France.

Vallerand, R. J., Guay, F., Mageau, G., Blanchard, C. M., & Cadorette, I. (2005). *Self-regulatory processes in human behavior: A test of the hierarchical model of intrinsic and extrinsic motivation.* Manuscript submitted for publication.

Vallerand, R. J., & Losier, G. F. (1994). Self-determined motivation and sportsmanship orientations: An assessment of their temporal relationship. *Journal of Sport and Exercise Psychology, 16,* 229–245.

Vallerand, R. J., & Losier, G. F. (1999). An integrative analysis of intrinsic and extrinsic motivation in sport. *Journal of Applied Sport Psychology, 11,* 142–169.

Vallerand, R. J., & O'Connor, B. P. (1991). Construction et validation de l'Échelle de Motivation pour les personnes âgées (EMPA) [Construction and validation of the French form of the Elderly Motivation Scale]. *International Journal of Psychology, 26,* 219–240.

Vallerand, R. J., Pelletier, L. G., Blais, M. R., Brière, N. M., Senécal, C., & Vallières, E. F. (1992). The Academic Motivation Scale: A measure of intrinsic, extrinsic, and amotivation in education. *Educational and Psychological Measurement, 52,* 1003–1019.

Vallerand, R. J., Pelletier, L. G., Blais, M. R., Brière, N. M., Senécal, C., & Vallières, E. F. (1993). On the assessment of intrinsic, extrinsic, and amotivation in education: Evidence on the concurrent and construct validity of the Academic Motivation Scale. *Educational and Psychological Measurement, 53,* 159–172.

Vallerand, R. J., & Perreault, S. (1999). Intrinsic and extrinsic motivation in sport: Toward a hierarchical model. In R. Lidor & M. Bar-Eli (Eds.), *Sport psychology: Linking theory and practice* (pp. 191–212). Morgantown, WV: Fitness Information Technology.

Vallerand, R. J., & Ratelle, C. F. (2002). Intrinsic and extrinsic motivation: A hierarchical model. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (pp. 37–64). Rochester, NY: University of Rochester Press.

Vallerand, R. J., & Reid, G. (1984). On the causal effects of perceived competence on intrinsic motivation: A test of cognitive evaluation theory. *Journal of Sport Psychology, 6,* 94–102.

Vallerand, R. J., & Reid, G. (1988). On the relative effects of positive and negative verbal feedback on males' and females' intrinsic motivation. *Canadian Journal of Behavioral Sciences, 20,* 239–250.

Vallerand, R. J., & Rousseau, F. L. (2001). Intrinsic and extrinsic motivation in sport and exercise: A review using the hierarchical model of intrinsic and extrinsic motivation. In R. N. Singer, H. A. Hausenblas, & C. M. Janelle (Eds.), *Handbook of sport psychology* (2nd ed., pp. 389–416). New York: Wiley.

Vallerand, R. J., & Thill, E. E. (1993). Introduction au concept de motivation [Introduction to the concept of motivation]. In R. J. Vallerand & E. E. Thill (Eds.), *Introduction à la psychologie de la motivation* [Introduction to the psychology of motivation] (pp. 3–39). Laval, Canada: Éditions Études Vivantes.

Vlachopoulos, S. P., Karageorghis, C. I., & Terry, P. C. (2000). Motivation profiles in sport: A self-determination theory perspective. *Research Quarterly for Exercise and Sport, 71,* 387–397.

Wagner, S. L., Lounsbury, J. W., & Fitzgerald, L. G. (1989). Attribute factors associated with work/leisure perceptions. *Journal of Leisure Research, 21,* 155–166.

Wang, C. K. J., & Biddle, S. J. H. (2001). Young people's motivational profiles in physical activity: A cluster analysis. *Journal of Sport and Exercise Psychology, 23,* 1–22.

Wang, C. K. J., Chatzisarantis, N. L. D., Spray, C. M., & Biddle, S. J. H. (2002). Achievement goal profiles in school physical education: Differences in self-determination, sport ability beliefs, and physical activity. *British Journal of Educational Psychology, 72,* 433–445.

Weinberg, R. S., & Ragan, J. (1979). Effects of competition, success/failure, and sex on intrinsic motivation. *Research Quarterly, 50,* 503–510.

Weiner, B. (1972). *Theories of motivation: From mechanism to cognition.* Chicago: Markham.

Weiss, M. R., & Amorose, A. J. (2005). Children's self-perceptions in the physical domain: Between- and within-age variability in level, accuracy, and sources of perceived competence. *Journal of Sport and Exercise Psychology, 27,* 226–244.

White, R. W. (1959). Motivation reconsidered: The concept of competence. *Psychological Review, 66,* 297–333.

Wilson, P. M., & Rodgers, W. M. (2002). The relationship between exercise motives and physical self-esteem in female exercise participants: An application of self-determination theory. *Journal of Applied Biobehavioral Research, 7,* 30–43.

Wilson, P. M., & Rodgers, W. M. (2004). The relationship between perceived autonomy support, exercise regulations, and behavioural intentions in women. *Psychology of Sport and Exercise, 5,* 229–242.

Wilson, P. M., & Rodgers, W. M. (in press). Self-determination theory, exercise, and well-being. In M. S. Hagger & N. L. Chatzisarantis (Eds.), *Self-determination theory in exercise and sport.* Champaign, IL: Human Kinetics.

Wilson, P. M., Rodgers, W. M., Fraser, S. N., & Murray, T. C. (2004). Relationships between exercise regulations and motivational consequences in university students. *Research Quarterly for Exercise and Sport, 75,* 81–91.

Wilson, P. M., Rodgers, W. M., Hall, C. R., & Gammage, K. L. (2003). Do autonomous exercise regulations underpin different types of exercise imagery? *Journal of Applied Sport Psychology, 15,* 294–306.

CHAPTER 4

The Psychology of Superior Sport Performance

A Cognitive and Affective Neuroscience Perspective

BRADLEY D. HATFIELD and SCOTT E. KERICK

The aims of the present chapter are (a) to provide a neurobiological model to explain peak performance in sport based on a review of neuroimaging studies primarily employing electroencephalography (EEG) during self-paced and reactive psychomotor performances; (b) to discuss how distress interferes with these processes and, consequently, alters the quality of motor performance (i.e., skeletal muscle action); and (c) to describe a strategy for the management or amelioration of such stress-induced perturbations. A general principle, based on the scientific evidence reviewed, is also offered to practitioners such as coaches and sport psychologists in their efforts to guide athletes to high-quality performance. Such a principle provides a parsimonious perspective, or "neurophilosophy," that may help coaches and athletes to understand *how* and *why* psychological processes influence physical performance. The level of analysis used to describe brain processes throughout this chapter is that of cognitive and affective neuroscience. In essence, this approach seeks to understand the neurobiology underlying higher mental processes (i.e., cognition, or thinking, and emotion, or feeling), as opposed to basic molecular and cellular activity on which the system-level processes certainly depend, and typically employs neuroimaging tools such as EEG, magnetoencephalography (MEG), functional magnetic resonance imaging (fMRI), and positron emission tomography (PET) to capture these events in human subjects.

The chapter begins with a description of the essential economical or efficient action nature of mental processes during peak performance, which follows from the physiological descriptions of cardiovascular, metabolic, and musculoskeletal activity in trained athletes. This description is followed by an overview of the neuroimaging tools used by cognitive neuroscientists, with an emphasis on EEG as it has been the most widely used methodology to assess mental processes in the sport psychophysiology literature. Subsequently, a number of sections summarize the literature on cerebral cortical activity during motor behavior (see Hatfield, Haufler, Hung, & Spalding, 2004, and Hatfield, Haufler, & Spalding, 2006, for a detailed review of this literature). The summaries begin with the early studies of regional brain activity during self-paced visuomotor performance (i.e., the aiming period during marksmanship as well as archery, golf, and karate). The conceptual basis of these studies rests on the pioneering split-brain investigations of Roger Sperry and Michael Gazzaniga. The functional differences in brain regions noted by these investigators, such that the left temporal/parietal is associated with phonological processes and the homologous right regions are associated with visual-spatial processes, were considered to achieve cognitive inferences from simultaneous records of left and right hemispheric cortical activity during motor performance. Subsequent sections in the chapter illustrate the concept of mental economy as a marker of superior performance by (a) contrasting cortical activity (i.e., EEG spectral content) in expert and novice target shooters, (b) describing the changes or evolution of cerebral cortical activity as a function of practice, and (c) contrasting networking patterns or cortico-cortical communication in marksmen who differ in competitive performance ability. More recent studies of cortical dynamics during reactive motor behavior are then described using both spectral and event-related potential (ERP) measures. These recent developments are important as they extend the findings on brain activity and sport performance beyond the constraints of the self-paced paradigm and open up the range of findings to be more inclusive of the types of conditions in which athletes perform. Of particular importance, the linkage between the observed cortical activity and psychomotor performance in a number of studies is discussed and interpreted within the framework of an inverted-U relationship.

A major development, still in its infant stages, is that of affective neuroscience applied to sport psychology. In essence, this involves the assessment of brain activity during stress or while performing psychomotor tasks under pressure. Surprisingly little work has been done in this area of research, although it is strongly established in the area of exercise psychology. A neurobiological model of stress-related brain dynamics is described and based largely on a marriage of concepts from LeDoux (1996), on the central role of the amygdala in fear-related processes, and the work of Davidson (1988, 2002, 2004) on the role of frontally mediated processes in the regulation of emotion. The pivotal role of frontal cortical activity in the management of emotion (e.g., fear and anxiety) is described in the context of the model; a simple yet powerful metric, frontal asymmetry, can then be employed during neurofeedback such that a number of physiological (i.e., mind-body) consequences or sequelae that would likely disrupt motor performance may be attenuated or reduced in magnitude. The model describes how the brain would be affected by stress and how motor performance would be affected. Empirical support is provided by the various studies described throughout the chapter. Finally, the chapter outlines the future directions or research emphases of this emerging field of study, the relationship between sport and military psychology, signal processing developments that will enable more sophisticated extraction of brain activity information from neuroimaging data, the emergence of realistic virtual reality environments within which to study the working brain during sport performance, and practical implications of the research.

EFFICIENCY OF MENTAL PROCESSES DURING SKILLED MOTOR PERFORMANCE

One of the essential characteristics of skilled athletic performance is efficient movement (Hatfield & Hillman, 2001; Lay, Sparrow, Hughes, & O'Dwyer, 2002). Efficient movement can be described in terms of energy cost of work output (Sparrow, 2000). Simply stated, skilled athletes perform with minimal effort as constrained by the task demands. In this manner, the athlete may be engaged in an intense activity, such as sprinting in a 100-meter dash, but optimal performance would be characterized by work output *limited* to the prime mover muscles (e.g., gluteal and upper hamstring action) in the absence of any unnecessary tension or motor unit recruitment in the prime movers as well as any nonessential muscles (i.e., those that do not directly contribute to moving the performer's center of mass in a rectilinear manner toward the finish line). To illustrate, the muscular actions of Carl Lewis, the great American sprinter, have been described as a state of "relaxed explosiveness."

Evidence has been provided to support this notion for a number of physiological parameters. For example, deVries (1968) discussed the concept of efficiency of electrical activity of muscle, a measure derived from electromyographic (EMG) recordings during force production. In essence, a muscle with a higher capacity to produce force (i.e., a stronger muscle) will exhibit lower levels of integrated EMG (IEMG), an index of motor unit recruitment, during similar absolute levels of submaximal work when compared to the levels of IEMG produced by a muscle with less capacity (i.e., a weaker muscle; deVries & Housh, 1994). In this manner, a stronger muscle accomplishes a given amount of work with fewer motor units. Such a quality may be a result of genetic endowment but is more likely an adaptation from resistance training.

According to the general adaptation syndrome advanced by Selye (1976), repeated negotiation of a stressor results in the stage of adaptation—a state that allows a biological system to respond to the stressor with less strain or cost because of anabolic adaptations in the tissue. As such, the notion of more efficient work in a trained muscle is entirely consistent with the fundamental principle of stress adaptation outlined by Selye. On a more global level, Sparrow (2000) stated that the dynamics of coordinated muscle activity are organized on the basis of minimization of energy expenditure in a process of adaptation to constraints imposed by both task and environment. Lay et al. (2002) recently provided empirical evidence for this notion by assessing EMG activity in a group of subjects who underwent several sessions of training on a rowing ergometer. Training clearly resulted in reduced EMG activity in the vastus lateralis and biceps brachii muscles during rowing stroke production, greater coordination between muscle groups, and greater consistency or stability in movement pattern.

In addition, Daniels (1985) advanced the related notion of running economy, a metabolic characteristic of superior endurance performers. That is, superior runners, in a group characterized by homogeneity of aerobic capacity, exhibit lowered oxygen consumption (expressed as ml O_2/kg/minute) than that shown by slower members of the group when engaged in similar submaximal absolute work. In this manner, the superior runner consumes less O_2 than the less accomplished runner (per kilogram of body weight) when both run at the same speed at the same grade. Such relative economy may well be due to minimization of unproductive and unnecessary muscular activity (e.g., excess circumduction of the pelvis or abduction of the upper extremities). As such, numerous examples exist in the physiological domain that provide evidence of the ubiquity of economy of highly trained biological systems. The utility of such energy-saving adaptation is the reduction of stress and the opportunity for enhanced survival due to less load and wear and tear on the organism. The focal question that guides the present review is this: Does such a state also characterize the central neural processes of the skilled performer?

Phenomenological reports of high-performance athletes support such a position. Williams and Krane (1998) described a number of psychological qualities associated with the ideal performance state that largely related to a sense of effortlessness, not thinking during performance, and an involuntary experience. Such subjective experience is also consistent with the notion of automaticity in skilled motor behavior advanced by Fitts and Posner (1967). Accordingly, Fitts and Posner described three progressive stages that the learner experiences, evolving from the beginning stage of cognitive analysis, to the intermediate stage of association during which conscious regulation of motor processes is required, and finally to the advanced stage of automaticity in which the performer negotiates task demands without conscious effort.

In essence, one could speculate that the association areas of the cerebral cortex become relatively quiescent with practice and enhanced skill level so as to minimize potential interference with the central motor control processes responsible for neuromuscular activity. The cortical association areas that deal with cognitive processes are intricately interconnected to the motor loop, which is largely composed of the striatum (caudate nucleus and putamen), globus pallidus, and ventro-lateral nucleus of the thalamus with projection to the motor cortex in order to enable depolarization of the appropriate cell bodies for ultimate activation of skeletal muscle motor units (Kandel & Schwartz, 1985). Refinement of associative processes from practice may result in more specific networking and possible reduction of interference with the motor structures, thereby reducing the complexity in the organization of the musculoskeletal actions. Hatfield and Hillman (2001) described this quality of cognitive-motor processing as psychomotor efficiency. Less complexity in the processes associated with motor control or a reduction in the degrees of freedom of relevant neural network actions may lead to greater consistency of the resultant motor performance because of less variability in the orchestration of movement preparation. Evidence to support this notion is provided later in the chapter.

NEUROIMAGING: TOOLS USED TO EXAMINE THE WORKING BRAIN

Cognitive and affective neuroscience, as opposed to other levels of analysis of mental processes (e.g., cellular and behavioral neuroscience), seek to understand the neural mechanisms responsible for higher levels of human mental activity, such as attention, executive functioning, and language (Bear, Connors, & Paradiso, 2001). In this manner, brain activation or neuroimaging measures allow one to see the brain at work and include assessment of regional activation and metabolic activity of brain structures such as the cerebral cortex, the amygdala (a subcortical structure that mediates emotional processes such as fear), and specific regions of the cortex such as the frontal lobes, which mediate executive or planning processes, as well as emotional states such as approach and avoidance/withdrawal. In essence, such measurement is detailed and further enables the sport scientist to detect changes in cognitive function and emotion occurring as a result of practice or imposed stress that would be invisible with behavioral observation.

The brain processes that mediate cognition and affect may be detected with a high degree of temporal and spatial resolution by employing electrophysiological and neuroimaging techniques. Temporal resolution refers to the sensitivity of a measure to detect changes in brain activity as a function of time and is high in EEG and MEG. Spatial resolution refers to the ability to detect the locations of brain structures and processes and is characteristic of MRI, fMRI, PET, and SPECT (Tomporowski & Hatfield, 2005). Although a number of tools are available for seeing the brain at work, EEG has the advantage over all other techniques of ecological validity, or use in unconstrained settings (i.e., real-world tasks or virtual reality environments as opposed to confined spaces).

Electroencephalography

EEG recordings represent time series of electrical activity recorded from the brain by placing electrodes at selected sites on the scalp. Figure 4.1 illustrates standardized EEG recording sites (a) and a marksman being monitored for EEG during the attention-demanding aiming period (b). The standard electrode placement system specifies electrode locations based on anatomical landmarks on the head, referred to as the International 10–20 system (Figure 4.2), which allows for comparison of results from var-

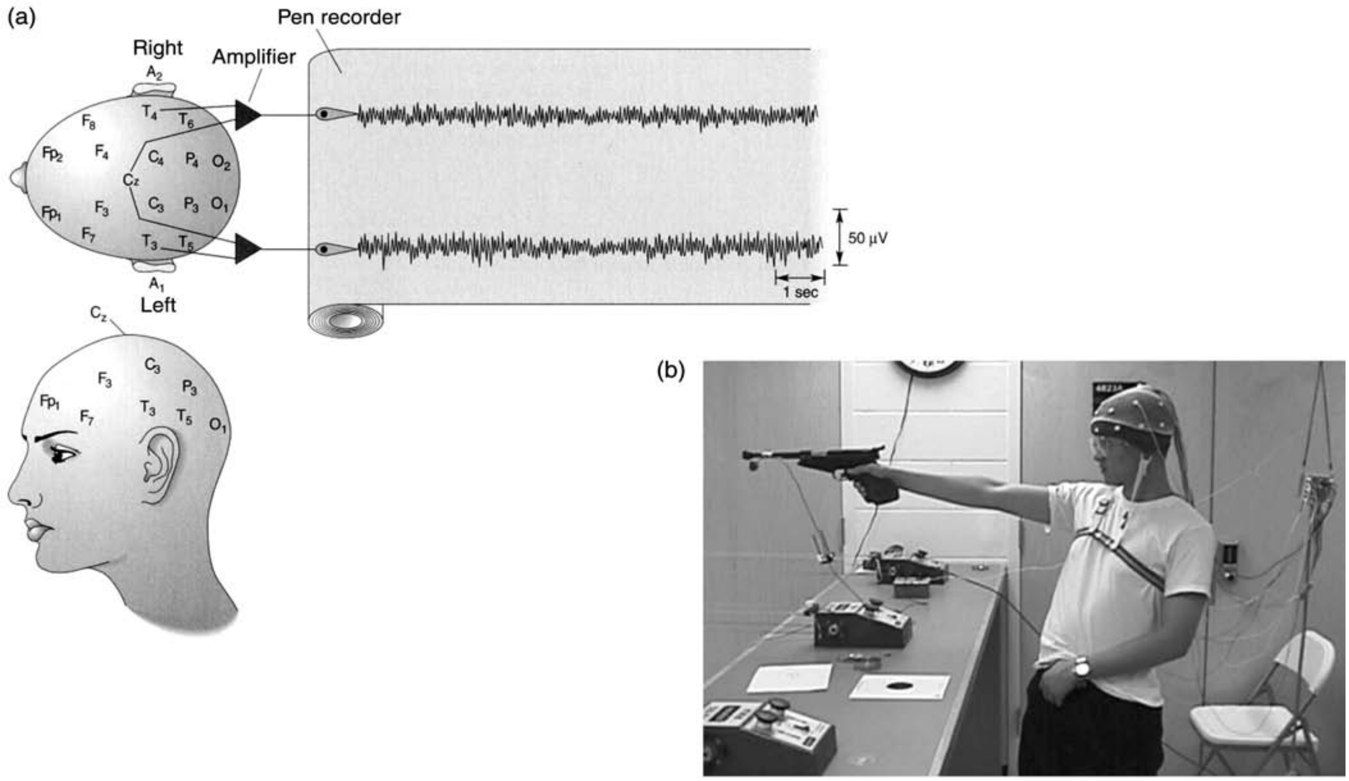


Figure 4.1 (a) EEG recording and (b) marksman being monitored for EEG and eye movements during the motionless aiming period. *Note:* A = auricle (or ear), C = central, Cz = vertex, F = frontal, Fp = frontal pole, O = occipital, P = parietal, T = temporal. Wires from pairs of electrodes are fed to amplifiers, and these drive pen recorders.

ious laboratories and clinical settings (Jasper, 1958). As discussed in Hatfield et al. (2006) the EEG sensor detects the transient or fluctuating summation of excitatory and inhibitory postsynaptic potentials (currents) from tens of thousands of neurons, and possibly glial cells, located below the scalp surface within the cortex of the brain, which collectively generate an electrical charge or potential. The current detected by the EEG sensors is manifest on the order of millionths of volts, or microVolts (μV). The transient continuous potentials or analog signals, changing in magnitude over time, are sampled and converted to digital values by an analog-to-digital (A-D) converter and amplified 20 to 50 thousand times although the amplification can be much less with the employment of high-resolution A-D converters because of the ability to discriminate very small increments in voltage. The current is then subjected to differential amplification, a process by which the resultant EEG actually creates a record of the difference in voltage between the recording sites and a reference site that is typically placed on a nonbrain region, such as the earlobe, mastoid, or tip of the nose. The differential amplification process enables rejection of any signals common to the two sites, thought to be nonbrain in origin, so that the amplified time series is reflective of brain electrical activity.

The EEG record is a two-dimensional time series of voltage fluctuations (see panel a, Figure 4.1) characterized by amplitude and frequency. The frequency range or spectrum extends from 1 to approximately 50 cycles per second (Hz), with higher frequencies indicative of greater activation. In essence, the raw EEG signal is composed of a mixture of the frequencies in the spectrum; it can be decomposed into its primary ingredients or sinusoidal frequency components to determine the degree of activation. The decomposition of the complex record or EEG wave for a given time period or epoch is termed spectral analysis, and is accomplished mathematically by fast Fourier transformation (FFT). In this regard, lower frequencies, such as the high-amplitude delta (i.e., 1 to 3 Hz), theta (i.e., 4 to 7 Hz), and alpha (i.e., 8 to 13 Hz) bands, are indicative of a relaxed state, whereas higher frequencies, such as the lower-amplitude beta (i.e., 13 to 30 Hz) and gamma (i.e., 36 to 44 Hz) bands are indicative of localized activation (Figure 4.3). Synchronous activity results in higher amplitude potentials and is likely

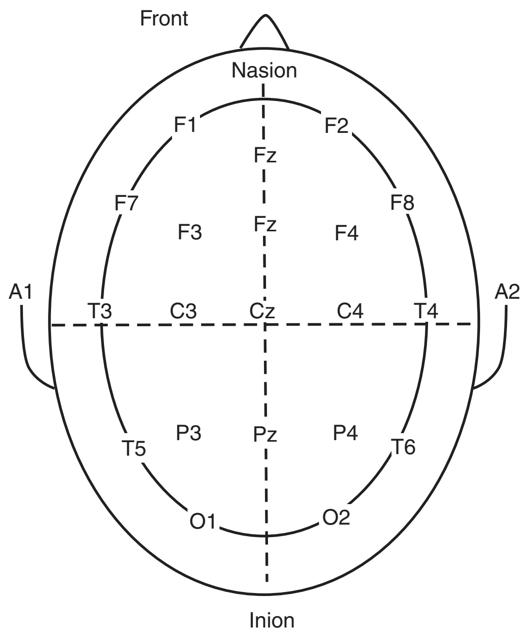


Figure 4.2 The international 10–20 system for standard EEG sensor placement on the head, enabling the acquisition of differential amplification and the resulting time series of fluctuating voltages. The nomenclature is based on the fact that electrode placements are based on fixed percentages (10% and 20%) of the distances between standard landmarks, such as nasion (bridge of nose) and inion (occipital bone protuberance). More recent recording montages contain up to 256 sensors for source localization, or solving the inverse problem.

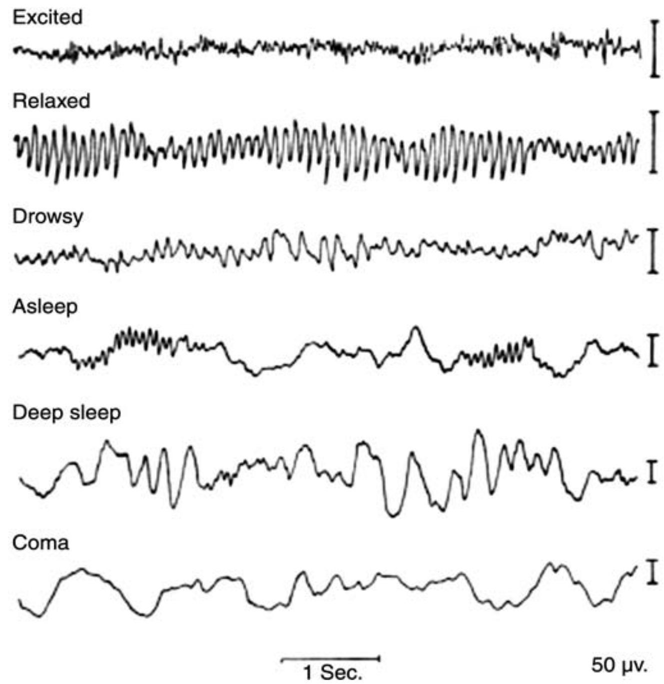


Figure 4.3 EEG frequency and associated arousal states. The excited time series is composed primarily of beta and gamma frequencies; the relaxed time series is composed mainly of alpha frequencies; while the drowsy time series is composed largely of delta and theta frequencies.

the result of similar neuronal states in the brain region of interest (ROI). In regard to alpha power, a similar state of neuronal assemblies is likely to occur during *a relaxed state,* resulting in summation of postsynaptic potentials (and alpha synchrony) due to similarity of neuronal states (e.g., similar to members of a chorus singing in unison). Conversely, a dissimilar state of neuronal assemblies is likely to occur during active task engagement, resulting in differential assignment of neurons and desynchrony or reduced alpha power or amplitude.

The advantage of EEG is that it not only captures fast-changing events, but it can also be used to detect the timing of communication between different cortical regions by means of coherence analysis. Similarity in the spectral content of EEG recorded at different sites (i.e., high coherence) is assumed to indicate cortico-cortical communication. Only EEG and MEG can be used to definitively assess the timing or sequencing of events of hypothesized network models. A major limitation of EEG, however, is the problem of volume conduction, or the spreading of electrical charge throughout the liquid medium of the brain so that the signal is also detected (albeit with reduced influence) by sensors beyond those overlying the tissue or ROI. For this reason, EEG is said to be relatively poor in spatial resolution compared to neuroimaging techniques such as fMRI and PET. However, both EEG and MEG are superior to all other neuroimaging techniques for temporal resolution.

Recent advances in EEG technology have improved spatial resolution by using dense electrode recordings involving up to (and beyond) 250 recording sites. Such dense electrode or sensor arrays allow for computation of the inverse solution, that is, estimation of the location of brain sources that are responsible for, or are likely candidates for, determining the surface-recorded EEG. The recordings from such dense arrays can also be coregistered with structural MRI scans to individualize the precise locations of the neural generators or sources of the surface-recorded EEG. In this manner, dense electrode arrays for EEG recording enable spatial resolution of cortical sources while simultaneously capitalizing on the superior temporal resolution. In addition, *EEG is the only technique that allows study participants to be tested in nonconfining settings and even naturalistic environments* *through the use of portable recording systems or larger systems used in conjunction with virtual reality settings.* All of the other neuroimaging techniques require confinement of the study participant such that movement must be minimized while lying in a closed environment. Movement must be minimized for artifact-free EEG recording, too, but the restrictions are significantly reduced relative to all of the other techniques. In terms of cost, the economy of EEG is far superior to the other techniques.

To further capitalize on temporal resolution, a derivative of the EEG can be used to assess basic sensory and attentional processes. This is the event-related potential, and it provides a precise chronometric index of neural processing. This index is derived from averaging a number of EEG epochs that are time-locked to repetitive stimuli (i.e., basic auditory, visual, or tactile stimuli). The resultant ERP time series (Figure 4.4) consists of early or exogenous components (50 to 150 ms) related to obligatory processing of sensory information and later endogenous components (300 to 800 ms) related to basic cognitive processing such as detection of a new stimulus or target stimulus—a process termed context updating. The P300 component of an ERP elicited during a detection task is a positive-going wave with a midline parietal maximum amplitude showing peak amplitude between 300 and 800 ms (longer latencies occur with aging). The latency of the P300 indexes the speed of elementary cognitive processing, and the amplitude indexes the neural resources devoted to task processing (Polich, 1996). In this manner, the amplitude and latency of the P300 can provide a simple yet powerful index of basic cognitive function that can be assessed in relation to age, fitness status, and task specificity as well as basic decision-making in sport performers.

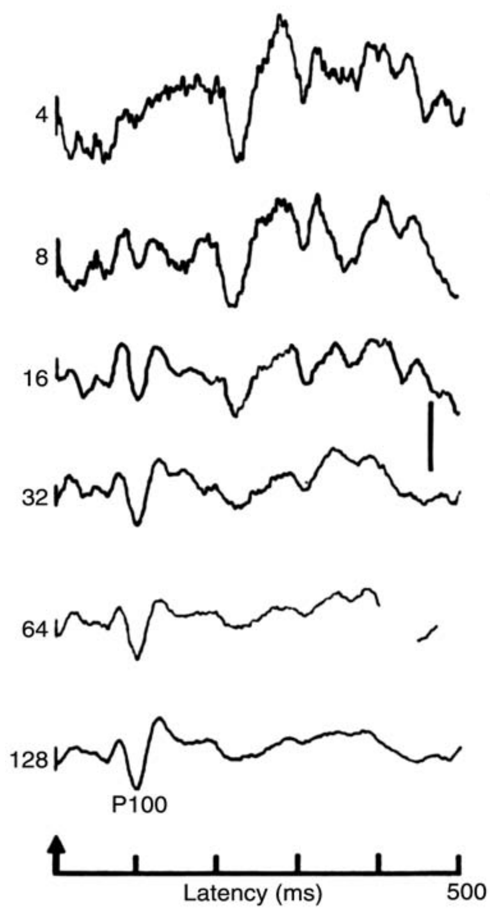


Figure 4.4 Averaging process to generate averaged event-related time series—event-related potentials (ERPs).

A need for precise localization of brain activity calls for a technique such as fMRI. For example, in clinical medicine, the final location of the site of a tumor for surgical intervention is best determined by fMRI. On the other hand, a cognitive neuroscientist interested in the sequence, timing, and coordination of neural events from different brain regions during a cognitive test would be best served by EEG or MEG coherence for assessing cortico-cortical communication patterns (Wang et al., 2001). In addition, comparisons of metabolism in the amygdala of individuals who vary in their genetic predisposition to stress would be well served by employing fMRI or PET such that the appropriate neuroimaging technique is always determined by the research question addressed by the neuroscientist.

Early Electroencephalography Studies of Regional Cortical Activity in Expert Performers

One of the earliest studies of cortical activity during psychomotor performance was conducted by Hatfield, Landers, Ray, and Daniels (1982), who assessed EEG activity at four recording sites (T3, T4, O1, and O2, all referenced to Cz) during the aiming period in 15 elite world-class competitive marksmen while in the standing position just prior to trigger pull. The study was based on a preliminary report by Pullum (1977), who observed heightened EEG alpha power in skilled marksmen during the aiming period compared to resting period, which suggested that superior performance was associated with mental relaxation. Based on the classic notions of hemispheric asymmetry or lateralization in cognitive function (Galin & Ornstein, 1972; Springer & Deutsch, 1998) Hatfield et al. to investigated one of the major issues in sport psychology from a cognitive neuroscience perspective: the notion of attenuated self-talk or avoidance of excessive analytical thinkin during superior performance (Gallwey, 1974;

Meichenbaum, 1977) by recording EEG from the left and right regions. Because EEG alpha power is indicative of relaxation—the concept of cortical idling later advanced by Pfurtscheller (1992)—the investigators predicted that left temporal alpha power would be relatively higher than that observed in the right temporal region in such highly skilled performers. Such a finding would (a) offer objective evidence for attenuation of covert self-instructional activity or verbal-analytic processing in highly skilled athletes and (b) be consistent with attainment of the stage of automaticity. The study participants exhibited a marked elevation in left temporal (T3) alpha power averaged across three successive 2.5-second epochs during the aiming period just prior to trigger pull, relative to the level observed during rest. This pattern in the left hemisphere was accompanied by relative desynchrony (i.e., less power) of EEG alpha in the right temporal region (T4; see Figure 4.5) and indicative of a primary emphasis on visuospatial processing, a strategy entirely consistent with the specific demands of target shooting. Such a refinement of strategic neural processes accompanied by less reliance on analytical feature detection of environmental cues with experience seems entirely consistent with the formation of a memory-based internal model that guides skillful movement (Contreras-Vidal & Buch, 2003; Contreras-Vidal, Grossberg, & Bullock, 1997; Kinsbourne, 1982). In this manner the EEG evidence supports a regional relaxation effect in expert performers such that they refine brain activity processes to exclude nonessential processes.

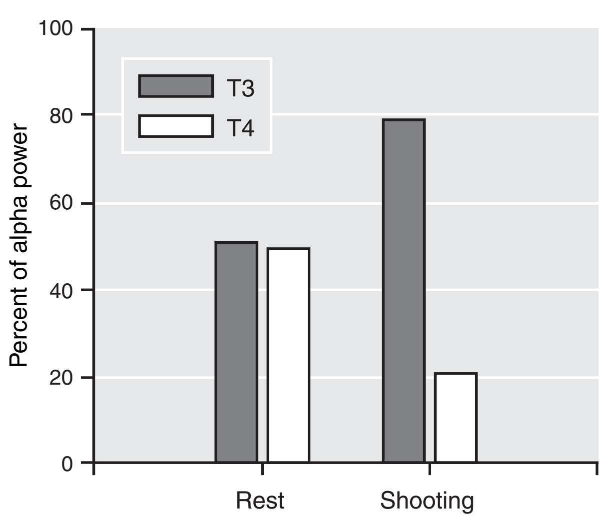


Figure 4.5 Percentage of alpha power averaged for 12 elite marksmen in the left and right temporal regions (T3 and T4) during rest and the aiming period of target shooting up to the time of trigger pull.

The early EEG studies with marksmen provided a classic paradigm for subsequent investigations of other self-paced activities (e.g., archery and golf) that was defined by recording EEG at homologous sites during the final 3 to 8 seconds of the preparatory period immediately prior to the self-initiated action (e.g., arrow release or putting). Typically, several performance trials are examined and the power spectrum estimates from each trial are then averaged to achieve a stable estimate of EEG activity. Although such a preparatory or readying state is present in numerous sports (e.g., addressing the vault in gymnastics, preparing to pitch in baseball, and addressing the bar in high jumping), aiming tasks lend themselves best to EEG recording, owing to the minimization of movement-related artifact while preserving ecological validity since they represent real-world sport tasks.

Using this paradigm, Hatfield, Landers, and Ray (1984) conducted a two-part study in which they replicated the results of Hatfield et al. (1982) in Study 1, and extended that work in an attempt to derive cognitive inference from the observed EEG recordings in Study 2. Specifically, in Study 1 EEG recordings at sites T3, T4, O1, and O2, commonly referenced to Cz, were observed in 17 right-handed and ipsilateral eye-dominant elite-level marksmen who executed 40 shots with an air rifle on a regulation 50-foot indoor range. EEG alpha was defined as average band power from 8 to 12 Hz. In addition, EEG temporal and occipital asymmetry metrics in the form of T4:T3 and O2:O1, respectively, were also generated such that higher alpha asymmetry scores (greater than 1) are indicative of greater relative left hemispheric activation; lower scores (less than 1) are indicative of greater relative right hemispheric activation. A successive change in magnitude over time indicates an increasing or decreasing trend toward left activation depending on whether the metric is rising or falling, respectively. Artifact-free EEG was typically evident prior to the trigger pull for at least 7.5 seconds across the various trials; these recordings were further divided into three successive 2.5-second epochs to assess the dynamic change in cortical activity as the athlete achieved the state of psychological readiness to take the shot. Furthermore, the 40 shots (or trials) were blocked into four successive sets of 10 trials to assess stability of brain activity in theses highly skilled performers. The temporal asymmetry scores revealed a progressive decline in magnitude across the blocks of shots that was consistent across the blocks of trials. The decline in temporal asymmetry scores across the three epochs during aiming was a result of relative stability in T4 alpha, accompanied by a progressive

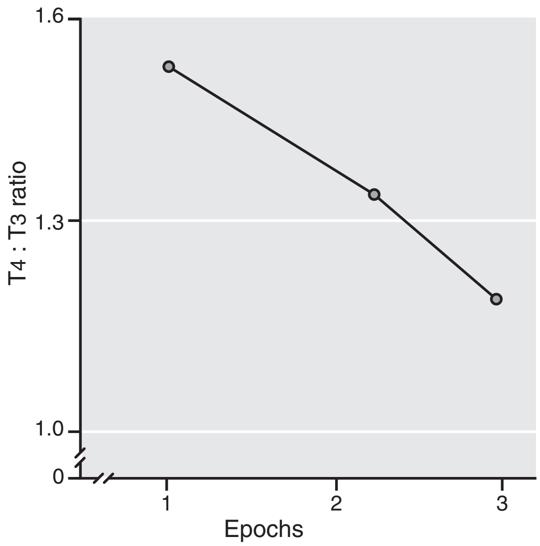


Figure 4.6 Averaged mean EEG alpha (8 to 12 Hz) asymmetry scores across three consecutive 2.5-second epochs immediately preceding the trigger pull exhibited by 17 elite marksmen.

rise in T3 alpha power (see Figure 4.6). In essence, the results of Study 1 revealed a steady decrease in left temporal activation from the early phase to the later phase of the aiming period. The magnitude of asymmetry was not evident at the occipital sites, which was expected in light of the relative similarity of neural processes at the homologous occipital sites compared to the disparity of neurocognitive processes associated with the homologous temporal sites. The findings implied that such elite performers were less and less reliant on verbal-analytical processes associated with the left temporal region as they successfully approached the trigger pull although such cortical associative activity (i.e., verbal-analytic) was prevalent during the early phase of the preparatory aiming period, perhaps to guide the marksman during the initiation of the performance. Furthermore, the similarity in the pattern of change across the aiming period over the course of the 40 shots (i.e., the nonsignificant effect for the blocks of trials) is consistent with the widely held position that elite athletes are mentally consistent.

Cognitive Inference

Although the results of Study 1 were suggestive of the cognitive processes involved during skilled visuomotor behavior, Hatfield et al. (1984) conducted Study 2 to validate the merit of such inference. In essence, the EEG signature during the aiming period, was compared to other EEG signatures recorded during known referents or defined tasks characterized by verbal-analytic or visual-spatial processing to determine similarities and differences. By comparing EEG during shooting to that recorded during the well-defined mental challenges, Hatfield et al. subscribed to a cognitive inference strategy described by Cacioppo and Tassinary (1990). Specifically, the investigators replicated and extended Study 1 with a group of intercollegiate marksmen by employing the shooting task and additionally challenging the subjects with verbal-analytic tasks (i.e., paragraph comprehension and arithmetic problem solving to engage left temporal region) and visual-spatial tasks (i.e., geometric puzzle solving to engage right temporal/parietal region). These additional challenges were presented to the participants to deduce whether the mental processes involved during highly skilled marksmanship were more similar to the verbal-analytic or the visual-spatial domain. The participants also executed the comparative cognitive challenges, which were presented via images projected on a screen, while they assumed the same posture as employed during the shooting position. This was done to equalize the motor demands of the tasks and any cardiovascular effects on central nervous system processes (Lacey, 1967). EEG recorded during the cognitive challenges was also divided into three successive 2.5-second epochs to contrast it to the temporal dynamic of the EEG derived during target shooting. Again, temporal asymmetry metrics in the form specified in Study 1 were generated for analysis.

The results revealed stable asymmetry scores across the epochs during the comparative cognitive challenges, with higher scores as predicted during the left hemisphere challenges compared to those observed during the right hemisphere challenges. However, those derived during the target-aiming period revealed a dramatic shift over time (see Figure 4.7). In fact, the asymmetry scores during the initial 2.5-second epoch of aiming on the target were similar to those observed during the verbal-analytic challenge, and significantly higher than that observed during the visual-spatial tasks, but they were significantly reduced in magnitude during the final two epochs just prior to trigger pull. By the third and final epoch the asymmetry scores during the shooting task were reduced relative to those during verbal-analytical processing and similar to those during visual-spatial processing (although lower in magnitude). Such a shift in temporal asymmetry, in conjunction with inspection of EEG alpha power at the individual homologous sites, suggests that the expert marksman explicitly controls attention during the early

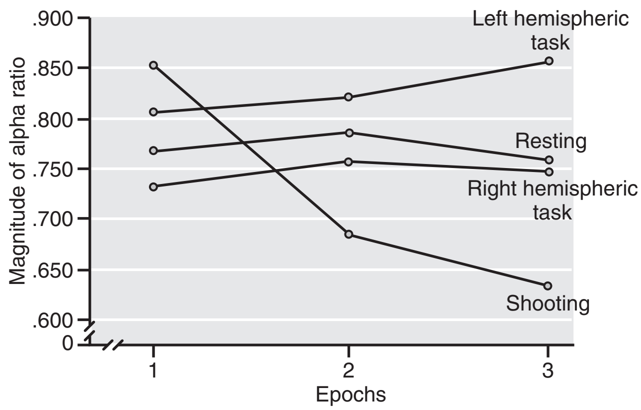


Figure 4.7 Mean EEG alpha (8 to 12 Hz) asymmetry scores (T4:T3) across three consecutive 2.5-second epochs immediately preceding the trigger pull in a rifle-shooting task and in three comparison conditions. Alpha asymmetry scores in the shooting condition were significantly lower in Epochs 2 and 3 as compared to Epoch 1. Asymmetry scores did not change across epochs in the nonshooting tasks.

part of the aiming period that quickly drops out with increased reliance on visual-spatial processing. The finding further suggests a refinement of nonessential cortical processes, or the simplification of the strategic approach to shot execution. Such a refined strategy may underlie the physical consistency (i.e., hitting the center of the bull) demonstrated by elite performers.

The interpretation of the results offered by the authors also appears consistent with phenomenological reports by athletes. Hall of Fame football player Walter Payton of the Chicago Bears was quoted by Attner (1984, pp. 2–3) as follows:

> I'm Dr. Jekyll and Mr. Hyde when it comes to football. When I'm on the field sometimes I don't know what I am doing out there. People ask me about this move or that move, but I don't know why I did something, I just did it. I am able to focus out the negative things around me and just zero in on what I am doing out there. Off the field I become myself again.

As discussed by Hatfield et al. (2006), it appears that the phenomenological and the psychophysiological levels of analysis are entirely consistent with the notion of automaticity of skilled performance (Fitts & Posner, 1967). The quote by Payton suggests a reduction of left temporoparietal activation during performance, as he reported "no thinking" while other areas of the cortex involved in kinesthetic awareness and spatial processing were specifically engaged. Excessive rumination and self-talk could cause performance degradation by generating nonessential brain activity and interfering with task-specific (e.g., rushing in football) attentional and motor processes. Because the various regions of the brain and cortex are highly interconnected (i.e., a neural network) it is likely that activity in one domain (e.g., cognitive) can influence that in another (e.g., motor). In support of this position, Rebert, Low, and Larsen (1984) observed EEG alpha power in left temporal and parietal regions recorded during the performance of a video game that demanded intense visual-spatial processing. Remarkably, the study participants exhibited increasing right temporal activation during the course of the rallies, which began to decline or reversed direction just prior to the commission of an error that terminated the rally (see Figure 4.8). Of note, the temporal and parietal asymmetry profiles were absent during the intervening rest intervals. It seems that the increased left temporal activation (increased verbal-analytic processing), observed just prior to initiation of error, resulted in an attentive state that was inconsistent with the task demands of the video game. The shift in hemispheric activation may have interfered with essential visuomotor processes due to overthinking the task demands and resulting in choking.

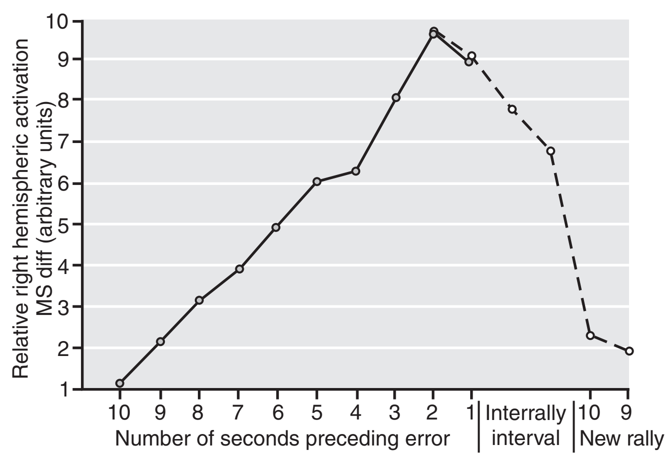


Figure 4.8 Changes in temporal EEG alpha power asymmetry during Pong rallies and interrally intervals. Asymmetry metrics were calculated by which increasing magnitude implied relative right activation. The horizontal axis shows the progressive rise in relative right hemispheric activation during the 10-second rally period and the reversal in this trend just prior to the occurrence of an error at second 1.

CONFIRMATION OF THE COGNITIVE BASIS OF ELECTROENCEPHALOGRAPHY DURING MOTOR PERFORMANCE

Other investigators have similarly observed EEG alpha band synchrony, or idling, in the left temporal region of the cortex during the preparatory period prior to the execution of movement during archery and rifle or pistol marksmanship (Bird, 1987; Hatfield et al., 1987; Hillman, Apparies, Janelle, & Hatfield, 2000; Janelle et al., 2000; Kerick, Douglass, & Hatfield, 2004; Kerick, Iso-Ahola, & Hatfield, 2000; Landers et al., 1991, 1994; Loze, Collins, & Holmes, 2001; Salazar et al., 1990). Although some investigations did not reveal EEG alpha synchrony during karate and golf putting performances in this specific region of the brain (Collins, Powell, & Davies, 1990; Crews & Landers, 1993), they did reveal alpha synchrony in other cortical areas. It may be that the specific demands of the sport tasks imposed on the subjects in these investigations (i.e., karate and golf putting) resulted in the allocation of different neural resources and that the quiescence of left temporal activation noted during target shooting may have been inappropriate or irrelevant during these particular tasks. The principle of psychomotor efficiency, as described by Hatfield and Hillman (2001), would apply, although the specific brain regions affected would likely vary from task to task (i.e., the principle of specific adaptation to imposed demand).

Although the studies of self-paced visuomotor performance have typically revealed greater EEG alpha synchrony in the left temporal region relative to that observed in the right homologous region, there is a need to substantiate that the change in cortical activation observed at site T3 is, in fact, a valid indicator of regional activity and is not simply due to measurement error owing to the relatively poor spatial resolution and volume conduction problem of EEG when compared to other neuroimaging techniques (e.g., MEG and fMRI). To address this concern, Salazar et al. monitored EEG at sites T3 and T4 in 28 elite right-handed archers during the period before the release of the arrow as well as three comparative conditions. The condition of interest involved a full draw of the bow and arrow release after the preparatory aiming period with a regulation-weight bow (14 to 22 kg). Another condition was designed to mimic the physical demands of the task but excluded the aiming process such that the participants held the arrow at full draw while simply looking at the target. Another condition involved a similar task with a light-weight bow (2 kg) and a final condition simply consisted of no draw while looking at the target. The authors observed relative EEG alpha synchrony in the left temporal region only during the aiming and shooting condition with the standard weight bow, but not during the other comparative conditions. They concluded that the T3 alpha synchrony was, in fact, due to strategic refinement and relaxation of nonessential cognitive events and not due simply to motoric processes.

A similar conclusion was reached by Kerick and colleagues (2001), who recorded EEG activity in elite rifle marksmen in the left and right central and temporal regions during three comparative conditions. The participants performed 40 shooting trials on a standard indoor rifle range with air rifles aimed at a target distance of 50 feet and assumed the same postural and gun-holding positions in the other two tasks; however, one involved trigger pull with no aiming on the target, and the other was absent any trigger pull. EEG records were examined over 8-second epochs prior to trigger pull (or an 8-second period without triggering, in the case of the last described comparison condition). The authors noted the oft-described progressive EEG alpha synchrony in the left temporal region as the trigger pull approached, and relative stability and less average power over the aiming period was noted in the right. The synchrony effect at T3 was not noted during either of the two comparative conditions and, more important, was distinct in pattern from that observed from the left motor cortex (C3). As such, the synchrony of EEG alpha in the left temporal region was not simply a reflection of ipsilateral motor cortex processes. Both of these investigations strengthen the notion that the observed EEG activity in the left temporal region is, in fact, indicative of cognitive processes and may well be due to the suppression of irrelevant cognitive processes.

EXPERTS VERSUS NOVICES: CONTRASTS OF ELECTROENCEPHALOGRAPHIC ACTIVITY DURING PSYCHOMOTOR PERFORMANCE

In one of the few studies of brain activity as function of motor skill ability, Haufler, Spalding, Santa Maria, and Hatfield (2000, 2002) compared regional cortical activation in expert marksmen and novice rifle shooters and predicted that experts would demonstrate less global cortical activation during the aiming period prior to the trigger pull based on the notion that experience results in the pruning of irrelevant neural processes (Bell & Fox, 1996).

More specifically, EEG was recorded at homologous frontal (F3, F4), central (C3, C4), temporal (T3, T4), parietal (P3, P4), and occipital (O1, O2) sites (referenced to averaged ears) in 15 expert marksmen (i.e., having national and international competitive experience) and 21 novice volunteers (i.e., having little to no experience with firearms and no experience with position shooting), who were all right-hand and ipsilateral eye dominant. Experts demonstrated higher shooting scores as compared to their novice counterparts (*M* = 339.8 and *M* = 90.7, respectively, out of a possible 400 points). Furthermore, Haufler et al. (2000) also challenged the participants with verbal and spatial tasks, with which the groups were equally unfamiliar, while recording the EEG in the shooting task posture.

Figure 4.9 illustrates comparative spectral plots (1 to 44 Hz) for the experts and novices recorded at the left temporal site during the shooting task. As predicted, the expert marksmen showed higher levels of alpha power (8 to 12 Hz) and lower levels of beta and gamma activation (14 to 44 Hz) as compared to that observed in the novice volunteers during the shooting task. Figure 4.10 illustrates the relative economy of cortical activation in the experts during aiming (i.e., reduced gamma power in the frontal and temporal regions); no such group difference was observed during the comparative tasks supporting the specificity of cortical adaptation to cognitive motor challenge. A Group × Task × Hemisphere interaction was also revealed, such that the expert marksmen demonstrated greater alpha power in the left hemisphere during the shooting task compared to their novice counterparts and similar alpha power in the right.

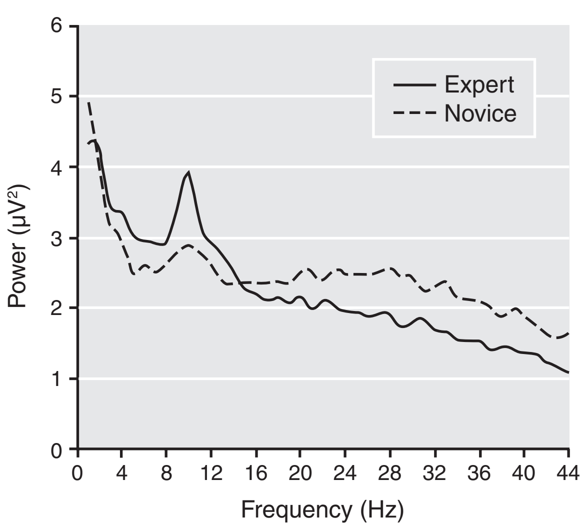


Figure 4.9. Comparative group spectral plots of expert marksmen and novice target shooters showing greater synchrony of EEG alpha (8 to 13 Hz) and relative desynchrony of beta and gamma EEG power (14 to 44 Hz inclusive) in the experts.

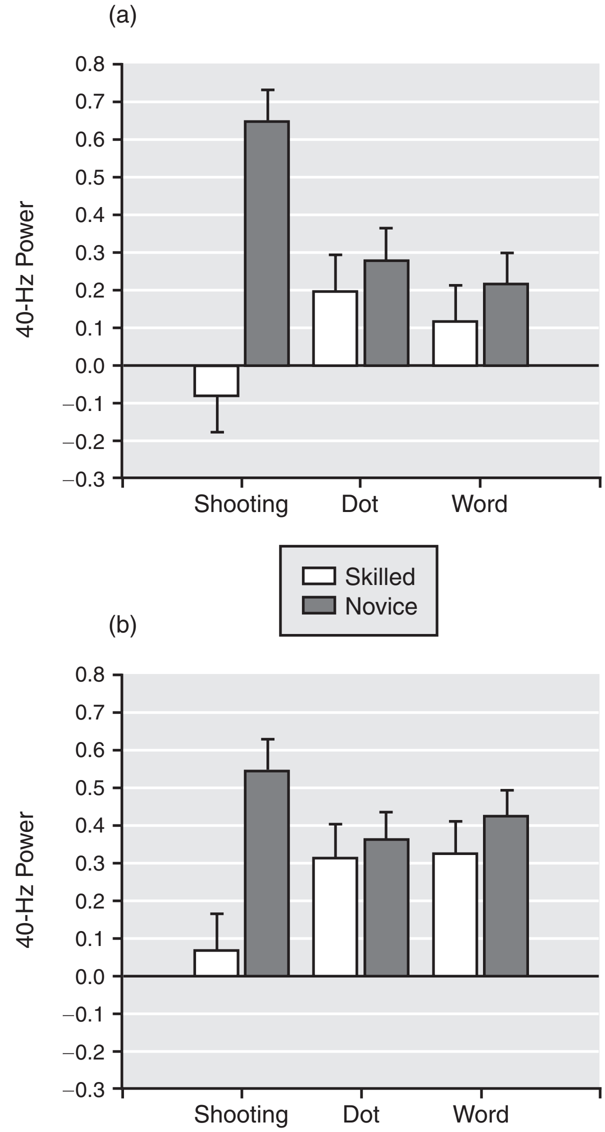


Figure 4.10 (a) Log-transformed EEG gamma power averaged across left and right frontal sites for expert marksmen and novice target shooters during the aiming period of target shooting and the comparative spatial (i.e., dot) and verbal (i.e., word) tasks. (b) Log-transformed EEG gamma power averaged across left and right temporal sites for expert marksmen and novice target shooters during the aiming period of target shooting and the comparative spatial (i.e., dot) and verbal (i.e., word) tasks.

In a related study, Di Russo, Pitzalis, Aprile, and Spinelli (2005) contrasted the amplitudes of movement-related cortical potentials (MRCPs) recorded from the left and right motor cortex regions (C3 and C4, respectively) in expert and novice rifle shooters while performing separate finger flexion tasks with the right (i.e., trigger) and left index fingers. The amplitude of the MRCP indicates the magnitude of neural activation required to perform the tasks such that lower amplitude is characteristic of efficiency or economy of effort. Of particular importance, the amplitudes recorded from the contralateral motor cortex (C3) to the right finger (or trigger finger) were significantly lower in the experts, whereas no such difference was noted at C4 for finger movements performed with the left finger. The authors also employed dense EEG recording to enable source localization of the potentials, which revealed that the signals were generated in the motor cortex. As such, the contrast between expert and novice marksmen clearly supported the notion of specific adaptations in the cerebral cortex as a function of practice characterized by economy or efficiency of effort.

Overall, the findings of Haufler et al. (2000) and Di Russo et al. (2005) revealed that experts exhibited less cortical activation compared to the novices, which clearly supports the notion of increasing economy of cerebral cortical processes with task-specific practice. Differences were observed in cortical activation patterns both by slow potential amplitude and by a broad range of spectral power estimates providing convergent evidence of psychomotor efficiency. Of particular importance, no differences in EEG were observed while the participants performed the comparative tasks, with which the groups were equally familiar, implying a high degree of specificity in brain-related adaptations to skill training.

Training Studies

The majority of investigations of cortical processes during psychomotor performance have been cross-sectional in nature (Bird, 1987; Crews & Landers, 1993; Hatfield et al., 1984; Hatfield, Landers, & Ray, 1987; Haufler et al., 2000; Hillman et al., 2000; Janelle et al., 2000; Loze et al., 2000; Salazar et al., 1990). This type of study design leaves open the possibility that any differences in brain activity may be inherent in the performers as opposed to an adaptation resulting from practice and learning.

In an attempt to determine the causal influence of training on cortical activation, Landers et al. (1994) conducted a study with novice archers in which EEG was recorded from sites T3 and T4 during the aiming period just prior to arrow release before and after 12 weeks of instruction that involved 27 sessions with an Olympic-caliber coach. Although no differences in spectral power were noted between the left and right temporal sites at the time of the pretest, relative synchrony at site T3 was noted during the aiming period after the training, which supports a causal influence. Performance also significantly improved over the course of instruction. No difference in EEG power was noted during the resting trials either before or after training supporting task-specific brain-related processing.

Kerick et al. (2004) replicated and extended this finding with 11 midshipmen at the United States Naval Academy who underwent pistol training to become members of a competitive shooting team. The participants had little or no experience with firearms prior to 12 to 14 weeks of supervised instruction with a qualified coach. EEG was recorded from 11 sites (F3, Fz, F4, C3, Cz, C4, T3, T4, P3, Pz, P4) to determine practice induced changes in activation. Mean alpha power and its rate of change were hypothesized to increase in the left temporal region during aiming from early to late season as participants improved their accuracy and reduced cognitive effort. EEG was recorded over a 5-second aiming period during target shooting (40 trials) and two comparative tasks that involved either seated rest or shooting with no trigger pull. A high level of temporal resolution of the spectral estimates was achieved by subscribing to a signal-processing technique employed by Pfurtscheller (1992) called event-related alpha power (ERAP) that enabled a more refined assessment of temporal dynamics during the aiming period. Although the previous studies in this area of research examined successive epochs in the range of 1 to 2 seconds of temporal resolution the present technique allowed for 125-millisecond precision such that 40 successive estimates of alpha power were examined over the 5-second aiming period. This sampling strategy allowed for a line of fit to be applied to the EEG power estimates so as to determine both a slope and average power measures. This allowed for much greater precision in the detection of change in brain activity.

The mean levels of (ERAP) increased at T3 from the beginning to the end of the training period during both the shooting and postural simulation conditions but not during the resting baseline. Interestingly, the magnitude of change in right temporal (T4) activation was reduced probably due to the maintenance of visual-spatial processing. Figure 4.11 illustrates the overall topographical EEG alpha power (i.e., distributed across the entire scalp) across the aiming period and the comparative baseline periods at the beginning and at the end of the training period. The global synchrony or increase in the ERAP during the marksmanship task attests to a rather widespread change (i.e., reduction) in cortical activity and seems consistent with the phenomenological reports of well-practiced athletes that performance becomes effortless. In this regard, the human brain is highly plastic and seems to undergo significant change in response to the

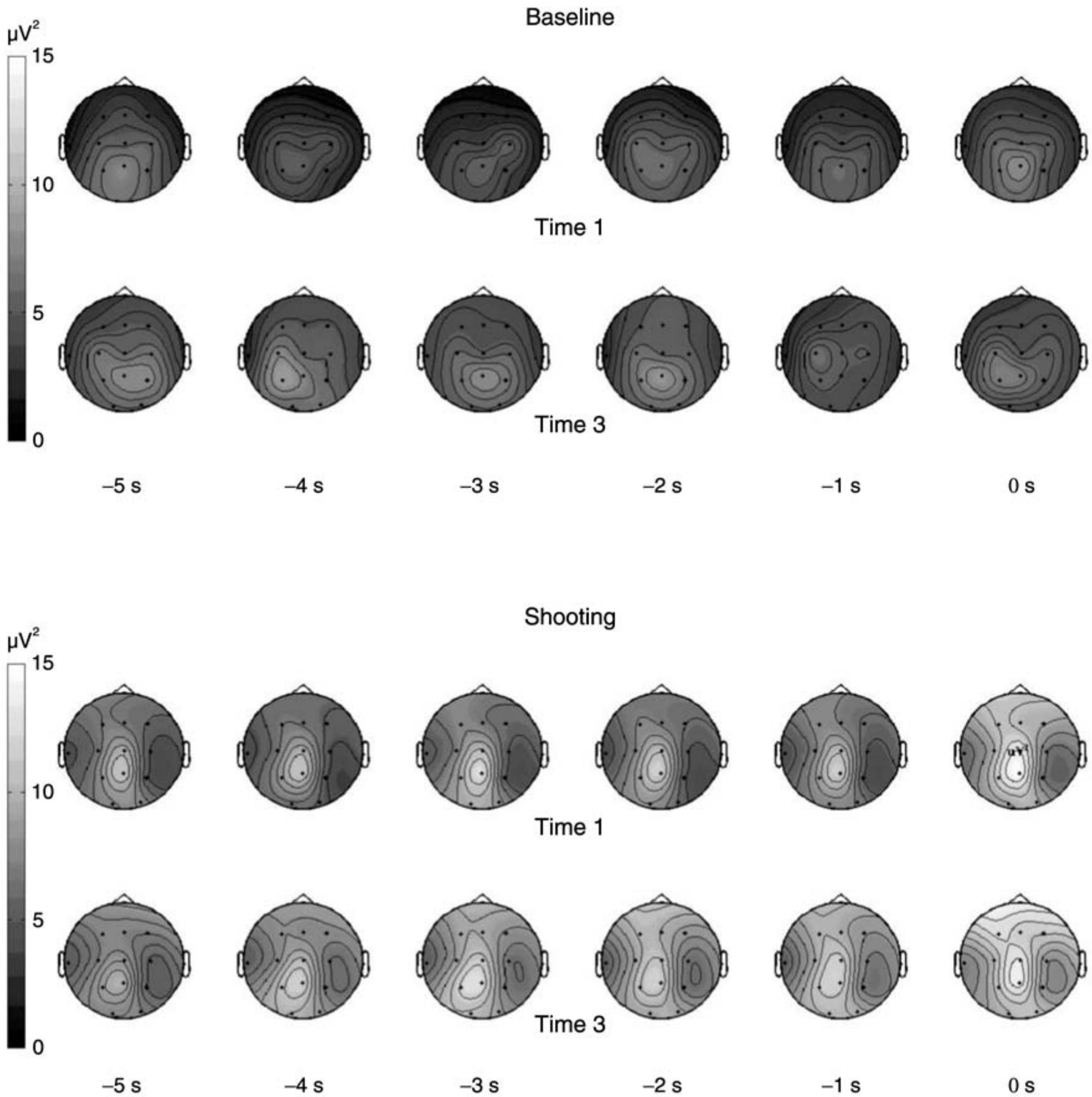


Figure 4.11 Topographical maps of event-related alpha power (ERAP) for successive 1-second periods during baseline and target shooting before (Time 1) and after (Time 3) marksmanship training. The magnitude of alpha power is indicated by the scaling bars illustrated on the left side of the panels. The shading is darker during the baseline periods, relative to that during shooting shown in the lower panel, and shows little change during the 6-second aiming periods and before and after 3 months of training. Note that during the shooting task (lower panel), the brain maps become progressively lighter in shade over the 6 seconds prior to the trigger pull (i.e., 0s) after 3 months of practice (Time 3), relative to the progressive change observed at the beginning of training (Time 1), indicating higher levels of EEG alpha power and cortical relaxation as the trigger pull is approached.

practice- and performance-related demands that are imposed on it (Elbert, Pantev, Wienbruch, Rockstroh, & Taub, 1995). Using fMRI technology of cortical and subcortical processes, economical brain activity has also been shown with performers in other sports (Milton, Small, & Solodkin, 2004). Such a notion is also consistent with PET imaging studies of the change in cortical activity of motor skill learning (Haier et al., 1992). Although the time period in which such change was demonstrated was appreciable in these studies, such change can occur in relatively short order (i.e., hours; Etnier, Whitever, Landers, Petruzzello, & Salazar, 1996), as observed during a pursuit rotor motor tracing task.

THE RELATIONSHIP BETWEEN CEREBRAL CORTICAL ACTIVITY AND MOTOR PERFORMANCE

In one of the first investigations of cortical activation and target shooting performance, Bird (1987) conducted a case study in which an expert marksman, monitored at a single recording site (T3), executed superior shots when he exhibited less high-frequency EEG activity. Such a preliminary finding is consistent with the notion of quiescence of the left temporal region resulting in less interference with essential attentional or motor processes. To further assess the relationship between cortical activation and performance Salazar et al. (1990) contrasted EEG spectral content at T3 in archers during the aiming periods associated with best and worst shots. In contrast to their expectation, they observed higher amplitude of spectral power at 6, 12, and 28 Hz in the left hemisphere during the period prior to the worst shots. Similarly, Landers et al. (1994) observed higher alpha power during worst shots in novice archers. As such, it would seem that the findings from these studies are more consistent with an inverted-U type relationship between performance and left temporal activation as opposed to a positive linear relationship such that excessive relaxation is associated with a decline in performance. In support of this position Hillman et al. (2000) reported a study in which they monitored EEG alpha and beta power in seven skilled marksmen at the left and right frontal, central, temporal, and parietal sites (F3, F4, C3, C4, T3, T4, P3, P4; referenced to Cz) during 4-second aiming periods prior to successfully executed shots. The observed activity was contrasted to that occurring in the period preceding the decision to abort or terminate a shot. The latter refers to an inability by the participant to achieve a state of readiness. Alpha power was typically higher at T3 than at T4, thus replicating the temporal asymmetry observed in other studies, but the rejected preparatory intervals were characterized by higher power than that observed during the period prior to executed shots (see Figure 4.12). The authors theorized that the decision to reject a shot was characterized by a failure to allocate the appropriate neural resources specifically associated with successful task execution. Kerick et al. (2004) also noted a curvilinear relationship between ERAP and pistol-shooting accuracy such that higher accuracy was associated with greater ERAP up to an optimal level, beyond which further increases in power were associated with reductions in accuracy. In summary it seems that better performance is associated with elevated but limited temporal alpha power.

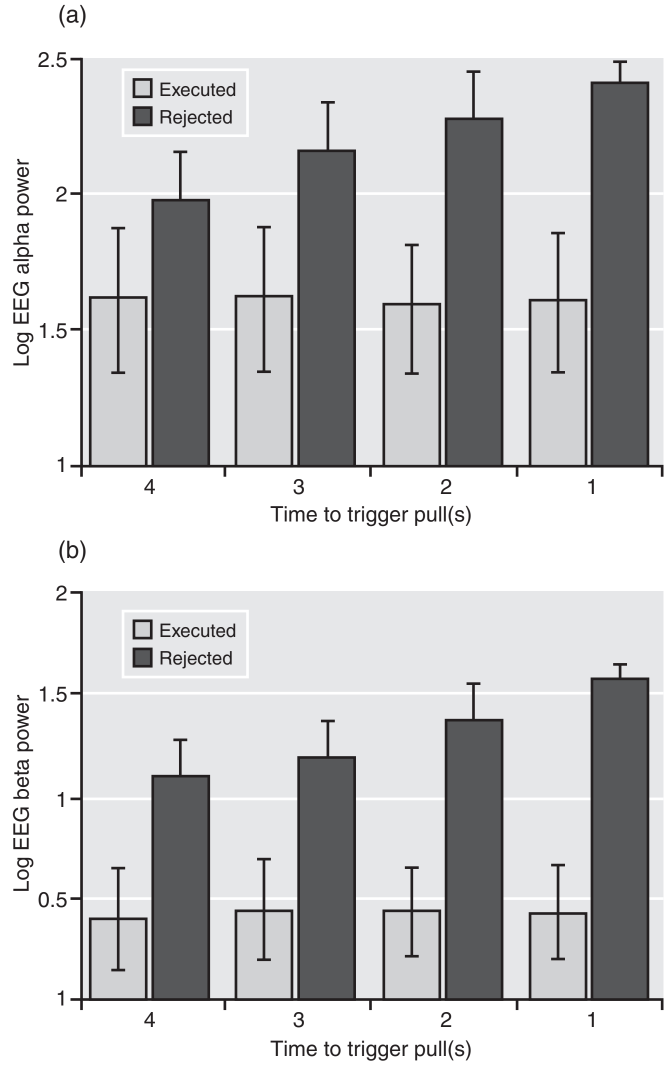


Figure 4.12 Differences in alpha (a) and beta (b) spectral power during the 4-second period prior to trigger pull and the decision to reject or terminate a shot.

However, the nature of the relationship may be critically related to the skill level of the athlete. In this regard, each of the studies discussed previously involved participants who typically were at lower levels of skill. In contrast, Crews and Landers (1993) noted that expert golfers who showed more alpha power (reduced activation) in the right motor cortex during the last second of preparation demonstrated superior golf-putting performance or less error. A positive association between occipital alpha power and performance was also reported by Loze et al. (2001), who examined cortical activity in expert air-pistol shooters. The shooters were monitored for EEG at midline occipital (Oz) and left and right temporal (T3 and T4) locations during a 60-shot match. The EEG alpha power recorded over three successive 2-second epochs during the five best shots was contrasted to that during the five worst shots. The data clearly revealed a significant rise in alpha power at Oz over epochs prior to the best shots, whereas a progressive reduction in power was associated with the worst shots. Furthermore, superior performance was associated with a rise in alpha power during the last two epochs, and a reduction was associated with worst shots. The right hemisphere revealed lower levels of alpha power with no differentiation between best and worst performance. The positive linear relationship noted by Loze et al. may have been due to superior self-regulation in such highly skilled performers compared to the participants in the other studies. That is, the experience of the elite shooters may have largely prevented states of inattention and excessive synchrony of EEG alpha, thus precluding the detection of an inverted-U relationship.

Finally, in a more definitive assessment of the causal link between cortical activation and target-shooting performance, Landers et al. (1994) conducted the only study published to date in which biofeedback was used to alter brain activity in an attempt to facilitate archery performance. Accordingly, 24 preelite archers underwent one of three treatment conditions: One group received a single session of correct feedback to reduce left hemispheric activation, a second group received incorrect feedback to reduce right hemispheric activity, and a third group rested and received no feedback. Comparison of pretest and posttest performance scores revealed that only the correct feedback group improved target-shooting accuracy after treatment, whereas the incorrect feedback group declined in performance. Although the study did not address the nature of the relationship between the magnitude of cerebral cortical activity and performance (i.e., curvilinear versus linear) it provided strong evidence for the causal influence of regional cortical relaxation on sport performance.

NETWORKING BETWEEN CORTICAL ASSOCIATION AND MOTOR REGIONS

Assessment of regional cerebral cortical activity is informative in regard to the relationship between brain activity and motor performance, but additional insight can be attained by examining functional interconnectivity or cortico-cortical communication between specified topographical regions. Such networking activity can be quantified by deriving coherence estimates between selected pairs of electrodes or recording sites. As summarized by Hatfield et al. (2006), Busk and Galbraith (1975) monitored EEG at occipital (Oz), motor cortex (C3 and C4), and motor planning areas (Fz) in participants before and after practice trials on a pursuit-rotor task, which involves a high level of eye-hand coordination. The authors noted that coherence between pairs of electrodes over areas known to have strong neuroanatomical connections (such as the motor planning region and the motor cortices) revealed the highest estimates, which provided a validation check of coherence estimates as indicative of cortico-cortical communication. Overall coherence estimates between the recording sites were significantly reduced as a result of practice, implying greater regional autonomy or specialization as a result of training. Such a finding can also be framed within the context of efficient adaptation to imposed demand, as the change in coherence may well imply a pruning or refinement of neural processes with visuomotor practice (Bell & Fox, 1996). In this manner, novice performers may be heavily engaged in feature detection of the environment to guide their actions. As such, heightened communication between visual processing and motor planning areas would be necessary prior to the formation of memory traces or an internal model to guide the neuromuscular apparatus. Such heightened activity would not only be more metabolically demanding (i.e., less efficient) but may well result in greater variability of network activity, thereby resulting in less consistency of performance.

In a more recent study, Deeny, Hillman, Janelle, and Hatfield (2003) extended the work of Busk and Galbraith (1975) by assessing coherence estimates in skilled marksmen between motor planning (Fz) and association regions of the brain by monitoring EEG at sites F3, F4, T3, T4, P3, Pz, and P4 as well as the motor cortex (C3, Cz, C4) and visual areas (O1 and O2). More specifically, EEG coherence was assessed during the aiming period just prior to trigger pull in two groups of participants who were similar in terms of years of training but differed in competitive performance history. One group was labeled experts and exhibited superior performance during competition; the other group was labeled skilled shooters and was characterized by relatively poor performance during the stress of competition. Both groups were highly experienced (approximately 18 years of experience in each group). Given that specialization of cortical function occurs as domain-specific expertise increases, experts were predicted to exhibit less cortico-cortical communication, especially between the cognitive and motor areas, relative to that observed in the lesser skilled group. The primary analysis involved a comparison between the groups of the coherence estimates between Fz and the lateral sites examined in each hemisphere. Interestingly, in terms of alpha band coherence, there were no differences between the groups at any site except for the Fz-T3 pairing in the left hemisphere, at which the experts revealed significantly lower values. Lowered coherence between Fz-T3 in the experts was also observed for the beta band (13 to 22 Hz; see Figure 4.13). The authors interpreted the findings to mean that the experts were able to limit or reduce the communication between verbal-analytic and motor control processing. On a more global level, this finding would imply that those who performed better in competition did not overthink during the critical aiming period.

Again, the potential importance of this refined networking in the cerebral cortex in regard to motor behavior is the reduction of potential interference from irrelevant associative, affective (e.g., limbic), and executive processes with the motor loop (basal ganglia) connections to the motor cortex that largely controls corticospinal outflow and the resultant quality of the motor unit activation (Grafton, Hari, & Salenius, 2000). Excessive networking may result in undesirable alterations in the kinematic qualities of limb movement. Refinement or economy of cortical activation would more likely result in smooth, fluid, graceful, and efficient movement. Any reduction of associative networking with motor control processes would also help to reduce the complexity of motor planning and should result in greater consistency of performance.

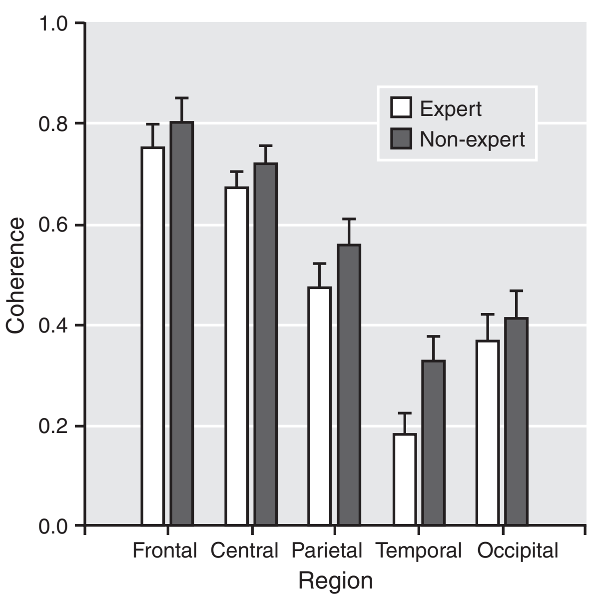


Figure 4.13 Comparative EEG beta coherence measures between Fz and each recording site within the left hemisphere for expert and lesser skilled marksmen.

SLOW POTENTIAL ELECTROENCEPHALOGRAPHIC RECORDING DURING SELF-PACED MOTOR PERFORMANCE

It seems tenable that the superior athlete would adopt a neurocognitive strategy by which he or she learns not to interfere with essential motor control processes and that he or she extracts information from the environment in an efficient manner (i.e., extracting only cues that are relevant to the intended performance). A related line of research by Konttinen and colleagues (Konttinen & Lyytinen, 1992, 1993a, 1993b) using slow potential (SP) recordings from the motor planning, motor cortex, and visual areas offers further support for this notion. Slow potential recordings are time-averaged potentials that precede a self-initiated event such as the trigger pull in marksmanship. The averaging period is typically accomplished for the 2- to 3-second period prior to the motor act (i.e., preparatory period). The SP is achieved by a time-averaging process to enhance the signal-to-noise ratio. Slow-going negativity, relative to a preceding baseline period, is typically interpreted as increasing readiness to respond, whereas increasing positivity is typically interpreted as inhibition of neuromotor activity or a controlled decrease in activation.

Konttinen and Lyytinen (1992) recorded EEG from three expert and three novice marksmen at sites Fz, C3, C4, and Oz to determine whether there were differences in the SPs recorded during best and worst trials in a series of shots. Sites C3 and C4 were assessed to determine any differences in laterality. Slow potentials were computed as change scores, or the difference between the mean value of the first 1.5-second baseline window and the mean values of each of the subsequent windows up to the trigger pull. Shooting scores were divided into best and worst categories. In general, the findings showed increasing negativity at C3 and C4, a logical result given that the participants were preparing for a motor act, but surprisingly, no lateralization effect was revealed. In the expert participants, the negativity associated with motor preparation was attenuated in the case of the best shots, suggesting a fine-tuning of the preparatory response. The attenuated negativity with superior performance implies a more efficient strategy as the goal was accomplished with lessened motor preparation.

A more recent report by Konttinen, Landers, and Lyytinen (2000) suggested that elite rifle marksmen are characterized more by a rifle-balancing strategy than relying primarily on visual processing as compared to lesser skilled individuals. It seems that the elite marksman has developed a strong internal model based in long-term memory that guides the performance with less reliance on visual feature detection. As such, a reduction in cognitive load would be experienced as far as a search for external cues is concerned and the execution of the task is relatively automatic. The participants have a feel for the task that guides their effort and do not have to think about it. It would be interesting to assess temporal-parietal spectral content during these investigations to determine if, in fact, the expert performer also shows relative quiescence of left temporal activation.

BRAIN PROCESSES DURING REACTIVE PSYCHOMOTOR PERFORMANCE

The vast majority of the research in this area has examined cortical activity during self-paced performance (performer controls initiation of the act), as opposed to reactive sports (performer responds to events initiated by environment or an opponent). Such a limitation on the nature of the tasks studied has been restrictive, but studies are beginning to appear in the literature in which cortical responses have been examined during such reactive sport situations as baseball batting and table tennis performance. Radlo, Janelle, Barba, and Frehlich (2001) recently employed ERP measures to assess decision making in 10 advanced and 10 intermediate baseball players who were presented with a type of oddball task. More specifically, 400 trials consisting of video images of baseball pitches were presented via a large projection screen (200 fastball images and 200 curveball images). The participants were administered a cost-benefit precuing paradigm in which 75% of the cues were valid. The participants were required to attend carefully to the stimuli and discriminate the nature of the pitch type by pressing an appropriate button. The intermediate players showed heightened P300 amplitudes, longer reaction times, and fewer correct responses relative to advanced batters. The authors concluded that the intermediate batters were less efficient in their perceptual decision making.

Electroencephalographic Power during Reactive Visuomotor Performance

Using a military psychology setting, Kerick, Hatfield, and Allender (2006) recently designed a study to examine cortical dynamics of soldiers during a reactive shooting task in which targets appeared in random locations and were exposed for various durations (2 to 6 s) in a simulated field environment. The soldiers' task was to correctly identify targets as enemy or friendly and then make a decision whether to aim and fire the weapon (enemy) or disengage from the target (friendly). This reactive shooting paradigm differs from the self-paced shooting paradigm in many respects. First, the shooter does not know when or where a target will appear. Second, once the shooter detects a target, he or she must identify the target as enemy or friendly. Third, the shooter must make a decision whether to engage or disengage from the target depending on its identification. Fourth, the shooter does not know how long the target will be exposed, and therefore does not know how much time is available to execute the correct response. In addition to examining the cortical dynamics of soldiers during the performance of a reactive shooting task, Kerick et al. (2006) also examined the effects of increased task demands by manipulating three factors: task load (single, dual task), decision load (enemy only, enemy or friendly targets), and response time demands (short, long target exposure time). Cognitive workload is defined as the difference between the capacities of the information-processing system that are required for task performance to satisfy performance expectations and the capacity available at any given time and must take into account the interaction between the task and the person performing the task.

Changes in theta power during the preparatory period of self-paced target shooting has been reported only by Haufler et al. (2000), who found no changes over the seconds preceding the trigger pull. However, for many tasks, theta increases during the encoding of sensory information and in response to increased task difficulty and cognitive load (Dussault, Jouanin, & Guezennec, 2004; Hankins & Wilson, 1998; Klimesch, 1996, 1999; Klimesch, Doppelmayr, Russegger, & Pachinger, 1996). Upper alpha power (11 to 13 Hz) typically increases during the seconds preceding the trigger pull for self-paced shooting tasks (Hatfield et al., 1984; Haufler, Spalding, Santa Maria, & Hatfield, 2000; Kerick et al., 2001; Kerick et al., 2004). For many cognitive and motor tasks, however, alpha exhibits a task-specific decrease in power (Pfurtscheller, 1992; Pfurtscheller & Lopes da Silva, 1999). This apparent discrepancy in alpha responses between shooting and other spatial and motor tasks may be related to the complexity of a realistic task, such as shooting versus controlled laboratory tasks. The increased alpha observed prior to trigger responses in shooters is thought to reflect widespread inhibition of task-irrelevant cortical areas that may interfere with execution of the shot (Hatfield & Hillman, 2001).

Kerick et al. (2006) predicted that the higher shooting demand conditions (i.e., dual-task load, choice-decision load, and short target exposure time scenarios) would require higher cortical effort, as indicated by higher theta power and lower alpha power during the aiming period from target onset to the time of the trigger response. This study was the first to investigate both stimulus- and response-related cortical dynamics of soldiers during the performance of a reactive shooting task, as well as to investigate the cortical dynamics of shooting as a function of varied task demands. The findings revealed both similarities and differences in the cortical dynamics associated with a reactive shooting task compared to that observed during self-paced shooting tasks.

Across all shooting conditions, theta power exhibited an early stimulus-related peak that occurred shortly after the onsets of targets (~1,060 ms) and a later response-related peak that occurred approximately coincident with the time of the trigger response (~3,050 ms). Kerick et al. (2006) suggested that the functional significance of the early theta peak is to encode target stimuli in working memory (i.e., detecting and identifying targets) and to retrieve matching stimulus-response associations from long-term memory, whereas the functional significance of the late theta peak is sensorimotor integration (i.e., coordinating the timing of the trigger response with target alignment). Further, the early peak varied by decision and task load demands in the expected direction (i.e., higher peak amplitude for choice-decision load scenarios and longer latency for dual-task demand scenarios). A significant positive relation was also observed between the latency of the late theta peak and shooting accuracy. The findings of increased theta power with increased task demands during shooting are consistent with research revealing increased theta power in response to working memory demands for encoding information (Burgess & Gruzelier, 1997; Klimesch, 1996, 1999; Klimesch, Doppelmayr, Russegger, & Pachinger, 1996) and processing multitask demands (Dussault, Jouanin, & Guezennec, 2004; Hankins & Wilson, 1998). Relative to that observed in the theta band, power in the alpha band exhibited a less distinct early stimulus-related peak but a similar late response-related peak that coincided with the trigger response (~3,055 ms). Of particular importance, the response-related alpha power increase observed during reactive shooting is consistent with that observed during self-paced shooting.

In summary, the findings suggest that the different oscillatory patterns in theta and alpha frequency bands were sensitive to different mental processes and task load variations (i.e., stress levels). Specifically, the early theta peak appears related to stimulus encoding and sensorimotor integration, whereas the late theta peak and both alpha peaks appear related to motor planning and execution. A functional relation between theta and alpha appears to underlie reactive shooting such that theta oscillations increase during the encoding of target stimuli, and at the same time alpha oscillations increase as the shooter orients toward the target. For enemy targets, activity in both frequency bands continues to increase, perhaps reflecting functional communication among networks for detecting and identifying targets, recalling stimulus-response associations from memory, and preparing the appropriate action in parallel (i.e., engaging the target). For friendly targets, the appropriate action is to disengage the target, which would require less sensorimotor integration for executing the perception-action cycle. Future efforts are under way to determine whether unique components account for the unique demands imposed by the different task demand factors and to more precisely classify stimulus-locked, response-locked, and nonphase-locked components of the EEG (Jung et al., 2001). The present findings confirm that attention is of limited capacity, is temporally and spatially distributed among cortical networks oscillating at different frequencies to enable both parallel processing of sensorimotor information and sequential processing of cognitive demands, and is influenced by task demands and perceived effort.

AFFECTIVE NEUROSCIENCE: BRAIN PROCESSES DURING DISTRESS

Although a robust corpus of work has been developed on the cortical concomitants of skill level and practice during self-paced and reactive motor performance, there has been a relative dearth of published studies of cortical concomitants of motor performance under psychological stress with the exception of the study by Kerick et al. (2006). Bear et al. (2001) recently summarized the neural structures involved in a system or circuit, which mediates the psychological and physiological response to stress. Generally, the stress response is orchestrated by the limbic system, but the central components of this functional circuit are the amygdalae, small almond-shaped structures located bilaterally and anterior to the hippocampi on the inferior and medial aspect of the temporal lobes (Bear et al., 2001). Multiple sensory pathways converge in the basal lateral nuclei of the amygdalae so that environmental events are immediately processed (Pare, Quirk, & LeDoux, 2004). Depending on the valence of the stimuli, the lateral nuclei then communicate with the central nucleus in each amygdala, and subsequent connections travel to critical forebrain, brain stem, autonomic, and endocrine structures that mediate the expression of emotion. Specifically, there are interconnections from the central nuclei to the (a) hypothalamus, which results in sympathetic arousal and stimulation of stress hormones via the hypothalamic-pituitary-adrenocortical (HPA) axis; (b) the periaqueductal grey, which results in motor responses; and (c) the cingulate cortex, which results in additional communication with neocortical association regions such as the temporo-parietal regions. Additionally, interconnections to pontine nuclei in the reticular formation result in an increase in overall arousal. Orchestrated sequelae occur in response to a stressful environment, which, collectively, can change the performer's mental and physical state in a profound manner. For example, heart rate and cortisol levels rise, as does muscle tension, and athletes may concomitantly experience excessive self-talk and "too much thinking" such that their attention is compromised and the execution of normally automated psychomotor skills such as marksmanship become explicitly managed. Timing and coordination are then altered and likely reduced in quality and attention shrinks. In support of the overthinking hypothesis, Chen and colleagues (2005) recently provided psychophysiological evidence of increased networking between the left temporal region and the motor planning regions of the brain, by assessment of T3-Fz alpha EEG coherence levels, when study participants were asked to perform a dart-throwing task under the pressure of social evaluation. Relative to a nonstress control condition, the increased traffic in the brain was accompanied by heightened reports of state anxiety and lower self-confidence. As expected, and consistent with the psychomotor efficiency principle, the accuracy of performance was also reduced (see Figure 4.14).

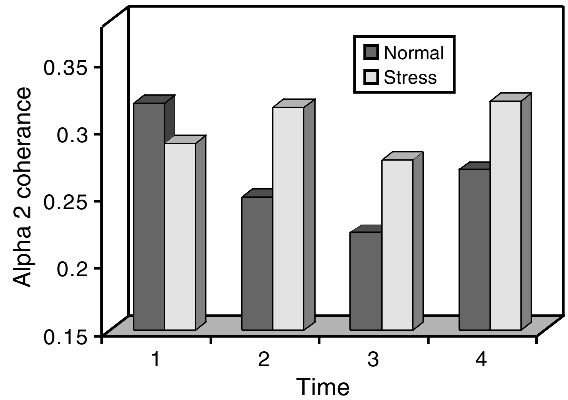


Figure 4.14 Coherence estimates between sites T3 (left temporal region) and Fz (motor planning region) during practice-alone and stressed conditions during the preparatory period for a dart-throwing task. Coherence was significantly elevated during stress.

The notion that heightened cognitive load and induced anxiety states can alter the quality of motor performance is clearly supported by the work of Beuter and Duda (1985) and that of Weinberg and Hunt (1976). The former study revealed that kinematic qualities of gait were marked by a decrease in efficiency of motion in the lower limbs of young children who were subjected to a stressful intervention. The authors reported that the task of stepping, which was controlled automatically in a low-stress condition, became less smooth and efficient as volitional control took over under heightened stress. In a similar vein, Weinberg and Hunt observed heightened motor unit activation and co-contraction (reciprocal inhibition and failure of complete relaxation in the antagonists) of the involved muscles in an overhead throwing motion in college students who were also subjected to stress. The link between cognitive-affective states and the quality of motor performance is causal in nature, but the central mechanisms of effect from such studies are unclear. One compelling possibility is heightened cross-talk between cortical association and motor regions, as described earlier in the section on networking between brain regions.

In light of the mental and physical alterations that occur, the activation of the left and right amygdalae serves as a pivotal event in the manifestation of stress, and the control of activity in the amygdalae would exact a powerful influence on the athlete's or soldier's mental and physical state. Beyond the structures and processes outlined by Bear et al. (2001), a critical component of the neurobiology of fear (see Figure 4.15) is the frontal control (medial and orbitofrontal regions) over limbic function and subcortical emotional circuits, which is housed anatomically in the frontal regions of the forebrain. Particularly important, the anterior cortical regions have extensive anatomical connections, with several subcortical limbic structures implicated in emotional behavior, particularly the amygdala (Davidson, 2002, 2004).

Davidson and colleagues (Davidson, 1988; Tomarken, Davidson, Wheeler, & Doss, 1992) have generated a significant body of literature that clearly shows a positive association between greater relative left frontal activation and positive affect and, conversely, greater relative right activation during negative affect. Although the lateralization of frontal activation is robustly related to the valence of

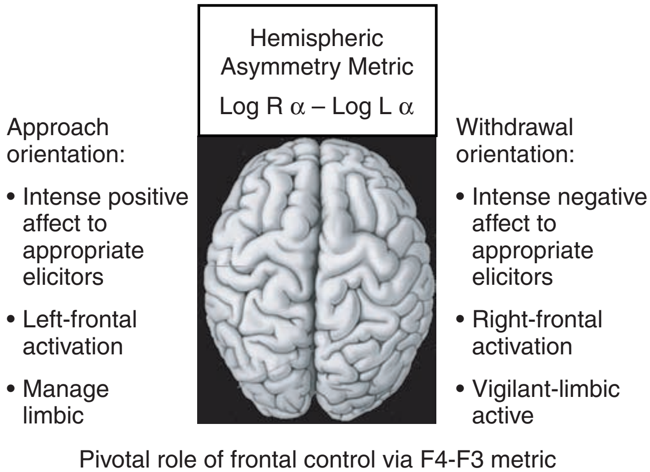


Figure 4.15 Frontal asymmetry metric.

emotion as described earlier, recent evidence points to a more fundamental association such that left frontal activation mediates approach-oriented behavior and right frontal activation is associated with avoidance or withdrawal-oriented behavior (Davidson, 2004; Jackson et al., 2003). For example, left frontal activation is manifest during hostile behavior, which is certainly not a positive affective state but most definitely involves approach toward an intended target. Whether positive in nature, approach-oriented, or a combination of the two, it would appear that such a neurobiological state would be highly adaptive for the soldier, who must control his or her arousal during active engagement with challenging tasks while under great pressure. Because EEG alpha power is inversely related to activation (i.e., relaxation), R – L alpha power (Log right frontal alpha power – Log left frontal alpha power), a positive value for this metric implies greater relaxation in the right region, or, in other words, a relative state of left frontal activation. Hence, positive numbers for this metric imply left activation and executive control over emotion structures and processes. Conversely, a negative value implies greater relaxation in the left region and a lack of executive control over limbic circuits. Therefore, this EEG metric provides an opportune target for neurofeedback training to enable a heightened level of executive control over emotional response and task engagement during challenge.

Model of Stress-Induced Cortical Dynamics

Figure 4.16 provides a schematic model of the processes and outcomes underlying stress reactivity and integrates affective and cognitive activity with psychomotor performance. A central tenet is that lack of frontal executive control over subcortical processes would result in heightened emotional influence (limbic structures) that, in turn, disrupt higher cortical association processes and the activation of the motor loop—the frontobasal ganglia structures that initiate and execute movement. Such disregulation interferes with attention and the motor loop connections (i.e., basal ganglia) to the motor cortex that largely control corticospinal outflow and the resultant quality of the motor unit activation (Grafton et al., 2000). Excessive networking in the cortex may result in undesirable alterations in information processing as well as inconsistency of motor performance. If the motor cortex becomes busy with excessive input from limbic processes via increased neocortical activity in the left hemisphere, then inconsistent motor behavior will likely result (Deeny et al., 2003). Refinement or economy of cortical activation would more likely result in enhanced attention and smooth, fluid, graceful, and efficient movement. Any reduction of associative networking with motor control processes would also help to reduce the complexity of motor planning and should result in greater consistency of performance.

According to this model, individuals under high stress will exhibit reductions in prefrontal asymmetry, as identified in Box 1 of Figure 4.16, compared to a low-stress condition implying a lack of frontal executive control over the medial frontal-meso-limbic circuit. Consequently, participants will experience heightened activation of the limbic region (amygdala; Box 6). The resultant emotional reactivity, in turn, will result in EEG alpha desynchrony, particularly in the left temporal (T3) and parietal (P3) regions (Box 8) along with increased noise or nonessential cortico-cortical communication between these regions and the motor planning centers (Box 4). Such disregulation of the cerebral cortex will be expressed as inconsistent input to the motor loop (Boxes 2 through 5), resulting in inconsistent corticospinal output and motor performance (motor unit activity—trigger pull; Boxes 9 and 10). It is well established that attention capacity shrinks with arousal; consistent with this notion, the excessive cortico-cortical networking during heightened stress, as proposed here, would compromise information processing (Easterbrook, 1959). In addition, cardiovascular activity (vagal tone) will be inversely related to the activity in the central nervous system such that vagal tone will be reduced in the high-stress condition. Cortisol levels will rise, as indicated in Box 10, by the predicted alteration in endocrine function (i.e., primarily indexed by increased activation in the HPA axis). The magnitude of change specified in the model will

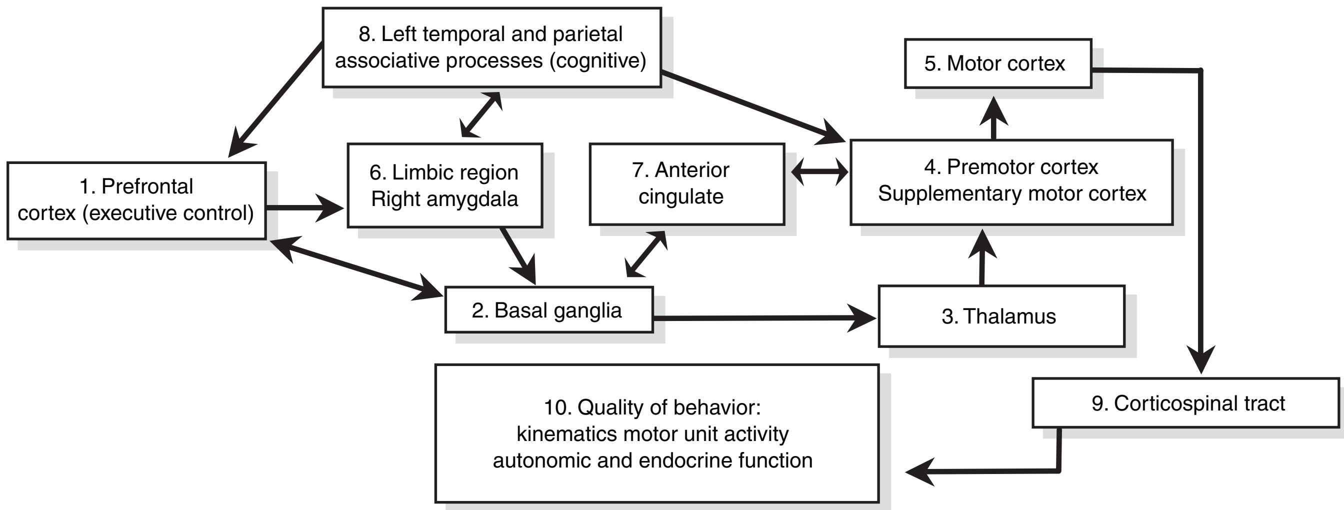


Figure 4.16 Neurobiological model of the fear circuit, with central roles of the amygdala (Box 6) and medial and orbital frontal regions (Box 1) in the expression and management of anxiety. The amygdalae (left and right) are largely responsible for the orchestrated response to fear-eliciting stimuli; however, the action of these important brain regions is affected by the prefrontal cortex (dorso-lateral, medial and orbital frontal regions) as well as the anterior cingulated region (Box 7) such that the higher centers can exert inhibitory control for the purpose of emotional regulation. Lack of control or hyperactivity of the amygdalae may cause interference and noise in the motor loop (basal ganglia and thalamus), resulting in unintended alterations in motor behavior.

be related to sport performance based on the nature of the changes and whether they are adaptive or maladaptive in relation to the task demands.

GENETIC BASES OF INDIVIDUAL DIFFERENCES IN STRESS REACTIVITY

There are individual differences in reactivity of the amygdalae in response to stressful events based on genetic factors. Variation in anxiety-related personality traits is 40% to 60% heritable. The disregulation of cortical processes with presentation of stress may be particularly problematic for carriers of the short alleles of the serotonin (5-HT) transporter gene (5-HTT), as this gene variant is strongly associated with hyperactivity of the amygdala during emotional tasks (Hariri et al., 2002). The genotypes are distributed according to the Hardy-Weinberg equilibrium as follows: LL—32%, LS—49%, and SS—19%. As such, there is a high degree of prevalence of this anxiogenic or anxiety-producing S allele. The S-type allele of the 5-HTT promoter region holds significant implications for information processing and motor control and is a critical component of a proposed individual differences model of the stress response. A more efficient response to stress in the L carriers would lead to enhanced information processing, more decisive decision making, and improved coordination of motor skills (a more intelligent response to stimuli). In military settings this biologically based disposition could increase performance under stress and survivability. In essence, S carriers may be considered stress-prone, whereas L carriers may be considered stress regulators. Recently, it has been well documented that the promoter region of the serotonin transporter gene is polymorphic such that those with the short allele (about 50% of population) show heightened activation of the amygdalae to emotion-eliciting stimuli, and those carrying the long allele show attenuation of fear (Hariri et al., 2002). This would imply that frontally mediated executive control of the "fear circuit" is critical for a large segment of the population who are predisposed to be especially reactive. In addition to such biologically based differences in anxiety response, genetic variation or polymorphism in neurotrophic factors such as brain-derived neurotrophic factor and nerve growth factor would imply that some individuals could experience adaptive alterations in the brain due to neural plasticity from practice and performance to a greater extent than others. This would imply that some individuals have an advantage in altering the architecture of the central nervous system to reap any advantages from practice and training such as efficiency of neural networks.

CONCLUSION

The present review began with the theme of economy of effort as a marker of superior psychomotor performance. The study by Haufler et al. (2000) offered powerful evidence for this phenomenon by contrasting the EEG spectral content during rifle marksmanship in experts versus novices. In line with the position advanced by Sterman and Mann (1995), in which EEG alpha is inversely related to cognitive load, experts showed remarkably reduced cerebral cortical activation relative to the novices. Such a finding of reduced cognitive load is consistent with the decreased cerebral metabolic profiles (using PET) associated with skill learning as reported by Haier et al. (1992). Furthermore, there seems to be a degree of specificity, in that this effect is largely related to reduced activation in cortical association areas that are nonspecific to the visuospatial task demands. For example, several authors have reported relative synchrony in the left temporal area during target shooting in high-skill performers and relative activation in the right posterior regions, which seems logical in those who have reached the stage of automaticity. Smith et al. (1999) showed a similar effect during the playing of a video game (Space Fortress) such that EEG alpha synchrony was noted in the left hemisphere during the visual-spatial challenge, whereas right posterior parietal activity was characterized by relative desynchrony or activation. In this regard, the participants seem to be characterized by specific allocation of neural resources to the task demands; that is, experience with the task results in an appropriate fit of neural resources to demand and a reduction in irrelevant processing. Such a process seems entirely consistent (albeit much more complex) with the concept of specific adaptation to imposed demand evidenced in other physiological systems and is essential to the process of focused attention, adaptive cognitive motor behavior, and high-quality motor performance.

In addition to conceptual models of cortical function in skilled performers, a number of technical advances may help to clarify the manner in which the cerebral cortex orchestrates superior motor performance. In particular, the sport performance EEG research has typically employed few electrode sites, although dense electrode arrays consisting of 32, 64, 128, or 256 sites allow for greater spatial resolution and dipole or source localization. Such spatial resolution along with the superior temporal resolution of EEG allows for a powerful measurement tool to assess dynamic cortical function during psychomotor preparation and performance. But such measurement sophistication needs to be applied with study designs that allow for cognitive inference (such as employed by Hatfield et al., 1984, Study 2), as opposed to simple description of regional activation patterns. Furthermore, the neural structures involved in skillful motor behavior are much more extensive than those considered in the sport EEG research.

In addition, this field of research is largely undeveloped in terms of studies in which psychological stress is applied to participants to determine the manner by which cerebral cortical processes are disrupted or perturbed by anxiety and tension. In particular, fMRI studies with the spatial resolution to detect subcortical limbic activity during the imposition of stress need to be conducted. In this regard, Milton et al. (2004) described reduced activity in the amygdala of expert golfers compared to novices while imaging the golf stroke; this difference was likely due to a reduction in self-awareness and, possibly, anxiety in the advanced performers. Although deep neural structures such as the amygdala cannot be assessed with surface EEG, future studies using this technology are needed that assess the complex networking relationships between relevant cortical regions during stress, such as the frontal executive processes and anterior and posterior cingulate, in addition to temporal and parietal activity.

In this regard, specified personality types, or genotypes that underlie such phenotypic expressions as trait anxiety, may be differentially responsive to stress manipulations such that defined categories of cortical networking patterns may begin to emerge. Such process-oriented studies, as opposed to outcome-oriented studies, may allow for understanding of the central neural mechanisms by which personality and stress are related to skilled motor performance. To elicit emotion, meaningful cognitive-motor challenges also need to be carried out in realistic environments that engage the study participants. Virtual reality technology offers exciting possibilities by which critical environmental events can be simulated and presented to athletes and military personnel who are likely to engage the tasks in a serious manner. Such environments are conducive to EEG recording while performing under pressure so that sensory, attentional, cognitive, emotional, and motor processes can be monitored. For example, EEG recording could be conducted with military personnel in simulated warfare environments to assess brain responses to enemy combatants as a function of military experience, personality, and genetic characteristics. Such measurements may also enable assessment of treatment effectiveness using cognitive-behavioral and neurofeedback interventions.

Hopefully, the lessons learned from such studies will transfer to the real world and increase the effectiveness of soldiers in the field as they perform challenging mental and physical tasks under extreme conditions. Ultimately, with the advent of high-quality telemetry of brain activity we will be able to assess brain activity in the field. One can only imagine the exciting possibilities for the acquisition of knowledge if the classic studies on emotion regulation in sport parachutists as conducted by Fenz (1975) had included brain activity in addition to the peripheral physiological measures of heart rate, skin conductance, and respiration. Advances in engineering applied to telemetry of EEG would allow incredible insights into the workings of the brain under stress. The theoretical model discussed earlier and supported by the studies conducted to date (i.e., regional relaxation, efficient networking, and psychomotor efficiency) may provide a benchmark or target profile by which to gauge the effectiveness of the brain of the soldier or athlete to engage and execute his or her responsibilities.

Finally, studies are needed that incorporate multiple measures in addition to cerebral cortical assessment. For example, stress-related studies that examine cortical dynamics, EMG activity, autonomic activity, and kinematic analyses of limb movement are needed to determine how cognitive-motor behavior is controlled from a systems perspective. This kind of approach has been attempted by some investigators who have observed the relationship between EEG during skilled motor behavior and other aspects of performance, such as the quality of limb movement (Contreras-Vidal & Buch, 2003) and concurrent eye movements or gaze behavior (Janelle, Hillman, Apparies, Murray, et al., 2000). At the present time, such studies are generally lacking but are needed to see how cortical activity covaries with other biological systems to explain the linkage of nervous system activity to the quality of motor behavior and further explain variability in performance.

The relevance of this work to the sport practitioner lies in the overwhelming support in the scientific literature for the notion that high-level performance is marked by economy of brain activity that underlies mental processes. Coaches should structure the practice environment to facilitate the emergence of this state. That is, instructional strategies should be simple and focus on correct ways of executing skills as opposed to emphasis on what not to do. In addition, the teaching style should be primarily based on reinforcement rather than punishment. Coaches should focus on elements of skill learning that the athlete is doing correctly and reward appropriately rather than emphasizing the reduction of mistakes. In this manner leadership style may be profoundly related to the neural dynamics associated with effective skill learning and the scientific literature can provide the coach with a concrete rationale, or neurophilosophy, for the adoption of a coaching style that helps the athlete to achieve high-quality performance.

REFERENCES

Attner, P. (1984, October). Payton vs. Harris vs. Brown. *Sporting News, 198,* 2–3.

Bear, M. F., Connors, B. W., & Paradiso, M. A. (2001). *Neuroscience: Exploring the brain.* Baltimore: Lippincott, Williams, & Wilkins.

Bell, M. A., & Fox, N. A. (1996). Crawling experience is related to changes in cortical organization during infancy: Evidence from EEG coherence. *Developmental Psychobiology, 29,* 551–561.

Beuter, A., & Duda, J. L. (1985). Analysis of the arousal/motor performance relationship in children using movement kinematics. *Journal of Sport Psychology, 7,* 229–243.

Bird, E. I. (1987). Psychophysiological processes during rifle shooting. *International Journal of Sport Psychology, 18,* 9–18.

Burgess, A. P., & Gruzelier, J. H. (1997). Short duration synchronization of human theta rhythm during recognition memory. *Neuroreport, 8,* 1039–1042.

Busk, J., & Galbraith, G. C. (1975). EEG correlates of visual-motor practice in man. *Electroencephalography and Clinical Neurophysiology, 38,* 415–422.

Cacioppo, J. T., & Tassinary, L. G. (1990). *Principles of psychophysiology: Physical, social, and inferential elements.* New York: Cambridge University Press.

Chen, J., Hung, T., Lin, J., Lo, L., Kao, J., Hung, C., et al. (2005, August). *Effects of anxiety on EEG coherence during dart throw.* Paper presented at the 2005 World Congress, International Society for Sport Psychology, Sydney, Australia.

Collins, D., Powell, G., & Davies, I. (1990). An electroencephalographic study of hemispheric processing patterns during karate performance. *Journal of Exercise and Sport Psychology, 12,* 223–243.

Contreras-Vidal, J. L., & Buch, E. R. (2003). Effects of Parkinson's disease on visuomotor adaptation. *Experimental Brain Research, 150,* 25–32.

Contreras-Vidal, J. L., Grossberg, S., & Bullock, D. (1997). A neural model of cerebellar learning for arm movement control: Cortico-spino-cerebellar dynamics. *Learning and Memory, 3,* 475–502.

Crews, D. J., & Landers, D. M. (1993). Electroencephalographic measures of attentional patterns prior to the golf putt. *Medicine and Science in Sports and Exercise, 25,* 116–126.

Daniels, J. T. (1985). A physiologist's view of running economy. *Medicine and Science in Sports and Exercise, 17,* 332–338.

Davidson, R. J. (1988). EEG measures of cerebral asymmetry: Conceptual and methodological issues. *International Journal of Neuroscience, 39,* 71–89.

Davidson, R. J. (2002). Anxiety and affective style: Role of prefrontal cortex and amygdala. *Biological Psychiatry, 51,* 68–80.

Davidson, R. J. (2004). What does the prefrontal cortex "do" in affect? Perspectives on EEG frontal asymmetry research. *Biological Psychology, 67,* 219–233.

Deeny, S., Hillman, C. H., Janelle, C. M., & Hatfield, B. D. (2003). Cortico-cortical communication and superior performance in skilled marksman: An EEG coherence analysis. *Journal of Exercise and Sport Psychology, 25,* 188–204.

deVries, H. A. (1968). Efficiency of electrical activity as a physiological measure of the functional state of muscle tissue. *American Journal of Physical Medicine, 47,* 10–22.

deVries, H. A., & Housh, T. J. (1994). *Physiology of exercise for physical education, athletics, and exercise science* (5th ed.). Dubuque, IA: Brown.

Di Russo, F., Pitzalis, S., Aprile, T., & Spinelli, D. (2005). Effects of practice on brain activity: An investigation in top-level rifle shooters. *Medicine and Science in Sports and Exercise, 37,* 1586–1593.

Dussault, C., Jouanin, J. C., & Guezennec, C. Y. (2004). EEG and ECG during selected flight sequences. *Aviation, Space, and Environmental Medicine, 75,* 889–897.

Easterbrook, J. A. (1959). The effect of emotion on cue utilization and the organization of behavior. *Psychological Review, 66,* 183–201.

Elbert, T., Pantev, C., Wienbruch, C., Rockstroh, B., & Taub, E. (1995). Increased cortical representation of the fingers of the left hand in string players. *Science, 270,* 305–307.

Etnier, J. L., Whitever, S. S., Landers, D. M., Petruzzello, S. J., & Salazar, W. (1996). Changes in electroencephalographic activity associated with learning a novel motor task. *Research Quarterly for Exercise and Sport, 67,* 272–279.

Fenz, W. D. (1975). Coping mechanisms and performance under stress. In D. M. Landers, D. V. Harris, & R. W. Christina (Eds.), *Psychology of Sport and Motor Behavior II* (Pennsylvania State HPER Series No. 10).

Fitts, P. M., & Posner, M. I. (1967). *Human performance.* Belmont, CA: Brooks/Cole.

Galin, D., & Ornstein, R. (1972). Lateral specialization of cognitive mode: An EEG study. *Psychophysiology, 9,* 412–418.

Gallwey, T. (1974). *The inner game of tennis.* New York: Random House.

Grafton, S. T., Hari, R., & Salenius, S. (2000). The human motor system. In A. W. Toga & J. C. Mazziotta (Eds.), *Brain mapping: The systems* (pp. 331–363). San Diego, CA: Academic Press.

Haier, R. J., Siegel, B. V., MacLachlan, A., Soderling, E., Lottenberg, S., & Buchsbaum, M. S. (1992). Regional glucose metabolic changes after learning a complex visuospatial/motor task: A positron emission tomographic study. *Brain Research, 570,* 134–143.

Hankins, T. C., & Wilson, G. F. (1998). A comparison of heart rate, eye activity, EEG, and subjective measurements of pilot mental workload during flight. *Aviation, Space, and Environmental Medicine, 69,* 360–367.

Hariri, A. R., Mattay, V. S., Tessitore, A., Kolachana, B., Fera, F., Goldman, D., et al. (2002). Serotonin transporter genetic variation and the response of the human amygdala. *Science, 297,* 400–403.

Hatfield, B. D., Haufler, A. J., Hung, T., & Spalding, T. W. (2004). Electroencephalographic studies of skilled psychomotor performance. *Journal of Clinical Neurophysiology, 21,* 144–156.

Hatfield, B. D., Haufler, A. J., & Spalding, T. W. (2006). A cognitive neuroscience perspective on sport performance. In E. O. Acevedo & P. Ekkekakis (Eds.), *Psychobiology of physical activity* (pp. 221–240). Champaign, IL: Human Kinetics.

Hatfield, B. D., & Hillman, C. H. (2001). The psychophysiology of sport: A mechanistic understanding of the psychology of superior performance. In R. N. Singer, H. A. Hausenblas, & C. M. Janelle (Eds.), *Handbook of sport psychology* (2nd ed., pp. 362–386). New York: Wiley.

Hatfield, B. D., Landers, D. M., & Ray, W. J. (1984). Cognitive processes during self-paced motor performance: An electroencephalographic profile of skilled marksmen. *Journal of Sport Psychology, 6,* 42–59.

Hatfield, B. D., Landers, D. M., & Ray, W. J. (1987). Cardiovascular-CNS interactions during a self-paced, intentional attentive state: Elite marksmanship performance. *Psychophysiology, 24,* 542–549.

Hatfield, B. D., Landers, D. M., Ray, W. J., & Daniels, F. S. (1982, February). An electroencephalographic study of elite rifle shooters. *American Marksman, 7,* 6–8.

Haufler, A. J., Spalding, T. W., Santa Maria, D. L., & Hatfield, B. D. (2000). Neuro-cognitive activity during a self-paced visuospatial task: Comparative EEG profiles in marksmen and novice shooters. *Biological Psychology, 53,* 131–160.

Haufler, A. J., Spalding, T. W., Santa Maria, D. L., & Hatfield, B. D. (2002). Erratum to "Neuro-cognitive activity during a self-paced visuospatial task: Comparative EEG profiles in marksmen and novice shooters." *Biological Psychology, 59,* 87–88.

Hillman, C. H., Apparies, R. J., Janelle, C. M., & Hatfield, B. D. (2000). An electrocortical comparison of executed and rejected shots in skilled marksmen. *Biological Psychology, 52,* 71–83.

Jackson, D. C., Mueller, C. J., Dolski, I., Dalton, K. D., Nitschke, J. B., Urry, H. L., et al. (2003). Now you feel it, now you don't: Frontal brain electrical asymmetry and individual differences in emotion regulation. *Psychological Science, 14,* 612–617.

Janelle, C. M., Hillman, C. H., Apparies, R. J., Murray, N. P., Meili, L., Fallon, E. A., et al. (2000). Expertise differences in cortical activation and gaze behavior during rifle shooting. *Journal of Sport and Exercise Psychology, 22,* 167–182.

Jasper, H. H. (1958). The ten-twenty electrode system of the International Federation. *Electroencephalography and Clinical Neurophysiology, 17,* 37–46.

Jung, T. P., Makeig, S., Westerfield, M., Townsend, J., Courchesne, E., & Sejnowski, T. J. (2001). Analysis and visualization of single-trial event-related potentials. *Human Brain Mapping, 14,* 166–185.

Kandel, E. R., & Schwartz, J. H. (1985). *Principles of neural science* (2nd ed.). New York: Elsevier.

Kerick, S. E., Douglass, L., & Hatfield, B. D. (2004). Cerebral cortical adaptations associated with visuomotor practice. *Medicine and Science in Sport and Exercise, 36,* 118–129.

Kerick, S. E., Hatfield, B. D., & Allender, L. E. (2006). *Event-related cortical dynamics of soldiers during shooting as a function of varied task demand.* Manuscript submitted for publication.

Kerick, S. E., Iso-Ahola, S. E., & Hatfield, B. D. (2000). Psychological momentum in target shooting: Cortical, cognitive-affective, and behavioral responses. *Journal of Sport and Exercise Psychology, 22,* 1–20.

Kerick, S. E., McDowell, K., Hung, T., Santa Maria, D. L., Spalding, T. W., & Hatfield, B. D. (2001). The role of the left temporal region under the cognitive motor demands of shooting in skilled marksmen. *Biological Psychology, 58,* 263–277.

Kinsbourne, M. (1982). Hemispheric specialization and the growth of human understanding. *American Psychologist, 37,* 411–420.

Klimesch, W. (1996). Memory processes, brain oscillations, and EEG synchronization. *International Journal of Psychophysiology, 24,* 61–100.

Klimesch, W. (1999). EEG and theta oscillations reflect cognitive and memory performance: A review and analysis. *Brain Research Reviews, 29,* 169–195.

Klimesch, W., Doppelmayr, M., Russegger, H., & Pachinger, T. (1996). Theta band power in the human scalp EEG and the encoding of new information. *Neuroreport, 7,* 1235–1240.

Konttinen, N., Landers, D. M., & Lyytinen, H. (2000). Aiming routines and their electrocortical concomitants among competitive rifle shooters. *Scandinavian Journal of Medicine and Science Sports, 10,* 169–177.

Konttinen, N., & Lyytinen, H. (1992). Physiology of preparation: Brain slow waves, heart rate, and respiration preceding triggering in rifle shooting. *International Journal of Sport Psychology, 23,* 110–127.

Konttinen, N., & Lyytinen, H. (1993a). Brain slow waves preceding time-locked visuomotor performance. *Journal of Sport Sciences, 11,* 257–266.

Konttinen, N., & Lyytinen, H. (1993b). Individual variability in brain slow wave profiles in skilled sharpshooters during the aiming period in rifle shooting. *Journal of Exercise and Sport Psychology, 15,* 275–289.

Lacey, J. I. (1967). Somatic response patterning and stress: Some revisions of activation theory. In M. H. Appley & R. Trumbull (Eds.), *Psychological stress* (pp. 14–42). New York: Appleton-Century-Crofts.

Landers, D. M., Han, M. W., Salazar, W., Petruzzello, S. J., Kubitz, K. A., & Gannon, T. L. (1994). Effects of learning on electroencephalographic and electrocardiographic patterns in novice archers. *International Journal of Sport Psychology, 25,* 313–330.

Landers, D. M., Petruzzello, S. J., Salazar, W., Kubitz, K. A., Gannon, T. L., & Han, M. (1991). The influence of electrocortical biofeedback on performance in pre-elite archers. *Medicine and Science in Sports and Exercise, 23,* 123–129.

Lay, B. S., Sparrow, W. A., Hughes, K. M., & O'Dwyer, N. J. (2002). Practice effects on coordination and control, metabolic energy expenditure, and muscle activation. *Human Movement Science, 21,* 807–830.

LeDoux, J. (1996). *The emotional brain.* New York: Simon & Schuster.

Loze, G. M., Collins, D., & Holmes, P. S. (2001). Pre-shot EEG alpha-power reactivity during expert air-pistol shooting: A comparison of best and worst shots. *Journal of Sports Sciences, 19,* 727–733.

Meichenbaum, D. (1977). *Cognitive behavior modification.* New York: Plenum Press.

Milton, J. G., Small, S. S., & Solodkin, A. (2004). On the road to automatic: Dynamic aspects in the development of expertise. *Journal of Clinical Neurophysiology, 21,* 134–143.

Pare, D., Quirk, G. J., & LeDoux, J. E. (2004). New vistas on amygdala networks in conditioned fear. *Journal of Neurophysiology, 92,* 1–9.

Pfurtscheller, G. (1992). Event-related synchronization (ERS): An electrophysiological correlate of cortical areas at rest. *Electroencephalography and Clinical Neurophysiology, 83,* 62–69.

Pfurtscheller, G., & Lopes da Silva, F. H. (1999). Event-related EEG/MEG synchronization and desynchronization: Basic principles. *Clinical Neurophysiology, 110,* 1842–1857.

Polich, J. (1996). Meta-analysis of P300 normative aging studies. *Psychophysiology, 33,* 334–353.

Pullum, B. (1977). Psychology of shooting. *Schiessportschule Dialogues, 1,* 1–17.

Radlo, S. J., Janelle, C. M., Barba, D. A., & Frehlich, S. G. (2001). Perceptual decision making for baseball pitch recognition: Using P300 latency and amplitude to index attentional processing. *Research Quarterly for Exercise and Sport, 72,* 22–31.

Rebert, C. S., Low, D. W., & Larsen, F. (1984). Differential hemispheric activation during complex visuomotor performance: Alpha trends and theta. *Biological Psychology, 19,* 159–168.

Salazar, W., Landers, D. M., Petruzzello, S. J., Han, M. W., Crews, D. J., & Kubitz, K. A. (1990). Hemispheric asymmetry, cardiac response, and performance in elite archers. *Research Quarterly for Exercise and Sport, 61,* 351–359.

Smith, M. E., McEvoy, L. K., & Gevins, A. (1999). Neurophysiological indices of strategy development and skill acquisition. *Cognitive Brain Research, 7,* 389–404.

Sparrow, W. A. (2000). *Energetics of human activity.* Champaign, IL: Human Kinetics.

Springer, S. P., & Deutsch, G. (1998). *Left brain—right brain: Perspectives from cognitive neuroscience.* New York: Freeman.

Sterman, M. B., & Mann, C. A. (1995). Concepts and applications of EEG analysis in aviation performance evaluation. *Biological Psychology, 40,* 115–130.

Tomarken, A. J., Davidson, R. J., Wheeler, R. E., & Doss, R. C. (1992). Individual differences in anterior brain asymmetry and fundamental dimensions of emotion. *Journal of Personality and Social Psychology, 62,* 676–687.

Tomporowski, P., & Hatfield, B. (2005). Effects of exercise on neurocognitive functions. *International Journal of Sport and Exercise Psychology, 3,* 363–379.

Wang, L., Kagigi, R., & Hoshiyama, M. (2001). Neural activities during Wisconsin Card Sorting Test: MEG observation. *Cognitive Brain Research, 12,* 19–31.

Weinberg, R. S., & Hunt, V. V. (1976). The interrelationships between anxiety, motor performance and electromyography. *Journal of Motor Behavior, 8,* 219–224.

Williams, J. M., & Krane, V. (1998). Psychological characteristics of peak performance. In J. M. Williams (Ed.), *Applied sport psychology* (pp. 158–170). Mountain View, CA: Mayfield.

PART II

Social Perspectives

CHAPTER 5

Leadership in Sports

PACKIANATHAN CHELLADURAI

This chapter outlines the major initiatives that have been undertaken in the study of leadership in sports. The first section discusses the various models of leadership that have been advanced and the associated measures of leadership. As extensive reviews of this leadership research have recently appeared (e.g., Chelladurai, 1990, 1993; Chelladurai & Riemer, 1998; Horn, 2002), this section provides a general overview of two of the models; readers are well advised to peruse the above reviews for more in-depth perspectives on the research in question. The second section describes the additions and modifications to existing models and measurement scales as well as the newer models and scales of leadership. The final section advances the notion that pursuit of excellence/expertise calls for forms of leader behavior that are distinct from those that have been described in the sport literature.

THE MEDIATIONAL MODEL OF LEADERSHIP

The original mediational model of leadership (R. E. Smith, Smoll, & Hunt, 1978) consisted of (a) coach behaviors, (b) players' perceptions and recollections of those behaviors, and (c) players' evaluative reactions. The cognitive processes of perceptions, recall, and reactions are as important as the behaviors themselves. Research on this model led the authors to revise it to include the situational and individual difference variables that influence coach behaviors, player perceptions and recollections, and players' evaluative reactions (Smoll & Smith, 1989). The complete model is shown in Figure 5.1.

The situational factors influencing the central elements of the model (i.e., coach behavior, players' perceptions/recollections of those behaviors, and reactions to them) are the nature of the sport, practice sessions versus games, previous team success/failure, current status in competitions, level of competition (i.e., recreational versus competitive), and interpersonal attraction within the team. The relevant coach characteristics include personal goals and/or motives, behavioral intentions, instrumentalities (i.e., perceived probability that a valued outcome will occur as a consequence of a behavior), the perceived norms associated with the role of the coach, inferences regarding player motivation, self-monitoring, and the coach's gender. Finally, the player individual difference variables are age, gender, perception of coaching norms, the valence attached to coaching behaviors, sport-related achievement motivation, competition anxiety, general self-esteem, and athletic self-esteem. The fundamental thrust of the mediational model was well articulated by Smoll and Smith (1989, p. 1532) when they said that "a truly comprehensive model of leadership requires that consideration be given not only to situational factors and overt behaviors, but also the cognitive processes and individual difference variables which mediate relationships between antecedents, leader behaviors, and outcomes." Hence, the emphasis is placed on player recall and evaluation of coach behaviors.

Measures of Leadership and Member Reactions

In conjunction with proposing their model, R. E. Smith, Smoll, and their associates also developed measures of leader behavior (observational method), athlete's perceptions and recollections of leader behavior (interview), athlete's affective reactions to the sport experience (interview), and coach's perceptions of own behavior (paper and pencil). The Coaching Behavior Assessment System (CBAS) is an observational scheme where 12 categories of leader behaviors (shown in Table 5.1) are observed and recorded.

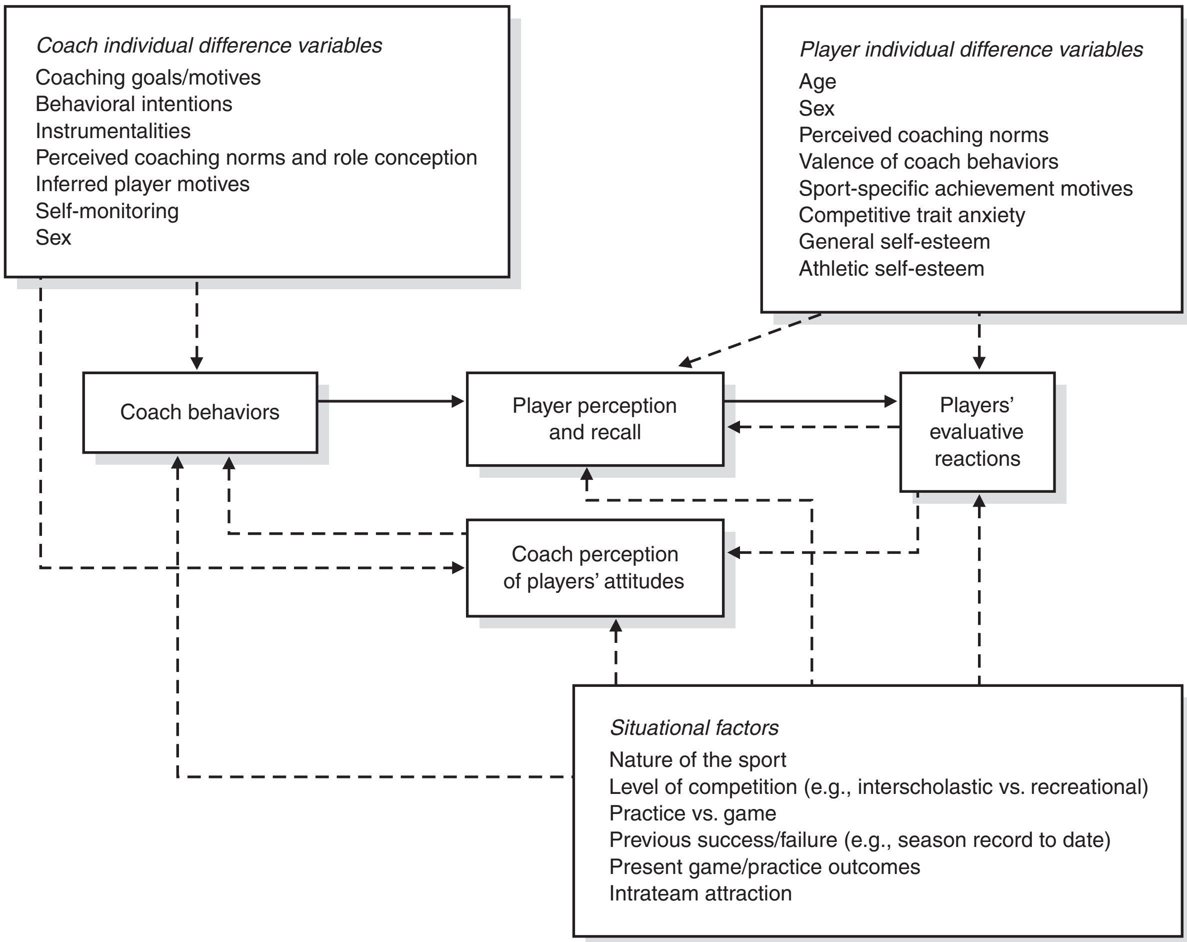


Figure 5.1 The mediational model of leadership. *Source:* "Leadership Behaviors in Sport: A Theoretical Model and Research Paradigm," by F. L. Smoll and R. E. Smith, 1989, *Journal of Applied Social Psychology, 19,* pp. 1522–1551. Reprinted with permission.

Some of these categories are reactive in that they are responses to immediately preceding player/team behaviors, such as desirable performances, mistakes, or misbehaviors. Other categories are spontaneous behaviors that are initiated by the coach without reference to any immediately preceding events. These spontaneous behaviors may be either game-related behaviors of technical instruction, encouragement, and organization, or game-irrelevant behaviors of general communication (R. E. Smith et al., 1977).

The frequencies with which a coach exhibits each one of the 12 categories of leader behaviors is the measure of actual behavior. One or more observers record the number of times a coach engages in a specified form of behavior. The steps taken to ensure the reliability of the coding system included extended study of a training manual (R. E. Smith, Smoll, & Hunt, 1977), group instruction in the use of the scoring system using a training videotape (R. E. Smith, Smoll, Hunt, & Clarke, 1976), written tests that require defining the 12 categories and scoring behavioral examples, scoring videotaped sequences, and extensive practice and reliability checks in actual field settings (R. E. Smith et al., 1977; R. E. Smith, Zane, Smoll, & Coppel, 1983). Additional assessment included the extent of agreement between two individuals in coding the leader behaviors or between two time-lagged codings by the same individual. With such rigorous steps, the agreement among raters in coding ranged from 87.5% to 100% (R. E. Smith et al., 1977, 1983). Interrater reliability has also been operationalized as the correlation of the coding frequencies between a pair of observers across the 12 categories. These correlations ranged from .77 to .99 for a mean of .88 in one study and from .50 to .99 for a mean of .88 in the second study reported by R. E. Smith et al. (1977). R. E. Smith et al. (1983) further reported that the correlations of the frequencies of observed leader

Table 5.1 Response Categories of the Coaching Behavior Assessment System

	Class I: Reactive Behaviors
Responses to Desirable Performance	
Reinforcement	A positive, rewarding reaction, verbal or nonverbal, to a good play or good effort
Nonreinforcement	Failure to respond to good performance
Responses to Mistakes	
Mistake-contingent encouragement	Encouragement given to a player following a mistake
Mistake-contingent technical instruction	Instructing or demonstrating to a player how to correct a mistake
Punishment	A negative reaction, verbal or nonverbal, following a mistake
Punitive technical instruction	Technical instruction given in a punitive or hostile manner following a mistake
Ignoring mistakes	Failure to respond to a player mistake
Response to Misbehavior	
Keeping control	Reactions intended to restore or maintain order among team members
	Class II: Spontaneous Behaviors
Game-Related	
General technical instruction	Spontaneous instruction in the techniques and strategies of the sport (not following a mistake)
General encouragement	Spontaneous encouragement that does not follow a mistake
Organization	Administrative behavior that sets the stage for play by assigning duties, responsibilities, positions, etc.
Game-Irrelevant	
General communication	Interactions with players unrelated to the game

Source: "A System for the Behavioral Assessment of Athletic Coaches," by R. E. Smith, F. L. Smoll, and E. B. Hunt, 1977, *Research Quarterly, 48,* pp. 401–407. Reprinted with permission.

behaviors in a field setting by an observer and an expert ranged from .85 to .98 (median = .96) across all the behavioral dimensions except nonreinforcement and ignoring mistakes. Other authors have also provided evidence of a high degree of agreement between raters (e.g., Chaumeton & Duda, 1988; Horn, 1985).

To assess players' perceptions of coach's behavior, Smith, Smoll, and Curtis (1978) developed the CBAS Perceived Behavior Scale (CBAS-PBS). In the scale, the players are provided with a verbal description and example of each of the 12 behavioral dimensions and then asked to indicate how frequently the coach engaged in each of those behaviors on a 7-point scale (1 for "almost never" to 7 for "to almost always"). Similarly, coaches are asked to indicate on 7-point scales (1 for "almost never" to 7 for "to almost always") the extent to which they engage in each of the behaviors. As these are single-item scales, reliability cannot be established. For a critique of these measures, see the review by Chelladurai and Riemer (1998).

With regard to players' evaluative reactions, players were asked to respond to a number of questions, varying from 6, to 8 (Barnett, Smoll, & Smith, 1992; Smoll, Smith, Barnett, & Everett, 1993), to 10 (R. E. Smith & Smoll, 1990; Smoll, Smith, Curtis, & Hunt, 1978), and finally to 11 items (R. E. Smith, Smoll, & Curtis, 1979). The items were scored on a 7-point Likert-type scale. Although there has been a report of the emergence of two factors from these items labeled *attraction toward the coach* and *attraction toward and cooperation with teammates* (Smoll et al., 1978), they have not been emphasized in subsequent research.

Although the 12-category CBAS is much more comprehensive than other leadership scales in sport (e.g., Chelladurai & Saleh's, 1980, Leadership Scale in Sport; to be discussed later), R. E. Smith and Smoll (1990, p. 991) have cautioned that the CBAS does not tap into important aspects of "coaching behaviors, such as verbal and nonverbal responses, magnitude of reinforcement, quality and duration of instruction, and so forth." In their review of the work of R. E. Smith, Smoll, and associates, Chelladurai and Riemer (1998) concluded that their comprehensive 12-dimensional scheme captures most of the meaningful coaching behaviors and commended them for developing measures to assess the variables of the study. It is noteworthy that R. E. Smith, Smoll, and associates have measured leadership from three different sources: the observers, the players, and the coaches themselves. Such an approach also highlights the difficulties emanating from the discrepancies among the three sets of scores. An important finding from their research is that coaches tended to behave consistent with their own goals and instrumentalities (their perceptions of what behaviors would lead to what goals). As noted by Chelladurai and Riemer, this finding underscores the need to assess coaches' goals in any attempts of training and development of coaches. In fact, R. E. Smith, Smoll, and associates have developed training programs for coaches and have found that such training has positive impact on coaches and players (e.g., R. E. Smith & Smoll, 1997; R. E. Smith, Smoll, & Barnett, 1995; R. E. Smith, Smoll, & Christensen, 1996; Smoll et al., 1993).

Recent Questionnaire Measures of the Coaching Behavior Assessment System

As the mediational model of leadership has great appeal for researchers and practitioners, it is not surprising that there have been two significant efforts to improve the measurement of some of the key concepts of the model. These are described next.

Coaching Feedback Questionnaire

A fundamental edict of Smoll and Smith (1989, p. 1527) is this:

> The ultimate effects of coaching behaviors are mediated by the meaning that players attribute to them. In other words, cognitive and affective processes serve as filters between overt coaching behaviors and youngsters' attitude toward their coach and their sport experience.

Yet, player evaluative reactions were not adequately measured in earlier research by Smoll and Smith and their associates. Amorose and Horn (2000) expanded and modified earlier scales to develop the Coaching Feedback Questionnaire (CFQ) to measure athletes' perceptions of the types of feedback provided by their coaches.

The CFQ contains 16 items to measure eight categories of feedback, including three categories of responses to players' performance successes in terms of *praise/reinforcement, nonreinforcement,* and *reinforcement combined with technical instruction,* and five categories of responses to errors reflected in *mistake-contingent encouragement, ignoring mistakes, corrective instruction, punishment,* and *corrective instruction combined with punishment.* As Amorose and Horn (2000) note, these categories correspond to those of the CBAS, specifically the reactive behaviors outlined by R. E. Smith et al. (1977). The respondents are required to indicate how typical it is for their coach to give them that particular type of feedback during practice and games on a 5-point scale ranging from "very typical" to "not at all typical."

Factor analysis of these 16 categories resulted in three meaningful factors: Positive and Informational Feedback, Punishment-Oriented Feedback, and Nonreinforcement/Ignoring Mistakes. The alpha values were .72, .83, and .78, respectively. Amorose and Horn (2000, p. 69) administered both the Leadership Scale for Sports (LSS) perceived version and the CFQ to their respondents, university-level athletes, because "the LSS provides a more general measure of leadership styles, while the CFQ provides a more specific measure of coaching behavior with regard to feedback patterns." They found that respondents high on intrinsic motivation perceived their coaches to be high on training and instruction and democratic behaviors and low in autocratic behavior (dimensions of LSS). In addition, intrinsically motivated athletes perceived their coaches to be high on positive and information-based feedback and low on punishment-oriented and ignoring behaviors (dimensions of CFQ). It is unfortunate that Amorose and Horn did not report the relationships between the dimensions of LSS and CFQ. Recently, L. S. Smith, Fry, Ethington, and Li (2005) factor-analyzed the CFQ items with the data of female high school basketball players and derived three factors: Positive Feedback (4 items), Punishment (6 items), and Ignoring Mistakes (2 items). They found that all three dimensions were significant in explaining 38% of the variance in perceived task climate, and positive feedback and punishment explained 27% of the variance in perceived ego-involving climate. (See Chapter 1 for discussion of task and ego climates.)

Coaching Behavior Questionnaire

To study the relationship of anxiety and self-confidence with the evaluation of coaching behaviors, Kenow and Williams (1992) developed their 28-item Coaching Behavior Questionnaire (CBQ); 21 are substantive items and 7 are filler items. The response format is a 4-point Likert scale ranging from 1 ("strongly disagree") to 4 ("strongly agree"). These items purported to measure athlete's perceptions of the coach's ability to communicate, the confidence displayed by the coach, the coach's composure and emotional control, and the effects of the coach's arousal level on athletes. These authors used the composite of the 21 items as a measure of coaching behavior. They found that higher levels of trait anxiety and state cognitive anxiety and lower self-esteem among athletes were associated with more negative evaluation of the coach's behavior. In a later study, Kenow and Williams (1997) derived five factors from the substantive items: Cognitive/Attentional Effects of Coach's Behavior, Supportiveness, Emotional Control and Composure, Communication, and Somatic Effects of Coach's Behavior. They found significant correlations between state somatic anxiety and coach's emotional control and composure, and between cognitive anxiety and perceived somatic effects of coach's behavior.

In the most recent refinement of the CBQ, Williams et al. (2003) noted that R. E. Smith and Smoll's mediational model provided the theoretical framework for the CBQ, which was focused on measuring athlete perceptions and evaluative reactions to both positive and negative coaching behaviors. They first carried out an exploratory factor analysis (EFA) with a random half of the responses to the CBQ by 484 college and high school athletes. They accepted two-factor and three-factor solutions as tenable. Then they used the data of the other half of the sample to carry out a confirmatory factor analysis (CFA). In the CFA, the two-factor model emerged as the best (compared to single-factor and three-factor models). The first factor, Negative Activation, contains 7 items reflecting the effects of leader behavior on athletes (e.g., "My coach's behavior during a game makes me feel tight and tense"; "My coach makes me feel uptight"). The second factor, Supportiveness/Emotional Composure, has 8 items to measure athletes' perceptions of coaching behavior (e.g., "My coach is appropriately composed and relaxed"; "My coach shows support for me even when I make mistakes"). The internal consistency estimates (Cronbach's alpha) were .82 and .83, respectively.

The latest version of the CBQ (Williams et al., 2003) measures both the behavior of the coach (i.e., Supportiveness/Emotional Control) and the effects of such behavior (i.e., the Negative Activation dimension). This is in contrast to R. E. Smith, Smoll, and associates' approach to measuring these two constructs through separate measures and separate methodologies. It is also different from Amorose and Horn's (2000) CFQ, which measures only the feedback provided by the coach. It is intriguing, however, that Williams et al. resorted to EFA to derive new factors when the data could have been subjected to CFA with the a priori factor structure proposed by Kenow and Williams (1992) or the 5-factor structure derived in Kenow and Williams (1997).

THE MULTIDIMENSIONAL MODEL

Chelladurai's (Chelladurai, 1978, 1993; Chelladurai & Carron, 1978) multidimensional model (shown in Figure 5.2a) incorporates three states of leader behaviors: *required* (Box 4), *preferred* (Box 6), and *actual* (Box 5). It is envisaged that the *situational characteristics* (Box 1), composed mainly of the goals of the group, the type of task (e.g., individual versus team, closed versus open tasks), and the social and cultural context of the group, set the parameters for the required behavior. That is, these situational characteristics place some prescriptions on the kinds of behaviors the leader should engage in and also some proscriptions on the kinds of behaviors that should be eschewed. For example, the leader should be demanding and directing when coaching an elite team of adults (e.g., a university athletic team) but be gentle and soft when leading a youth sports team.

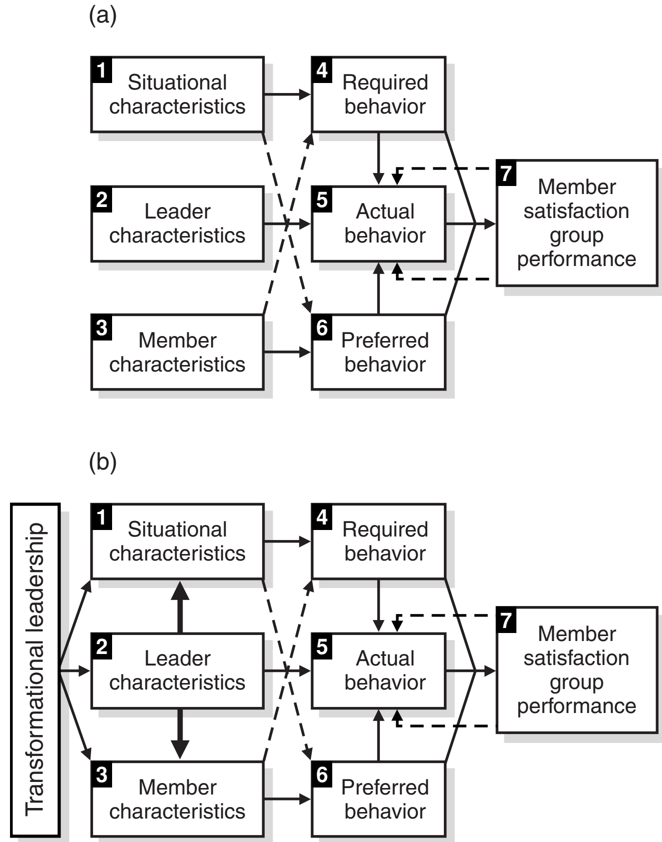


Figure 5.2 (a) The multidimensional model of leadership; (b) Transformational effects of leader behavior in the multidimensional model of leadership.

Preferred behavior (Box 6) refers to the preferences of members for instruction and guidance, social support, and feedback. These preferences are largely a function of member characteristics (Box 3), including personality (e.g., need for achievement, need for affiliation, cognitive structure) and ability related to the task. It is acknowledged in the model that the members of the group also recognize the situational requirements. Therefore, their preferences for specific forms of behavior from the leader will be partly shaped by those situational contingencies. By the same token, the required behavior will be partly defined by the nature of the group. Whereas preferred behavior is a reflection of individual differences within the group, the group as a whole may differ from another group in terms of gender, age, skill level, and so on. Thus, the leader behavior required in the context of one group (e.g., collegiate team or a men's team) may be different from those required in the case of another group (e.g., youth sports team or a women's team).

The actual behavior (Box 5) is largely a function of the leader's characteristics, including personality, expertise, and experience. The multidimensional model, however, stipulates that the actual behavior will also be shaped by the required behavior and the preferred behavior. That is, the leader will be cognizant of the prescriptions and proscriptions imposed by the situation. At the same time, the leader will be attuned to the preferences of the members of his or her group. In sum, the three factors of leader's personal characteristics, situational requirements, and member preferences underlie the actual behavior.

Congruence Hypothesis

The major proposition of the theory is that the degree of congruence among the three states will influence the outcome variables of performance and member satisfaction (Box 7). That proposition underscores the need for the leader to juggle and balance the demands imposed by the situation and the preferences of the members. There are two feedback loops from performance and member satisfaction to actual behavior. A leader is likely to alter behavior based on the relative attainment of the outcome variables. If the performance of the group fails to reach expectations, the leader is likely to emphasize task-oriented behaviors to enhance the performance capabilities of the group. If the leader perceives that the members are not satisfied with the leader and/or the group and their involvement, the leader is likely to focus more on those behaviors that would foster warm interpersonal interactions between the leader and members and among the members.

Value versus Perceptual Congruence

In their study of leadership and cohesion in sport, Shields, Gardner, Bredemeier, and Bostro (1997) conceived of two types of congruence, *value congruence* and *perceptual congruence,* relating to member preferences for leadership, their perceptions of leadership, and leader's perception of his or her own leadership. Value congruence refers to the congruence between athletes' perceptions and preferences. Athletes "are likely to interpret the discrepancy in terms of a gap between how the coach and the athlete value a particular behavior" (pp. 198–199). Perceptual congruence refers to the extent to which the athlete and the coach agree on the behavior of the coach. Noting that research in other areas has shown that perceptual disagreement has been associated with interpersonal problems such as marital distress and communication disruptions, these authors assumed that "perceptual congruence is an important construct to consider in investigating the relationship between sport leadership and team cohesion" (p. 199). They found that higher levels of task-oriented behaviors (i.e., training and instruction, positive feedback, and democratic behavior) were more strongly associated with task cohesion. (Please see Chapter 6, for a discussion of task and social cohesion.) They also found that although both types of value and perceptual congruence were strongly associated with cohesion, the association was stronger in the case of perceptual congruence. They conclude that "it is more important for athletes to agree with their coach on what 'is' than to share common opinion regarding what 'ought to be' " (p. 208).

Analytical Issues with Congruence

Finally, the congruence hypothesis fundamental to the multidimensional model poses some analytical issues. The common conception that the discrepancy scores adequately represent congruence is fraught with danger, as discrepancy scores have been shown to be unreliable (e.g., Johns, 1981). Therefore, it is suggested that hierarchical regression analysis be employed to test the congruence hypothesis (Chelladurai, 1993; Chelladurai & Riemer, 1998). That is, the main terms (e.g., preferred and perceived leadership) should be entered first, followed by the interaction term of the main terms (i.e., preferred × perceived scores) in the second step. If the contribution of the interaction term to the explained variance is significant, then the congruence hypothesis is supported. This was the approach taken by H. Reimer and Chelladurai (1995) in their finding that the congruence hypothesis was supported.

In contrast, Reimer and Toon (2001) did not find support for the congruence hypothesis employing the same technique. Riemer and Toon studied the effects of leader behaviors as measured by the LSS on four facets of satisfaction as measured by Riemer and Chelladurai's (1998) Athlete Satisfaction Questionnaire: training and instruction satisfaction, personal treatment satisfaction, team performance satisfaction, and individual performance satisfaction. In their study of collegiate tennis players, the preference scores were higher than perceptions in all dimensions except autocratic behavior. More important, they used the technique of hierarchical regression analyses to test the congruence hypothesis. As the interaction terms in the regression analyses were not significant, they concluded that the congruence hypothesis was not supported in any of the chosen facets of satisfaction.

Outcome Variables

The inclusion of performance and satisfaction as the outcome variables is justified on the basis that one reflects group goals and the other relates member reactions to their experiences. As Courneya and Chelladurai (1991) noted, several of the measures related to performance (e.g., win-loss percentage, the difference between points scored for and against the team, and the ratio of final score of the two contestants) are contaminated by random chance, opponent's outstanding performance, strategic choices made by the team/coach, and officials' wrong calls. One way to avoid this pitfall is to use player perception of individual and team performance (e.g., Chelladurai, 1984; Horne & Carron, 1985). Another way is to assess players' satisfaction with their own performance and that of the team. These two facets have been highlighted as related to product (Chelladurai & Riemer, 1997) and are included in the recently developed Athlete Satisfaction Questionnaire (Riemer & Chelladurai, 1998). In this regard, Chelladurai and Riemer (1998) pointed out the difficulty of player perceptions of performance being closely related to their affective reactions to such perceptions (i.e., satisfaction). Thus, it may prove problematic to separate the two measures, perceived performance and satisfaction thereof, particularly if a study includes both performance and satisfaction as outcome measures.

From a different perspective, the outcomes need not be confined to performance and/or member satisfaction. Coaching behavior can affect several other outcomes related to the athlete and/or the team. For instance, Price and Weiss (2000) have shown that coach's level of burnout influenced his or her behavior, and that coach's behavior had an effect on players' psychological responses. More specifically, coaches who were more emotionally exhausted were perceived by their players as more democratic and less autocratic and as providing less training and instruction and social support on the LSS dimensions. More germane to the present context is that coaches who were perceived to be less democratic and more autocratic and lower on training and instruction, social support, and positive feedback had players who were higher on anxiety and burnout and lower on enjoyment and perceived competence.

Gardner, Shields, Bredemeier, and Bostrom (1996) found that coaches perceived to be high on training and instruction, democratic behavior, social support, and positive feedback and low on autocratic behavior had teams high on task cohesion. Social cohesion was significantly associated with only training and instruction and social support. In a recent study of the relationships among leadership (LSS dimensions), cohesion (task and social), and outcome, Trail (2004) found that the leadership effects on outcomes (i.e., winning percentage, perceived success of team, satisfaction with team performance, and satisfaction with individual performance) were fully mediated by team cohesion. That is, leadership explained 38.8% of the variance in team cohesion, which, in turn, explained 39.8% of the outcomes. Trail noted that his results did not support Chelladurai's multidimensional model because the direct effect of leadership on outcomes was not significant.

Trail (2004) alerts us to an important issue. Although the multidimensional model specifies that the congruence of the three states of leader behavior leads to performance and satisfaction, it does not preclude such congruence to influence any mediating factors that would, in turn, influence outcomes. For instance, good leadership may enhance member ability and self-efficacy (i.e., member characteristics in the multidimensional model of leadership), which could result in better performances, as was the case with cohesion in Trail's study. For another example, consider Amorose (in press). In his review of the literature linking leadership styles (as measured by the LSS) and Ryan and Deci's (2000) self-determination theory, Amorose noted that, in general, the coaching behaviors measured by the LSS had significant influence on intrinsic motivation of athletes. In addition, these behaviors affected the three psychological needs of competence, autonomy, and relatedness which, in turn, influenced intrinsic motivation (Hollembeak & Amorose, 2005). Such intrinsic motivation should ultimately be related to enhanced performance and satisfaction. Hence, researchers need to be cognizant of other mediating and moderating variables that impinge on the general effects of leadership congruence on performance and satisfaction.

Leadership Scale for Sports

The LSS was developed in conjunction with the proposal of the multidimensional model of leadership so that the constructs of the model can be adequately tested. It consists of 40 items representing five dimensions of leader behavior: Training and Instruction (13 items), Democratic Behavior (9 items), Autocratic Behavior (5 items), Social Support (8 items), and Positive Feedback/Rewarding Behavior (5 items). These dimensions of leader behavior are described in Table 5.2.* Two of these dimensions (Democratic and Autocratic Behaviors) refer to the coach's style of decision making (i.e., the extent to which athletes are allowed to participate in decision making); two other dimensions (Training and Instruction and Positive Feedback) are task-oriented, and the fifth dimension (Social Support) is oriented toward creating a friendly and positive group climate. The response format refers to the frequencies of the behavior exhibited by the coach in five categories: (1) always, (2) often—75% of the time, (3) occasionally—50% of the time, (4) seldom—25% of the time, and (5) never.

Three versions of the LSS have been used to measure athletes' preferences for specific leader behaviors, athletes' perceptions of their coaches' leader behaviors, and/or coaches' perceptions of their own behavior.

Table 5.2 Dimensions of Leader Behavior in Sports

Dimension	Description
Training and instruction	Coaching behavior aimed at improving athletes' performance by emphasizing and facilitating hard and strenuous training; instructing them in the skills, techniques, and tactics of the sport; clarifying the relationship among the members; and structuring and coordinating the members' activities.
Democratic behavior	Coaching behavior that allows greater participation by the athletes in decisions pertaining to group goals, practice methods, and game tactics and strategies.
Autocratic behavior	Coaching behavior that involves independent decision making and stresses personal authority.
Social support	Coaching behavior characterized by a concern for the welfare of individual athletes, positive group atmosphere, and warm interpersonal relations with members.
Positive feedback	Coaching behavior that reinforces an athlete by recognizing and rewarding good performance.

Source: Manual for the Leadership Scale for Sports, by P. Chelladurai, 1989, Unpublished manuscript, University of Western Ontario, London, Canada.

Internal Consistency Estimates for the Leadership Scale for Sports Dimensions

The internal consistency estimates from selected studies are provided in Table 5.3. Although the estimates are adequate for four of the five dimensions, they were rather consistently low (<.70) for Autocratic Behavior. Estimates lower than .70 suggest that the items may not be measuring the same construct (i.e., the items are not from the same sampling domain). However, these values were .60 or higher in several studies listed in Table 5.3, a value considered marginal but acceptable for scales with fewer items (Amorose & Horn, 2000). But the problem may be more substantive than the mere number of items. Chelladurai and Riemer (1998, p. 239) pointed out:

> Two of the items in Autocratic Behavior refer to the aloofness of the coach (i.e., work relatively independent of the athletes; keep to him/herself), two refer to how he or she handles issues/decisions (i.e., not explain his or her action; refuse to compromise a point) and one seems to deal with how the coach addresses players (i.e., speaks in a manner not to be questioned). They certainly do not reflect autocratic behavior in the traditional sense (i.e., the opposite end of the continuum from democratic behavior).

So Chelladurai and Riemer suggested that the subscale be renamed "aloof behavior, authoritarian behavior, or inflexible behavior." But renaming (an easy process) does not solve the issue of low internal consistency of the items. Despite these low estimates, Autocratic Behavior with the same items emerged as a distinct factor in four different data sets. Accordingly, it would be wise to retain the dimension and strengthen it by adding more homogeneous items or split the dimension into two specific forms of behavior, such as aloofness and inflexibility (Chelladurai & Riemer, 1998). In their study of coach behaviors, coach burnout, and athlete burnout, Price and Weiss (2000) adopted the former strategy and added three more items to the Autocratic Behavior dimensions: (1) does not take into account athletes' suggestions when making decisions, (2) controls what athletes can do and cannot do, and (3) makes decisions regardless of

* Chelladurai (1993) noted that for the most part the content of the 12 behavioral categories of the CBAS (see Table 5.1) and the five dimensions of the LSS (see Table 5.2) are related. In the most recent study on the topic, Cumming, Smith, and Smoll (2006) empirically verified the parallel nature of the two instruments. They found "considerable convergence between measures of perceived coaching behaviors that originate from different theoretical and methodological traditions [i.e., the LSS and the CBAS-PBS], and their areas of convergence are also reflected in their relations with athletes' evaluative responses to their coaches" (p. 212). The players' evaluative responses related to their liking to play for the coach, coach's knowledge of the sport, and coach's teaching ability.

Table 5.3 Internal Consistency Estimates for the LSS Dimensions

Source	TI	DB	AB	SS	PF
	Dimensions				
Chelladurai and Saleh (1980):					
Canadian athletes	.83[a]	.75	.45	.70	.82
	.93[b]	.84	.79	.86	.92
Chelladurai et al. (1988):					
Japanese athletes	.81[a]	.72	.55	.72	.73
	.89[b]	.81	.57	.84	.81
Canadian athletes	.77[a]	.67	.55	.78	.77
	.88[b]	.76	.59	.84	.91
Isberg and Chelladurai (1990):					
Swedish athletes	.78[a]	.77	.44	.60	.57
	.88[b]	.72	.54	.86	.77
Kim, Lee, and Lee (1990):					
Korean athletes	.81[a]	.74	.61	.76	.66
	.86[b]	.83	.64	.80	.72
Iordanoglou (1990):					
Greek soccer players	.86[b]	.73	.11	.59	.60
H. Riemer and Chelladurai (1995):					
American university football players	.83[a]	.79	.57	.72	.80
	.89[b]	.85	.61	.83	.84
Gardner et al. (1996):					
Scholastic baseball/softball players	.88[b]	.83	.65	.81	.85
Price and Weiss (2000):					
American university female soccer players	.83[b]	.83	.71[d]	.80	.88
Amorose and Horn (2000):					
American university athletes	.89[b]	.83	.65	.82	.87
Riemer and Toon (2001):					
American college tennis players	.85[a]	.82	.67	.81	.81
	.88[b]	.86	.59	.78	.87
Shields et al. (1997):					
Baseball and softball players	.85[a]	.84	.62	.78	.85
	.88[b]	.83	.65	.81	.85
Baseball and softball coaches	.83[c]	.78	.62	.78	.68
Sullivan and Kent (2003):					
American and Canadian collegiate coaches	.83[c]	.79	.34	.51	.83
Trail (2004):					
American high school basketball players	.87[b]	.78	.46	.81	.86
Hollembeak and Amorose (2005):					
American university athletes	.91[b]	.85	.66	.78	.86

Note: TI = Training and Instruction; DB = Democratic Behavior; AB = Autocratic Behavior; SS = Social Support; PF = Positive Feedback.

[a] Athletes' preferences.

[b] Athletes' perceptions.

[c] Coaches' perceptions of own behavior.

[d] With three more items.

what athletes think. With these additional items, the alpha value for this dimension was .71.

Subscale Structure of the Leadership Scale for Sports

Several scholars have verified the subscale structure of the LSS (e.g., Iordanoglou, 1990; Isberg & Chelladurai, 1990; Kim, Lee, & Lee, 1990; Lacoste & Laurencelle, 1989; Serpa, Lacoste, Pataco, & Santos, 1988) but only through analysis of item-to-total correlations, a less rigorous technique. Chelladurai and Riemer (1998) employed the more rigorous method of confirmatory factor analysis to examine the construct validity of the preferred and perceived versions of the LSS (n = 317 and 217, respectively). They found the fit between the data provided by university football players and the measurement model was adequate as the selected indices met the acceptable standards ($\chi^2/df < 2$; root mean square error of approximation [RMSEA] = .06 and .062, respectively for the preference and perception versions). But two other indices were less than adequate (i.e., Bollen's, 1989, fit index of .78 and .85, respectively, and Tucker-Lewis Index of .77 and .83). More recently, Trail (2004) reported that although the test of close fit was rejected in the data of high school basketball players' perceptions, there was a reasonable fit (RMSEA = .058; $\chi^2/df = 1.65$) between the data and measurement model, indicating adequate construct validity for the LSS.

Chelladurai and Riemer (1998) noted that although there was enough evidence of adequate psychometric properties of the LSS, there was also the need to revise the scale in terms of its subscale structure. One area where such efforts may focus is to make the LSS more comprehensive such that it taps all the dimensions of critical coaching behavior. More specifically, Chelladurai and Riemer suggested that the essence of transformational leadership needs to be incorporated in the scheme. In the transformational process, coaches are expected to (a) incite the higher order needs of members, (b) motivate them to perform beyond expectations, (c) express confidence in members, and (d) empower them (e.g., B. Bass, 1985). This perspective is discussed in greater detail later in this chapter.

Revised Leadership Scale for Sports

Zhang, Jensen, and Mann (1997) modified and revised the LSS to include more dimensions and items. They kept the original five dimensions, the instructions, and response format of the LSS, as well as the same three versions, but they proposed two new dimensions of leader behavior: Group Maintenance Behavior and Situational Consideration Behavior. Group Maintenance Behaviors were "aimed at clarifying the relationship among the team members, structuring and coordinating the athletes' activities, and improving the coach-athlete relationship and team cohesion" (p. 109). Situational Consideration Behaviors were "aimed at considering the situation factors (such as the time, individual, environment, team, and game); setting up individual goals and clarifying ways to reach the goals; differentiating coaching methods at different stages; and assigning an athlete to the right position" (pp. 109–110). These authors began with interviews of 18 intercollegiate coaches and generated 240 new items to represent the seven dimensions. Then three linguistic experts perused the items and corrected them for proper English usage. In the next stage, 17 experts determined the appropriateness and clarity of the proposed factors and placed each of the 280 items in one of the seven dimensions. Based on the criterion of 70% agreement among these experts, 120 items were retained under the seven factors. The responses of (a) 696 athletes from NCAA Divisions I, II, and III on the preferred version, (b) 661 of the 696 athletes on the perception version, and (c) 206 coaches on the self-report version were subjected to factor analysis (unweighted least squares extraction with equamax rotation), which resulted in the emergence of six factors and the retention of 60 items to measure those six dimensions (8 to 12 items in the dimensions). The proposed Group Maintenance Behavior did not emerge as a distinct factor in the 6-factor solution. Noting that the items from this dimension loaded on other factors, Zhang et al. wrote, "In addition, many doubts exist regarding the actual existence of such a factor" (p. 113). It is not clear why they would have included the dimension in the first place if there were doubts about it.

The intercorrelations among the subscales were all less than .30. The internal consistency estimates were higher than .80 in all dimensions in all three versions except Autocratic Behavior, where it was .59 for the preference version, .48 for the perception version, and .35 for the coaches' self-report version. It is noteworthy that the dimension of Autocratic Behavior with added items in the Revised Leadership Scale for Sports (RLSS) continued to emerge from factor analyses of three different data sets, yet the internal consistency estimates remained as low as in other, earlier studies despite having more items. However, Jambor and Zhang (1997) subsequently reported that the alpha values were .84 for Training and Instruction; .66 for Democratic Behavior; .70 for Autocratic Behavior; .52 for Social Support; .78 for Feedback; and .69 for Situational Consideration.

As these authors proposed a 7-dimensional scheme of leader behaviors and had generated items to measure each dimension, it would have been most appropriate to have conducted confirmatory factor analyses instead of exploratory analyses. Further, it is unfortunate that Zhang et al. (1997) did not compare the RLSS to the original LSS, nor has there been any other investigation of the relationships between the two versions. Given that five of the six factors in the revised RLSS are same as the five dimensions of the LSS definitionally, the internal consistency estimates have not improved to any extent, and the substance of the emergent sixth factor in the RLSS could be subsumed by the five dimensions of the LSS, we have to await future studies employing both scales to demonstrate that the RLSS is superior. In the absence of such evidence, parsimony would dictate continued use of the shorter, 40-item, 5-dimensional LSS.

Horn's (2002) Model of Coaching Effectiveness

The foregoing advances relate to the measurement of the variables of the two dominant leadership models in sport. Taking a different approach and in an attempt to bridge the literature on the mediational model and the multidimensional model, Horn (2002) has advanced her coaching effectiveness model, shown in Figure 5.3. While it appears to be more complex than either of the previous models, Horn summarizes the salient points of her model: (a) Identifiable antecedents, shown in Boxes 1 to 3, influence a coach's behaviors (Box 5) as mediated by that coach's expectancies, values, beliefs, and goals (Box 4); (b) a coach's behaviors affect athletes' performance and behavior directly (Boxes 5 and 6), as well as indirectly through athletes' perceptions, interpretation, and evaluation of coach's behaviors (Box 8), which influence athletes' self-perceptions, beliefs, and attitudes (Box 9), which, in turn, influence athletes' level and type of motivation (Box 10). Horn claims that she has drawn the constructs of the model and the linkages among them from several theories, including achievement goal theories, attribution theory, competence motivation theory, the expectancy-value model, self-determination theory, self-efficacy theory, and the sport commitment model.

The sociocultural context and organizational climate in Horn's (2002) model may be subsumed under the situational characteristics in Chelladurai's multidimensional model, and coach's personal characteristics and coach's expectancies, values, and beliefs are tantamount to leader characteristics in the multidimensional model. Similarly, athletes' personal characteristics, athletes' level and type of motivation, and athletes' self-perceptions, beliefs, and attitudes are implicitly included in members' characteristics in the multidimensional model. Horn has adapted the mediational processes of Smoll and Smith's (1989) model

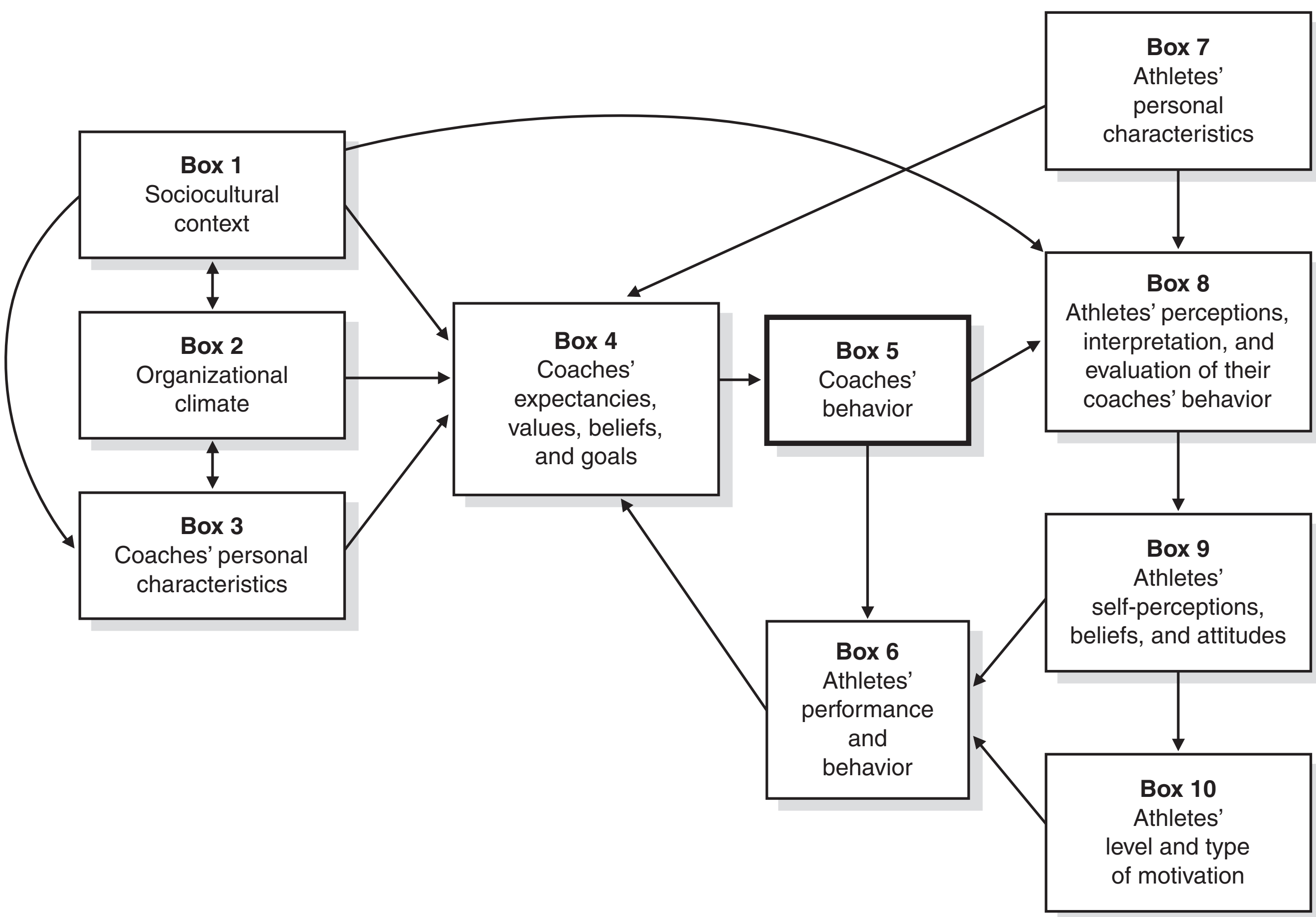


Figure 5.3 The coaching effectiveness model.

and articulates them as sequential outcomes of leader behaviors that influence athletes' performance and behavior. The efficacy and utility of Horn's coach effectiveness model have yet to be verified through empirical research.

LEADERSHIP IN YOUTH AND ADULT SPORTS

Although the multidimensional model of leadership and the mediational model of leadership are similar in many respects and dissimilar in others, a more fundamental difference between the two models is purported to be in their applicability to youth and adult sports. There is a general belief that the multidimensional model is applicable to adult sports, and the mediational model is applicable to youth sport. This belief is substantiated by the fact that most of the research on the multidimensional model was carried out with adult samples, whereas only youth samples were used in the research on the mediational model. Further, the writings by R. E. Smith, Smoll, and their associates implicitly suggest that their model is more suited to youth sports. Other scholars on leadership in sports have confirmed this view (e.g., Duda, 1994, 1996).

The problem here is the confounding of (a) the conceptual frameworks (i.e., the two models in question), (b) the measurement systems (i.e., the LSS and the CBAS), and (c) the populations in which the frameworks were developed and tested. Although it is useful to compare and contrast these three aspects of the two models, it is counterproductive to lump them together in suggesting that one aspect necessarily implies the other two. For instance, there is nothing in the multidimensional and mediational models to suggest that they are restricted to either adult sports or youth sports. Similarly, the models themselves do not proscribe the use of any measure of leadership. For instance, the CBAS can be used in conjunction with the multidimensional model and the LSS can be used in testing the mediational model.

Irrespective of this argument over the contexts in which the two measures (CBAS and LSS) are relevant, neither measurement scheme considers a critical distinction between sport as pursuit of pleasure and athletics as pursuit of excellence (Chelladurai, 1998, 2005a). That is, the behavioral dimensions measured and/or observed do not encompass the qualitatively different and conceptually distinct dimensions of leader behavior that may be most relevant to pursuit of excellence. In this section, I outline the critical differences in purposes and processes of these two enterprises and then identify some of the leadership behaviors relevant to the pursuit of excellence.

Purposes of Sport Participation

Keating (1964) distinguished between athletics and sport. The term *sport* is derived from the French word *desporter,* meaning a diversionary activity to carry away from work, and whose purpose is maximizing pleasure for all participants. The term appeared in old French during the thirteenth century, and it meant any means to spend time pleasantly, such as conversation, recreation, bantering, and games (J. Camy, personal communication, December 4, 2005). Later, the term was modified in England to *disporten* and subsequently to *disport,* to refer to "frolicsome diversion" ("Disport," 2005) in physical activities "that involve a degree of physical strength or skill" ("Sports," 2005a). Sport is characterized by *spontaneity* (i.e., it does not need any preparation or training), *moderation* (i.e., it is not practiced in excess), and *generosity* (i.e., being generous to other participants, particularly one's opponents). Such participation is a *cooperative effort to maximize the pleasure for all participants.* The term *athletics,* on the other hand, is derived from the Greek words *athlos* (a contest), *athlon* (a prize), and *athlein* (to contend for a prize). It is a *competitive* and *agonistic* activity to establish the superiority of one over others in seeking the coveted prize. It is characterized by a very high degree of devotion and commitment to the pursuit, extraordinary efforts over a prolonged period of training, and considerable personal sacrifice.

Given the fundamental differences in their purposes and processes, participants need to display different attitudes and behaviors in the two enterprises. For instance, the cliché "It's not whether you win or lose but how you play the game" is applicable to and meaningful in pursuit of pleasure but irrelevant to and irrational in pursuit of excellence (Keating, 1964). Moreover, the athlete (e.g., the prize-fighter) would lose sight of his or her purpose and insult opponents if he or she displays generosity and magnanimity, which is essential to the pursuit of pleasure (i.e., sport). Keating (1964, p. 28) summarized the distinction between sport and athletics as follows:

> In essence, sport is a kind of diversion which has for its direct and immediate end fun, pleasure, and delight and which is dominated by a spirit of moderation and generosity. Athletics, on the other hand, is essentially a competitive activity, which has for its end victory in the contest and which is characterized by a spirit of dedication, sacrifice, and intensity.

As the term *athletics* refers to one form of physical activity in the international context (e.g., track and field), I have been using in my writings Keating's other labels—*pursuit of pleasure* and *pursuit of excellence*—to refer to these contrasting enterprises.

It must be noted that whereas *to excel* is to surpass others (Keating, 1964; Sternberg, 1993), the others in question are one's peers. An outstanding athlete in the junior ranks who surpasses his or her peers may not be outstanding when compared to senior athletes. Similarly, an excellent female javelin thrower would not be considered excellent when compared to male throwers. Thus, excellence is defined as performance at the highest levels within each comparative group of participants, and it is established through victories in organized competitions.

It must also be noted that excellence denotes an attained status, whereas *pursuit of excellence* refers to a process whereby one attempts to attain excellence, which is the focus of this section. Such pursuit of excellence may go through three stages: *initiation, development,* and *perfection* (B. S. Bloom, 1985). In the initiation phase, the performer is joyful, playful, and excited. Correspondingly, the mentor/coach is kind, cheerful, and caring. In the developmental stage, the performer is hooked and committed to the endeavor, and the mentor/coach is strong and demanding. Finally, in the perfection stage, the performer is obsessed and responsible, and the mentor/coach demands even more from the performer in terms of commitment and effort and becomes emotionally bonded with the performer.

Common Processes in Distinct Purposes

The clear distinction between these two purposes of sport participation becomes blurred because of two processes that are common to both: *skill acquisition* and *competition* (Chelladurai, 1998). Pursuit of skill is fundamental to the pursuit of both pleasure and excellence. In pursuit of pleasure, such pleasure is maximized to the extent the participants are skilled in that activity. We must also note that the pleasure in sport is maximized when both contestants are *equally* skilled. It is obvious that developing and mastering the skills is also fundamental to pursuit of excellence. The critical function of enhanced skills in pursuit of excellence is to ensure a victory in a contest, that is, demonstration of excellence. In other words, establishing *inequality* in skills is a legitimate and dominant way to demonstrate excellence.

Competition is also an essential component of both pursuit of pleasure and pursuit of excellence. However, in sport as pursuit of pleasure, the *process of winning* (trying hard to win a point) is the ingredient that contributes to pleasure. It is immaterial if, in fact, one wins that point or not. Such pleasure is maximized when both contestants engage with equal intensity in the process of winning. In pursuit of excellence, however, the outcome of the competition is critical. That is, one can establish excellence only by defeating the opponents in the contest. It will not matter if the opponents are of lesser caliber. What matters is the victory in the contest. Although skill acquisition and competition facilitate the goals in both pursuit of pleasure and pursuit of excellence, the conceptual and functional distinction between the two should not be overlooked.

This distinction between pursuit of pleasure and pursuit of excellence is not fully captured by other dichotomies that we use, such as youth sports versus adult sports, mass versus elite sport, or competitive versus recreational (noncompetitive) sport. In the first case, the distinction rests on the age of the participants. In the second case, the distinction refers to the obtained status (i.e., elite athletes are those few who have attained a very high level of proficiency) and/or the number of participants (i.e., mass sport involves a large number of participants). In the third case, the relative emphasis placed on competition is the distinguishing characteristic. Thus, the distinction between pursuit of pleasure and pursuit of excellence is even more critical because it highlights the different purposes and processes of the two enterprises without reference to age, attained status, or the competitive element.

Sport Expertise

Recent literature (e.g., Ericsson, Krampe, & Tesch-Römer, 1993) employs terms such as "sport expertise," "expert performance," and "elite performance" to refer to excellence in sport. (See Chapters 9 to 14 in Part III on Sport Expertise.) The study of expertise in sport had taken great strides in the past 2 decades (e.g., Baker, Côté, & Deakin, 2005; B. S. Bloom, 1985; Côté, 1999; Côté, Baker, & Abernethy, 2003; Durand-Bush & Salmela, 2002; Gould, Dieffenbach, & Moffett, 2002; Holt & Dunn, 2004; Salmela & Moraes, 2003; Soberlak & Côté, 2003; Vallée & Bloom, 2005; Vernacchia, McGuire, Reardon, & Templin, 2000; Wolfendon & Holt, 2005). The recent publication of *Expert Performance in Sports: Advances in Research on Sport Expertise* (Starkes & Ericsson, 2003) is a testament to these efforts. That this handbook includes six chapters on sport expertise is a further indication of the growing prominence of the study of sport expertise.

In general, research on the topic has focused on (a) the process of gaining expertise/excellence, (b) the person seeking expertise, and (c) the role of the family and/or coach. As for the process of gaining expertise, Ericsson (2003) and Ericsson et al. (1993) echo Keating's (1964) view that athletics is characterized by dedication, sacrifice, and intensity, emphasizing that the route to expertise is through deliberate practice. They claim that meticulously planned deliberate practice over a lengthy period of time is both *necessary* and *sufficient* to become an expert. Although the sufficiency hypothesis is questioned (e.g., Abernethy, Farrow, & Berry, 2003; Baker et al., 2005), there is consensus that deliberate practice is necessary. As Deakin and Cobley (2003, p. 116) paraphrased:

> Practice activities were considered to be deliberate practice if they were structured to improve current performance, if they were highly relevant to the particular domain, if they were substantial enough to require concerted effort to complete, and if they were not inherently enjoyable.

As for the time taken for deliberate practices, Lavallee, Kremer, Moran, and Williams (2004) reported that on an average, karate experts spent 26.2 hours per week in training, figure skaters spent 28 hours per week in training, and wrestlers trained for 24.9 hours per week. Deliberate practice has been studied in the context of specific sports such as figure skating and volleyball (Deakin & Cobley, 2003), elite hockey (Soberlak & Côté, 2003), and ultra endurance events (Baker et al., 2005). Thus, the notion of deliberate practice sets apart pursuit of excellence from pursuit of pleasure.

Another focus of research on expertise is on the person seeking expertise or one with such expertise (e.g., Holt & Dunn, 2004; Janelle & Hillman, 2003). For example, Janelle and Hillman suggest that, to become an expert, a person must excel in no fewer than four dimensions: *physiological, technical, cognitive,* and *emotional.* In addition, an overarching requirement is that the person masters the *psychological skills* of motivational and goal-setting strategies, imagery and mental training, and interpersonal skills.

A third focus has been on the coaches who facilitate the pursuit of excellence/expertise (e.g., G. A. Bloom, Stevens, & Wickwire, 2003; Côté, Salmela, Trudel, Baria, & Russell, 1995; Côté & Sedgwick, 2003; Fahlstrom, 2005; Isberg, 2005; Salmela & Moraes, 2003; Wolfenden & Holt, 2005). Several scholars studying the development of talent and giftedness have noted that the mentor (i.e., the coach, in our context) is quite instrumental in both the identification and development of talent (e.g., B. S. Bloom, 1985; Ericsson, 1996; Heller, Mönks, & Passow, 1993; Hemery, 1986; Salmela & Moraes, 2003). Van Rossum (1995) found that his sample of national-level Dutch athletes identified their coaches along with their parents as the most important persons in their athletic careers. Even more significant, their respective coaches were most instrumental in identifying them as talented individuals. Based on the premise that most contexts of pursuit of excellence in sport are guided and controlled by coaches, and based on the extant literature, I present next a model of the pursuit of excellence and a set of leader behavior categories best suited to facilitate the pursuit of excellence.

Leadership in the Pursuit of Excellence

The model of pursuit of excellence in sport is illustrated in Figure 5.4. In brief, the person with the relevant talent, dispositions, and beliefs engages in deliberate practice to master the skills and gain the strategic and tactical knowledge

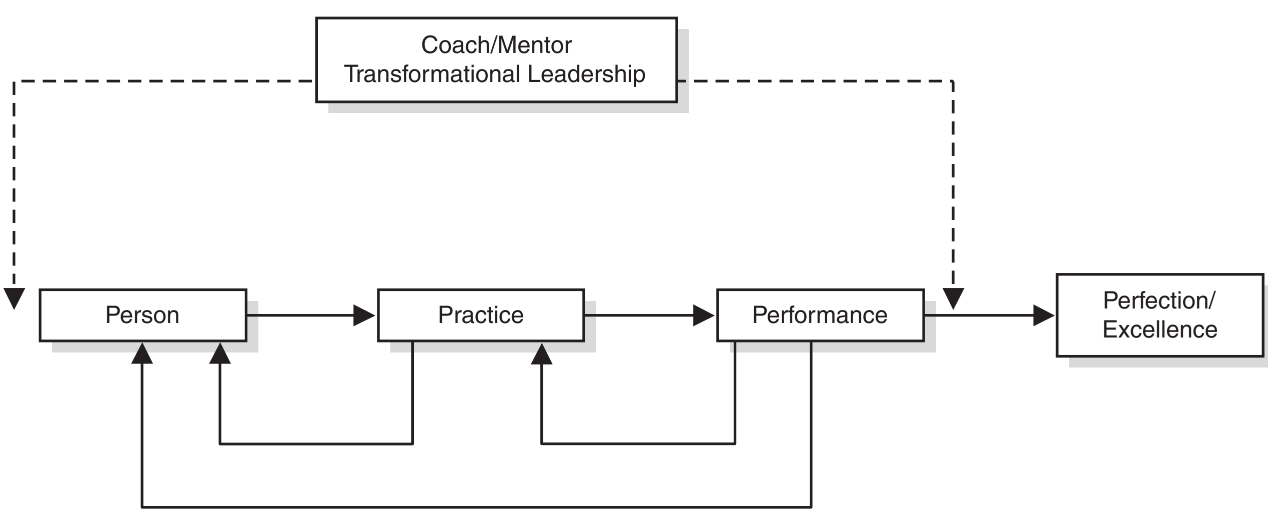


Figure 5.4 A model of pursuit of excellence in sport.

to perform well. The performance successes will, in turn, indicate the level of perfection or excellence achieved. The coach's most intense and deepest involvement in pursuit of excellence is at the practice stage. Through planned, deliberate, and meaningful practice, the coach is able to most effectively shape the person's skills and abilities, attitudes, and beliefs (i.e., person's characteristics) that will facilitate pursuit of excellence. In addition, the coach has a significant role at the performance stage, where he or she helps the athlete concentrate on the task at hand and keep control of thoughts and emotions thereof. Insofar as the stages of deliberate practice and performance are generally guided and monitored by a coach, the salient behaviors of the coach in planning and directing the deliberate practice and managing performance become critical.

By definition, pursuit of excellence is characterized by progressive increases in physical, mental, and emotional capabilities, which, in turn, lead to performance increments. In the process, the person is transformed from an easygoing, playful individual to a dedicated, committed, and hardworking athlete. The leadership influences or behaviors that facilitate this metamorphic process are not fully captured by the existing instruments of leadership in sports. Hence, there has been a call for revising the LSS to include dimensions of transformational leadership (Chelladurai, 1998, 2005a; Chelladurai & Riemer, 1998). There has been only one study dealing with transformational leadership in sports. Charbonneau, Barling, and Kelloway (2001) found that intrinsic motivation mediated the effects of transformational leadership (measured by B. M. Bass & Avolio's, 1995, Multifactor Leadership Questionnaire from organizational psychology) in university sports. Recently, Vallée and Bloom (2005) related their findings of behaviors of expert coaches to aspects of transformational leadership in providing *inspirational motivation, idealized influence,* and *intellectual stimulation.* The following sections describe some of the leader behaviors that are deemed essential to foster and facilitate pursuit of excellence.

Creating a Vision

As the typical novice in the pursuit of excellence is drawn from the general population, his or her vision of performance and excellence and his or her capacities may be somewhat limited due to previous socialization. It becomes the responsibility of the coach to create a new vision for the performer by setting new objectives and instituting new strategies. In addition, the coach needs to convince the performer of the viability of the new vision and express his or her confidence that the performer is capable of fulfilling that vision. It is also important to secure the commitment of the performer to the new vision. In their qualitative study of expert coaches (interviews with five Canadian female coaches), Vallée and Bloom (2005) found that their coaches' creation of vision (i.e., goals and direction) and selling of that vision to the players were fundamental to their building a successful program. Earlier, Desjardins (1996) also noted that expert coaches tend to establish a mission and transform it into a mission statement for the team to bear in mind and endeavor to achieve it.

Inspirational Communication

Pursuit of excellence is a process in which the athlete strives to continuously improve his or her performance, that is, perform beyond previously demonstrated capacity. To B. Bass (1985), this is performance beyond expectations. One critical function of leaders in this regard is to inspire their athletes to extend themselves to achieve excellence. Such leader behavior includes stimulating enthusiasm, building confidence, instilling pride, enhancing morale, setting examples of courage and dedication, and sharing the hardships. These behaviors cumulatively result in what B. Bass calls the "Pygmalion effect," a performance-stimulating effect. That is, those who are led to expect that they will do well will do better!

Intellectual Stimulation

A component of talent development is to engage the intellect even in those activities dominated by psychomotor abilities. That is, the performer should be able to see his or her activity in its totality and understand the scheme of things surrounding the performance. The coach can stimulate the intellect of the athletes by challenging existing assumptions and attitudes, encouraging creativity and innovation, and presenting holistic perspectives. In other words, the coach facilitates the conceptualization, comprehension, and discernment of the problems and contemplation and thought prior to action (B. Bass, 1985).

Individualized and Supportive Leadership

The coach's talent development efforts are facilitated if he or she bestows individualized attention on the athletes. One-on-one interactions and communications make the coach a mentor in the true sense. The coach can fill the role by individualized and personal attention to the athletes and their needs, treating them individually, expressing appreciation, providing corrective feedback, assigning special responsibilities, counseling, and being empathetic, caring, concerned, and supportive. The coach makes frequent contacts with an athlete and communicates informally but generously (B. Bass, 1985; Rafferty & Griffin, 2004).

Personal Recognition

Most athletic performances are public, so the athlete is likely to be recognized for good performances by the family, the fans, and the media. However, the deliberate practice sessions are carried out privately, with specific preplanned goals. The achievement of these practice goals is critical to the pursuit of excellence, and an athlete's persistence in such activities is contingent on such achievements being recognized and rewarded. The coach, as the most significant other (perhaps the only significant other in the context), needs to recognize those small achievements and provide rewards such as praise.

Demanding and Directive Leadership

As noted, deliberate practice in sport can be boring and tiring both mentally and physically. Hence, it is conceivable that some of those in pursuit of excellence will give up on the practice. The coach needs to demand that they persist in the planned training regimen and direct them to carry out the activities (Salmela & Moraes, 2003). The essence of this form of behavior is what is meant when a coach is described as a hard taskmaster or a slave driver.

Promotion of Self-Efficacy and Self-Esteem

Coach behavior should also be focused on cultivating athletes' *self-efficacy,* that is, "judgments about what one can accomplish with those skills" (Feltz & Lirgg, 2001, p. 340). The coach attains this objective by extolling the talents and skills of the performer, expressing confidence in the person's capacity to achieve higher levels of performance, and encouraging the performer to even greater efforts (Feltz & Lirgg, 2001). In the same vein, it is important that *self-esteem* is also enhanced. Self-esteem is centered around a belief in the self, respect for the self, and confidence in the self (B. Bass, 1985).

In our context, an equally important component of self-esteem is *esteem from others.* That is, the respect and admiration others bestow on a performer is equally motivational. Because pursuit of excellence is a comparative process, esteem by others is reflective of one's performance. Hence, it is critical that the performer seeks esteem from others. The coach needs to instill in the performers the desire for esteem from others.

Emphasis on Winning

A necessary ingredient of the pursuit of excellence is winning in competitions against opponents. That is, the way sport is structured and practiced around the world, excellence can be demonstrated only through victories in contests. So it is necessary for the coach to emphasize performance and victories in competitions. The cliché "Winning isn't everything, it is the only thing" is relevant to the pursuit of excellence in sport. Following dictionaries that define *cost* as "time, labor, and money involved in an enterprise" and *means* as "that by which a result is brought about," I would like to distinguish between "winning at all costs" and "winning by any means." Pursuit of excellence is a costly affair in terms of time spent, energy expended, and money, due to immediate outlay of cash and forgone income. Going to a competition or spending a few more hours in practice are additional costs. If such expenditures are likely to ensure winning, this is winning at all costs. On the other hand, winning by any means includes means not inherent in the activity or sanctioned by convention and policy (i.e., winning by foul means). Such activities include doping, cheating on the rules, and willfully injuring an opponent either in competition or outside of it. Obviously, the coach should instill in the athlete the difference between winning at all costs and winning by any means. While encouraging the former, the coach should strongly denounce the latter and ensure that the athlete does not engage in such shady activities.

Cultivating Self-Interest

Those in the pursuit of excellence should be highly selfish to seek the rewards of their efforts for themselves, even when their efforts may deprive another of the rewards. That is, self-interest is fundamental to the pursuit of excellence. But as Locke (Avolio & Locke, 2002) argues, egoism (i.e., self-interest) should be constrained and governed by a moral code defined by rationality and associated virtues. That is, athletes in pursuit of excellence, while seeking the rewards of competition for themselves, should be honest in their efforts (i.e., not doping oneself), respect opponents, and seek justice so that all contestants are treated fairly. It is equally important that athletes recognize excellence in others and respect such excellence.

It is the responsibility of the coach to reinforce this self-interest in the athlete, convince the athlete that self-interest is morally defensible, and show that such self-interest is foundational to the pursuit of excellence. It is equally important to educate athletes about the immorality of any act that violates the essence of the pursuit of excellence (e.g., doping, cheating on the rules). According to Locke (Avolio & Locke, 2002), acting in one's own interest refers to the fact that individuals must be the beneficiary of their own actions subject to virtues of honesty, integrity, independence, productiveness, justice (with regard to other people), and pride (in being a self-made soul). The coach needs to foster this rational self-interest while at the same time cultivating the sense of justice and fairness to all, including competitors.

Fostering Competitiveness

Gill (1993, p. 314) viewed competitiveness as simply an "achievement orientation toward competitive sport, or a sport-specific form of achievement orientation." She identified and measured three dimensions of sport orientation in her Sport Orientation Questionnaire. The first and most dominant dimension is *competitiveness:* "an enjoyment of competition and a desire to enter and strive for success in competitive sport achievement settings" (p. 318). The second dimension is the *win orientation:* "a focus on interpersonal comparison and winning in competition" (p. 318). The third and final dimension is *goal orientation:* "a focus on personal performance standards" (p. 318). It should be recognized that the last two dimensions parallel the concepts of task and ego orientation referred to earlier. The point here is that those who pursue excellence should be high on all three dimensions of sport orientation. Accordingly, a coach has to emphasize the importance of all three competitive orientations in the pursuit of excellence and spur the athlete to be growth-oriented, competitive, and focused on winning.

Instilling Task and Ego Orientation

Individuals also differ in their orientation toward achievement situations. Scholars have suggested that achievement situations elicit either task or ego orientations. Task-oriented individuals believe that concerted and continued effort can gain the necessary ability and competence. They judge their success in the activity by the extent of their learning and improvements they have made. As their conception of success and failure is self-referenced, they enjoy the intrinsic value of learning and mastery of the task. In contrast, ego-oriented individuals judge their success by how well they have done in comparison to others. To them, success is a function of high ability and not effort, and losing after trying hard demonstrates lack of competence.

A major responsibility for the coach is to cultivate and reinforce the task orientation of those who pursue excellence. That is, any individual pursuing excellence should be constantly striving to progressively improve personal performance. However, pursuit of excellence in sport also requires that one performs better than one's peers to demonstrate superiority. So the idea of external referents in performance is as important as the internal or self-based referents. The challenge for the coach is to instill in the athlete a focus on external referents without the associated detrimental and debilitating aspects of ego orientation such as the belief that ability is innate and that effort is a demonstration of ability. In other words, pursuit of excellence in sports requires a simultaneous focus on both internal and external referents on performance.

Task- and Ego-Involving Climates

The literature in this regard also distinguishes between the task-involving climate and the ego-involving climate. Newton, Duda, and Yin (2002) have developed the Perceived Motivational Climate in Sport Questionnaire to measure six dimensions of perceived motivational climate. Three of the dimensions—cooperative learning, important role, and effort/improvement—reflect a task-involving climate. The other three dimensions—punishment for mistakes, unequal recognition, and intrateam member rivalry—reflect the ego-involving climate. Many scholars recommend that creating and maintaining a task-involved climate is beneficial, and the other form of climate is detrimental to member satisfaction, enjoyment, and commitment to participation.

When we juxtapose these two forms of climate with the distinction between pursuit of pleasure and pursuit of excellence, we can see that a greater focus on task-involving climate is germane to pursuit of pleasure and that the ego-involved climate is antithetical to the essential thrust of that enterprise. When we look at pursuit of excellence, however, a task-involved climate is the bedrock of that enterprise. Nevertheless, the ego-involved climate also contributes to the pursuit of excellence. For example, when a coach expresses disappointment over a mistake at a crucial juncture in a competition, it is a punishment (reflecting an ego-involving climate), but it is legitimate and required in the context of the pursuit of excellence.

The issue of unequal recognition may be problematic in pursuit of pleasure, but in the pursuit of excellence, unequal recognition is part of the process. Those who perform better than others are recognized and accorded appropriate status. The distinction between starters and substitutes in basketball is unequal but equitable recognition. The processes of tryouts, team selection, and drafting underscore the excellence achieved by those who are selected. But the same selection process also excludes others who have not achieved the same level of excellence as those who were selected. From this perspective, pursuit of excellence is an exclusionary process, and therefore, the leaders and coaches in pursuit of excellence should not be faulted for not bestowing equal recognition on all.

Intrateam rivalry is also a necessary condition for pursuit of excellence in team sports. That is, the coach should encourage every athlete to be better than others, including teammates. The striving by everyone to be better than teammates with a view to getting on the starting line-up ensures that everyone gets better, so that the whole teams gets better.

There is considerable discussion over the conceptual and measurement issues related to the task and ego orientation as well as task- and ego-involving climates in sport (Harwood & Hardy, 2001; Harwood, Hardy, & Swain, 2000; Treasure et al., 2001). However, there is agreement that the task and ego orientations are orthogonal and represent two different continua and that "an individual can fluctuate from one state of involvement to another depending on his or her perception of the momentary situational cues and dispositional tendencies" (Treasure et al., 2001, p. 321). Harwood et al. (2000) cited competitive sport and recreational sport as situations with different cues calling for different goal orientations. Given that pursuit of excellence consists of both practice and performance stages, it is posited here that task involvement needs to be paramount in the practice stage and ego involvement in the performance stage. This is consistent with Treasure et al.'s view that "one particular focus dominates at any given time" (p. 321).

Training Behavior

Training behavior focuses on developing *technical, cognitive,* and *emotional* skills. It must be noted that the content and the relative significance of these forms of training may vary from sport to sport.

Technical Training. Technical training refers to training in the skills and movement patterns of a given sport (Janelle & Hillman, 2003). It includes the coach's instruction and directives toward increasing athletes' physical and physiological capacities (Janelle & Hillman, 2003). This category of behavior parallels the dimension of training and instruction in the LSS.

Cognitive Training. Cognitive training focuses on tactics and strategies and an understanding of their appropriateness in different circumstances (Janelle & Hillman, 2003). The attention to and interpretation of cues and the decision making thereof are also central to cognitive training.

Emotional Training. Emotions have a significant impact in pursuit of excellence in sport at the practice stage, and more so at the performance stage. It is incumbent on the coach to understand his or her emotions and regulate them to make the coaching process more effective. It is equally, if not more, important that the coach trains the athlete in recognizing and regulating personal emotions. By the same token, the athlete needs to learn to recognize the emotions of the opponent and to manipulate and exploit them to personal advantage.

Facilitating the Flow Experience

As noted, Ericsson et al. (1993) argued that deliberate practice is not intrinsically satisfying. The Greeks associated the term *agonia* with the term *athlos,* meaning that the pursuit of excellence is an agonistic process involving not only the mind but also the body (Keating, 1964). This is reflected in the common slogan "No pain, no gain." Although many subscribe to this perspective, there is a contrasting perspective that experts in sport performance actually enjoy their intense training, particularly those training activities that most relate to actual performance (e.g., Helsen, Hodges, Van Winckel, & Starkes, 2000; Hodges & Starkes, 1996; Starkes, Deakin, Allard, Hodges, & Hayes, 1996). This view is echoed in the concept of *runner's high,* which suggests that runners do enjoy and get a kick out of running.

The recent application of the concept of *flow* in the sporting context sheds some light on the experience of joy in agonistic practice. Flow is a "very positive state that typically occurs when a person perceives a balance between the challenges associated with a situation and her capabilities to accomplish or meet these demands" (Kimiecik & Jackson, 2002, p. 505). And "flow, as an optimal state, represent those moments when everything comes together for the performer; it is often associated with high levels of performance and a very positive experience" (Jackson & Eklund, 2002, p. 133). The most significant aspect of the flow experience is the felt balance between the challenge faced by the athlete and his or her skills. The coach can design the training sessions and the competitions in such a way that the challenge of the task increases progressively with the skills mastered by the athlete. That is, the coach can match the athlete's skills with the difficulty of the tasks assigned. This process over weeks, months, and years would culminate in the highest challenges being matched with requisite mastery of skills.

Summary

The foregoing categories of leader behaviors in the pursuit of excellence are aimed at transforming both the person in terms of personal attributes (e.g., ability, self-efficacy, self-interest, and competitiveness) and the situation in terms of vision and goals. These transformational effects of leader behavior are not fully captured in Chelladurai's original multidimensional model of leadership. Recently, Chelladurai (2001, 2005b, 2006) has modified the multidimensional model to include the effects of transformational leadership on situational and member characteristics for application in organizational settings where there are hierarchical levels of administrators. As shown in Figure 5.2b, the transformational leader influences the situation and the members as well as the subordinate leaders. This scheme would apply to sport teams such as baseball and football, where there are subordinate coaches to supervise specialized tasks (e.g., pitching in baseball and special teams in football). If there is only one leader involved, the transformational effects of the leader are indicated by the block arrows from Box 2 to Box 1 (situational characteristics) and Box 3 (member characteristics).

CONCLUSION

I have outlined two significant thrusts that have been undertaken in the study of leadership: Smoll and Smith's (1989) mediational model of leadership and Chelladurai's (1978, 1990, 1993) multidimensional model of leadership. In addition, I have discussed the measurement schemes associated with each of these models (i.e., the CBAS and the LSS), and the improvements thereof. Departing from these traditional approaches, I have drawn attention to Keating's (1964) distinction between sport as pursuit of pleasure and sport as pursuit of excellence. Having noted that these two pursuits are distinctly different enterprises, I have identified a set of leadership behaviors that are most relevant to pursuit of excellence. Some of these categories are drawn from the literature in organizational behavior and organizational psychology; others are derived from the literature in sport psychology. It will be easily recognized that some of the listed behaviors are antithetical to the pursuit of pleasure. This list of categories of leader behavior is neither exhaustive nor nonoverlapping, but it does point to the need for researchers and practitioners to be clear about the purposes of the two enterprises and resist imposing a set of processes appropriate to one enterprise on the other.

As noted earlier, many scholars have studied the acquisition and maintenance of expertise from interviews of coaches and players and through other forms of qualitative research. The present conceptual exercise is partly based on that literature. It is time to build on that tradition by consolidating the findings and developing refined models of the pursuit of excellence that can be subjected to empirical verification and confirmation. This step needs to be followed with the development of sound measures of the variables of the new models.

REFERENCES

Abernethy, B., Farrow, D., & Berry, J. (2003). Constraints and issues in the development of a general theory of expert perceptual-motor performance. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 348–369). Champaign, IL: Human Kinetics.

Amorose, A. J. (in press). Coaching effectiveness: Exploring the relationship between coaching behavior and motivation from a self-determination theory perspective. In M. Hagger & N. Chatzisarantis (Eds.), *Self-determination theory in exercise and sport.* Champaign, IL: Human Kinetics.

Amorose, A. J., & Horn, T. S. (2000). Intrinsic motivation: Relationships with collegiate athletes' gender, scholarship status, and perceptions of their coaches' behavior. *Journal of Sport and Exercise Psychology, 22,* 63–84.

Avolio, B. J., & Locke, E. A. (2002). Theoretical letters: Contrasting different philosophies of leader motivation: Altruism versus egoism. *Leadership Quarterly, 13,* 169–191.

Baker, J., Côté, J., & Deakin, J. (2005). Expertise in ultra-endurance triathletes: Early sport involvement, training structures, and the theory of deliberate practice. *Journal of Applied Sport Psychology, 17,* 64–78.

Barnett, N. P., Smoll, F. L., & Smith, R. E. (1992). Effects of enhancing coach-athlete relationships on youth sport attrition. *Sport Psychologist, 6,* 111–127.

Bass, B. (1985). *Leadership and performance beyond expectations.* New York: Free Press.

Bass, B. M., & Avolio, B. J. (1995). *Multifactor Leadership Questionnaire manual.* Palo Alto, CA: Mindgarden.

Bloom, B. S. (Ed.). (1985). *Developing talent in young people.* New York: Ballantine Books.

Bloom, G. A., Stevens, D. E., & Wickwire, T. L. (2003). Expert coaches' perceptions of team building. *Journal of Applied Sport Psychology, 15,* 129–143.

Bollen, K. A. (1989). *Structural equations with latent variables.* New York: Wiley.

Charbonneau, D., Barling, J., & Kelloway, E. K. (2001). Transformational leadership and sports performance: The mediating role of intrinsic motivation. *Journal of Applied Social Psychology, 31*(7), 1521–1534.

Chaumeton, N. R., & Duda, J. L. (1988). Is it how you play the game or whether you win or lose? The effect of competitive level and situation on coaching behaviors. *Journal of Sport Behavior, 11*(3), 157–174.

Chelladurai, P. (1978). *A contingency model of leadership in athletics.* Unpublished doctoral dissertation, University of Waterloo, Department of Management Sciences, Ontario, Canada.

Chelladurai, P. (1984). Discrepancy between preferences and perceptions of leadership behavior and satisfaction of athletes in varying sports. *Journal of Sport Psychology, 6*(1), 27–41.

Chelladurai, P. (1989). *Manual for the Leadership Scale for Sports.* Unpublished manuscript, University of Western Ontario, London, Canada.

Chelladurai, P. (1990). Leadership in sports: A review. *International Journal of Sport Psychology, 21*(4), 328–354.

Chelladurai, P. (1993). Leadership. In R. N. Singer, M. Murphey, & L. K. Tennant (Eds.), *Handbook of research on sport psychology* (pp. 647–671). New York: Macmillan.

Chelladurai, P. (1998, July). *Purpose of participation, task interdependence, and dimensions of leader behavior in sports.* Paper presented at the 2nd International Meeting on Psychology Applied to Sport and Exercise, University of Minho, Braga, Portugal.

Chelladurai, P. (2001). *Managing organizations for sport and physical activity: A systems perspective.* Scottsdale, AZ: Holcomb Hathaway.

Chelladurai, P. (2005a, March). *Leadership in the pursuit of excellence in sports.* Paper presented at the 9th annual Eastern Canada Sport and Exercise Psychology Symposium, University of Windsor, Ontario, Canada.

Chelladurai, P. (2005b). *Managing organizations for sport and physical activity: A systems perspective* (2nd ed.). Scottsdale, AZ: Holcomb Hathaway.

Chelladurai, P. (2006). *Management of human resources in sport and recreation* (2nd ed.). Champaign, IL: Human Kinetics.

Chelladurai, P., & Carron, A. V. (1978). *Leadership* (Sociology of Sport Monograph Series). Ottawa, Ontario, Canada: CAHPER.

Chelladurai, P., Imamura, H., Yamaguchi, Y., Oinuma, Y., & Miyauchi, T. (1988). Sport leadership in a cross-national setting: The case of Japanese and Canadian university athletes. *Journal of Sport and Exercise Psychology, 10,* 374–389.

Chelladurai, P., & Riemer, H. (1997). A classification of facets of athlete satisfaction. *Journal of Sport Management, 11,* 133–159.

Chelladurai, P., & Riemer, H. (1998). Measurement of leadership in sports. In J. L. Duda (Ed.), *Advances in sport and exercise psychology measurement* (pp. 227–253). Morgantown, WV: Fitness Information Technology.

Chelladurai, P., & Saleh, S. D. (1980). Dimensions of leader behavior in sports: Development of a leadership scale. *Journal of Sport Psychology, 2,* 34–45.

Côté, J. (1999). The influence of the family in the development of talent in sport. *Sport Psychologist, 13,* 395–417.

Côté, J., Baker, J., & Abernethy, B. (2003). From play to practice: A developmental framework for the acquisition of expertise in team sports. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 89–110). Champaign, IL: Human Kinetics.

Côté, J., Salmela, J., Trudel, P., Baria, A., & Russell, S. (1995). The coaching model: A grounded assessment of expert gymnastic coaches' knowledge. *Journal of Sport and Exercise Psychology, 17*(1), 1–17.

Côté, J., & Sedgwick, W. A. (2003, Winter). Effective behaviors of expert rowing coaches: A qualitative investigation of Canadian athletes and coaches. *International Sports Journal,* 62–76.

Courneya, K. S., & Chelladurai, P. (1991). A model of performance measures in baseball. *Journal of Sport Psychology, 13,* 16–25.

Cumming, S. P., Smith, R. E., & Smoll, F. L. (2006). Athlete-perceived coaching behaviors: Relating two measurement traditions. *Journal of Sport and Exercise Psychology, 28,* 205–213.

Deakin, J. M., & Cobley, S. (2003). A search for deliberate practice: An examination of the practice environments in figure skating and volleyball. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 114–135). Champaign, IL: Human Kinetics.

Desjardins, G., Jr. (1996). The mission. In J. H. Salmela (Ed.), *Great job coach! Getting the edge from proven winners* (pp. 69–100). Ottawa, Ontario, Canada: Potentium.

Disport. (2005). *The free dictionary.* Retrieved December 14, 2005, from http://www.thefreedictionary.com/disport.

Duda, J. L. (1994). A goal perspective theory of meaning and motivation in sports. In S. Serpa (Ed.), *International perspectives on sport and exercise psychology* (pp. 127–148). Indianapolis, IN: Benchmark Press.

Duda, J. L. (1996). Maximizing motivation in sport and physical education among children and adolescents: The case of greater task involvement. *Quest, 48,* 290–302.

Durand-Bush, N., & Salmela, J. H. (2002). The development and maintenance of expert athletic performance: Perceptions of world and Olympic champions. *Journal of Applied Sport Psychology, 14,* 154–171.

Ericsson, K. A. (Ed.). (1996). *The road to excellence: The acquisition of expert performance in the arts, sciences, sports, and games.* Mahwah, NJ: Erlbaum.

Ericsson, K. A. (2003). Development of elite performance and deliberate practice. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 49–83). Champaign, IL: Human Kinetics.

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review, 103,* 363–406.

Fahlstrom, P. G. (2005, June). *Leadership style: Required, preferred and actual leadership behavior in sports.* Presented at the 20th Conference of the North American Society for Sport Management, Regina, Saskatchewan, Canada.

Feltz, D. L., & Lirgg, C. D. (2001). Self-efficacy beliefs of athletes, teams, and coaches. In R. N. Singer, H. A. Hausenblas, & C. M. Janelle (Eds.), *Handbook of sport psychology* (pp. 340–361). New York: Wiley.

Gardner, D. E., Shields, D. L., Bredemeier, B. J., & Bostrom, A. (1996). The relationship between perceived coaching behaviors and team cohesion among baseball and softball players. *Sport Psychologist, 10,* 367–381.

Gill, D. L. (1993). Competitiveness and competitive orientation in sport. In R. N. Singer, M. Murphy, & K. Tennant (Eds.), *The handbook on research in sport psychology* (pp. 314–327). New York: Macmillan.

Gould, D., Dieffenbach, K., & Moffett, A. (2002). Psychological characteristics and their development in Olympic champions. *Journal of Applied Sport Psychology, 14,* 172–204.

Harwood, C., & Hardy, L. (2001). Persistence and effort in moving achievement goal research forward: A response to Treasure and colleagues. *Journal of Sport and Exercise Psychology, 23,* 330–345.

Harwood, C., Hardy, L., & Swain, A. (2000). Achievement goals in sport: A critique of conceptual and measurement issues. *Journal of Sport and Exercise Psychology, 22,* 235–255.

Heller, K. A., Mönks, F. J., & Passow, H. A. (Eds.). (1993). *International handbook of research and development of giftedness and talent.* Oxford: Pergamon Press.

Helsen, W. F., Hodges, N. J., Van Winckel, J., & Starkes, J. L. (2002). The roles of talent, physical precocity and practice in the development of football expertise. *Journal of Sport Sciences, 18,* 75–90.

Hemery, D. (1986). *The pursuit of sporting excellence: A study of sport's highest achievers.* London: Willow Books.

Hodges, N. J., & Starkes, J. L. (1996). Wrestling with the nature of expertise: A sport specific test of Ericsson, Krampe, and Tesch-Römer's theory of "deliberate practice." *International Journal of Sport Psychology, 27,* 400–424.

Hollembeak, J., & Amorose, A. J. (2005). Perceived coaching behaviors and college athletes' intrinsic motivation: A test of self-determination theory. *Journal of Applied Sport Psychology, 17,* 20–36.

Holt, N. L., & Dunn, J. G. H. (2004). Toward a grounded theory of the psychosocial competencies and environmental conditions associated with soccer success. *Journal of Applied Sport Psychology, 16,* 199–219.

Horn, T. S. (1985). Coaches' feedback and changes in children's perceptions of their physical competence. *Journal of Educational Psychology, 77,* 174–186.

Horn, T. S. (2002). Coaching effectiveness in the sport domain. In T. S. Horn (Ed.), *Advances in sport psychology* (2nd ed., pp. 319–354). Champaign, IL: Human Kinetics.

Horne, T., & Carron, A. V. (1985). Compatibility in coach-athlete relationships. *Journal of Sport Psychology, 7,* 137–149.

Iordanoglou, D. (1990). *Perceived leadership in Greek soccer: A preliminary investigation.* Unpublished paper, University of Manchester, Department of Education, Manchester, England.

Isberg, L. (2005, August). *Coaching in team sports: Super coach in National Hockey League.* Paper presented at the ISSP 11th World Congress of Sport Psychology, Sydney, Australia.

Isberg, L., & Chelladurai, P. (1990). *The Leadership Scale for Sports: Its applicability to the Swedish context.* Unpublished manuscript, University College of Falun/Borlänge, Sweden.

Jackson, S. A., & Eklund, R. C. (2002). Assessing flow in physical activity: The Flow State Scale-2 and Dispositional Flow Scale-2. *Journal of Sport and Exercise Psychology, 24,* 133–150.

Jambor, E. A., & Zhang, J. J. (1997). Investigating leadership, gender, and coaching level using the Revised Leadership for Sport Scale. *Journal of Sport Behavior, 20*(3), 313–321.

Janelle, C. M., & Hillman, C. H. (2003). Expert performance in sport. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 19–47). Champaign, IL: Human Kinetics.

Johns, G. (1981). Difference score measures of organizational behavior variables: A critique. *Organizational Behavior and Human Performance,* 27, 443–463.

Keating, J. W. (1964). Sportsmanship as a moral category. *Ethics, 75,* 25–35.

Kenow, L., & Williams, J. M. (1992). Relationship between anxiety, self-confidence, and the evaluation of coaching behaviors. *Sport Psychologist, 6,* 344–357.

Kenow, L., & Williams, J. M. (1997). *Factor structure of the Coaching Behavior Questionnaire and its relationship to anxiety and self-confidence.* Unpublished manuscript, University of Arizona, Tuscon.

Kim, B.-H., Lee, H.-K., & Lee, J.-Y. (1990). *A study on the coaches' leadership behavior in sports.* Unpublished manuscript, Korea Sport Science Institute, Seoul.

Kimiecik, J. C., & Jackson, S. A. (2002). Optimal experience in sport: A flow perspective. In T. S. Horn (Ed.), *Advances in sport psychology* (2nd ed., pp. 501–527). Champaign, IL: Human Kinetics.

Lacoste, P. L., & Laurencelle, L. (1989). *The French validation of the Leadership Scale for Sports.* Unpublished abstract, Université du Québec, Trois-Rivières, Canada.

Lavallee, D., Kremer, J., Moran, A. P., & Williams, M. (2004). *Sport psychology: Contemporary themes.* New York: Palgrave Macmillan.

Newton, M., Duda, J. L., & Yin, Z. (2000). Examination of the psychometric properties of the Perceived Motivational Climate in Sport Questionnaire-2 in a sample of female athletes. *Journal of Sport Sciences, 18,* 275–290.

Price, M. S., & Weiss, M. R. (2000). Relationships among coach burnout, coach behaviors, and athletes' psychological responses. *Sport Psychologist, 14,* 391–409.

Rafferty, A. E., & Griffin, M. A. (2004). Dimensions of transformational leadership: Conceptual and empirical extensions. *Leadership Quarterly, 15,* 329–354.

Riemer, H., & Chelladurai, P. (1995). Leadership and satisfaction in sport. *Journal of Sport and Exercise Psychology, 17*(3), 276–293.

Riemer, H. A., & Chelladurai, P. (1998). Development of the Athlete Satisfaction Questionnaire (ASQ). *Journal of Sport and Exercise Psychology, 20,* 127–156.

Riemer, H. A., & Toon, K. (2001). Leadership and satisfaction in tennis: Examination of congruence, gender, and ability. *Research Quarterly for Exercise and Sport, 72,* 243–256.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55,* 68–78.

Salmela, J. H., & Moraes, L. C. (2003). Development of expertise: The role of coaching, families, and cultural contexts. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 275–293). Champaign, IL: Human Kinetics.

Serpa, S., Lacoste, P., Pataco, V., & Santos, F. (1988). *Methodology of translation and adaptation of a specific sport test: A Leadership Scale for Sports.* Paper presented at the 2nd National Symposium on Psychology Research, Lisbon, Portugal.

Shields, D. L. L., Gardner, D. E., Bredemeier, B. J. L., & Bostro, A. (1997). The relationship between leadership behaviors and group cohesion in team sports. *Journal of Psychology, 13*(2), 196–210.

Smith, L. S., Fry, M. D., Ethington, C. A., & Li, Y. (2005). The effect of female athlete's perceptions of their coaches' behaviors on their perceptions of the motivational climate. *Journal of Applied Sport Psychology, 17,* 170–177.

Smith, R. E., & Smoll, F. L. (1990). Self-esteem and children's reactions to youth sport coaching behaviors: A field study of self-enhancement processes. *Developmental Psychology, 26*(6), 987–993.

Smith, R. E., & Smoll, F. L. (1997). Coaching the coaches: Youth sports as a scientific and applied behavioral setting. *Current Directions in Psychological Science, 6*(1), 16–21.

Smith, R. E., Smoll, F. L., & Barnett, N. C. (1995). Reduction of children's sport performance anxiety through social support and stress reduction training for coaches. *Journal of Applied Developmental Psychology, 16,* 125–142.

Smith, R. E., Smoll, F. L., & Christensen, D. L. (1996). Behavioral assessment and interventions in youth sports. *Behavior Modification, 20*(1), 3–44.

Smith, R. E., Smoll, F. L., & Curtis, B. (1978). Coaching behaviors in Little League Baseball. In F. L. Smoll & R. E. Smith (Eds.), *Psychological perspectives on youth sports* (pp. 173–201). Washington, DC: Hemisphere.

Smith, R. E., Smoll, F. L., & Curtis, B. (1979). Coaching behaviors in Little League baseball. In F. L. Smoll & R. E. Smith (Eds.), *Psychological perspectives in on youth sports* (pp. 173–201). Washington, DC: Hemisphere.

Smith, R. E., Smoll, F. L., & Hunt, E. B. (1977). A system for the behavioral assessment of athletic coaches. *Research Quarterly, 48,* 401–407.

Smith, R. E., Smoll, F. L., Hunt, E. B., Clarke, S. J. (1976). *CBAS audio visual training module* (Video). Seattle: University of Washington.

Smith, R. E., Zane, N. W. S., Smoll, F. L., & Coppel, D. B. (1983). Behavioral assessment in youth sports: Coaching behaviors and children's attitudes. *Medicine and Science in Sport and Exercise, 15,* 208–214.

Smoll, F. L., & Smith, R. E. (1989). Leadership behaviors in sport: A theoretical model and research paradigm. *Journal of Applied Social Psychology, 19,* 1522–1551.

Smoll, F. L., Smith, R. E., Barnett, N. P., & Everett, J. J. (1993). Enhancement of children's self-esteem through social support training for youth sport coaches. *Journal of Applied Psychology, 78*(4), 602–610.

Smoll, F. L., Smith, R. E., Curtis, B., & Hunt, E. (1978). Toward a mediational model of coach-player relationships. *Research Quarterly, 49,* 528–541.

Soberlak, P., & Côté, J. (2003). The developmental activities of elite ice hockey players. *Journal of Applied Sport Psychology, 15,* 41–49.

Sports. (2005). In *Encyclopedia Britannica.* Retrieved December 14, 2005, from http://www.britannica.com/eb/article-9108486.

Starkes, J. L., Deakin, J. M., Allard, F., Hodges, N. J., & Hayes, A. (1996). Deliberate practice in sports: What is it anyway? In K. A. Ericsson (Ed.), *The road to excellence: The acquisition of expert performance in the arts and sciences, sports, and games* (pp. 81–106). Mahwah, NJ: Erlbaum.

Sternberg, R. J. (1993). Procedures for identifying intellectual potential in the gifted: A perspective on alternative "metaphors of mind." In K. A. Heller, F. J. Monks, & A. H. Passow (Eds.), *International handbook of research and development of giftedness and talent* (pp. 185–208). Oxford: Pergamon Press.

Sullivan, P. J., & Kent, A. (2003). The relationship between coaching efficacy and leadership style among University coaches. *Journal of Applied Sport Psychology, 15*(1), 1–11.

Trail, G. T. (2004). Leadership, cohesion, and outcomes in scholastic sports. *International Journal of Sport Management, 5*(2), 111–132.

Treasure, D. C., Duda, J. L., Hall, H. K., Roberts, G. C., Ames, C., & Maehr, M. L. (2001). Clarifying misconceptions and misrepresentations in achievement goal research in sport: A response to Harwood, Hardy, and Swain. *Journal of Sport and Exercise Psychology, 23,* 317–329.

Vallée, C. N., & Bloom, G. A. (2005). Building a successful university program: Key and common elements of expert coaches. *Journal of Applied Sport Psychology, 17*(3), 179–196.

Van Rossum, J. A. (1995). Talent in sport: Significant others in the career of top-level Dutch athletes. In M. W. Katzko & F. J. Monks (Eds.), *Nurturing talent: Individual needs and social ability* (pp. 43–57). Assen, The Netherlands: Van Gorcum.

Vernacchia, R. A., McGuire, R. T., Reardon, J. P., & Templin, D. P. (2000). Psychosocial characteristics of Olympic track and field athletes. *International Journal of Sport Psychology, 31,* 5–23.

Williams, J. M., Jerome, G. J., Kenow, L. J., Rogers, T., Sartain, T. A., & Darland, G. (2003). Factor structure of the Coaching Behavior Questionnaire and its relationship to athlete variables. *Sport Psychologist, 17*(1), 16–34.

Wolfenden, L. E., & Holt, N. L. (2005). Talent development in elite junior tennis: Perceptions of players, parents, and coaches. *Journal of Applied Sport Psychology, 17,* 108–126.

Zhang, J., Jensen, B. E., & Mann, B. L. (1997). Modification and revision of the Leadership Scale for Sport. *Journal of Sport Behavior, 20*(1), 105–121.

CHAPTER 6

Who Cares What Other People Think?

Self-Presentation in Exercise and Sport

KATHLEEN A. MARTIN GINIS, MAGNUS LINDWALL, and HARRY PRAPAVESSIS

"You can't live your life worrying about what other people think." Certainly most of us have heard this advice at some point in our lives, usually from well-meaning friends or family trying to downplay the importance of other people's evaluations and impressions. In reality, however, what other people think of us really *does* matter. The impressions that we make—for instance, that we are smart, hard-working, and physically attractive (or, conversely, ignorant, lazy, and ugly)—have important implications for how we see ourselves, how other people treat us, and our success at obtaining valued material and social outcomes in life (Leary & Kowalski, 1990). Even in everyday social interactions, such as dinner parties and staff meetings, each person's response to another is based, in part, on one's impression of the other's personality, abilities, beliefs, and other attributes. Indeed, there are few social situations in which people can afford to completely disregard how others perceive and evaluate them (Leary, 1995).

Because the impressions people make on others can have important consequences, it is understandable that people sometimes behave in ways intended to create certain impressions in other people's eyes. *Self-presentation,* also referred to as *impression management,* refers to the processes by which people monitor and control how they are perceived and evaluated by others (Schlenker, 1980). The term *impression management* may suggest pretense and deliberate attempts to convey false images of oneself, but in actuality, the images people try to convey are usually consistent with how they see themselves. That is, self-presentation typically involves the selective presentation of self-relevant information and characteristics that will make desired impressions and the selective nondisclosure of information and characteristics that will create undesired impressions (Leary, 1995). Although people may be concerned with self-presentation in virtually any social context, the focus of this chapter is on self-presentation in physical activity contexts.

HISTORICAL BACKGROUND

The study of self-presentation has roots in Irving Goffman's (1959) seminal work, *The Presentation of Self in Everyday Life.* As a sociologist, Goffman wrote about the importance of self-presentation to social interactions and the construction of self-identity. He observed that in day-to-day social intercourse, we all behave like actors on a stage, employing various techniques to maintain our "performances" and to guide and control the impressions that others form of us. During the 1960s, Edward E. Jones extended the study of self-presentation to psychology (Leary & Kowalski, 1990). Jones and his colleagues were interested in the tactics people use to control others' impressions of them, such as ingratiation and the disclosure of personal information. His group generated considerable empirical data and knowledge regarding self-presentation processes. They also developed key conceptual, methodological, and empirical foundations that have guided self-presentation research for nearly 40 years.

Within the domains of sport and exercise psychology, social psychologist Mark Leary sparked interest with his 1992 review paper highlighting the pervasiveness and potency of self-presentational motives among athletes and exercisers. Leary cogently argued that self-presentational

This chapter was written with the support of a Canadian Institutes of Health Research (CIHR) New Investigator Award, held by the first author. We extend our appreciation to Heather Strong and Spero Ginis for their research assistance.

processes could affect several aspects of sport and exercise, including motivation, performance, and affective responses. Prior to the publication of Leary's paper, a self-presentational perspective had been applied to only a handful of sport and exercise studies. But since then, the self-presentational approach has gathered momentum as investigators have applied it to an expanding array of sport- and exercise-related phenomena such as competitive anxiety, sport fan loyalty, exercise setting and attire preferences, and adherence.

This upsurge of research activity was recognized in a special issue of the *Journal of Applied Sport Psychology* (Prapavessis, 2004). Readers are referred to this special issue for literature reviews on self-presentation in sport, exercise, and health contexts. Rather than simply reiterating these reviews, in this chapter, we take a generational approach to organizing the existing research and identifying research gaps. A generational approach conceptualizes research progress in terms of the types of research questions that have been asked about a particular phenomenon (Zanna & Fazio, 1982). Utilizing this approach, the goals of our chapter are to characterize the development and current state of research on self-presentation in sport and physical activity contexts and to identify future research directions.

A GENERATIONAL APPROACH TO CHARACTERIZING AND EVALUATING SELF-PRESENTATION RESEARCH

Three generations of research questions have been observed in social psychological research (Zanna & Fazio, 1982). *First-generation questions* are typically "is" questions—questions that ask whether there is a phenomenon, an effect, or a relationship present. For example, exercise psychologists might ask "Is there an effect of self-presentational concerns on exercise adherence?" Sport psychologists might ask "Is there a relationship between self-presentational concerns during competitions and sport competition anxiety?" The goal in first-generation research is simply to describe a phenomenon, its correlates, and its effects.

Second-generation research questions are "when" questions that ask about the conditions under which (a) the effects of the phenomenon emerge and (b) associations between the phenomenon and its correlates hold. Examples of second-generation questions are "Under what conditions do fitness classes elicit self-presentational concerns?" and "When do impression management strategies affect an athlete's performance?" In short, second-generation questions aim to identify moderator variables.

Third-generation research questions are "how" questions. For example, "How does the presence of other exercisers elicit self-presentational concerns?" and "By what mechanisms do self-presentational concerns affect sport performance?" These are questions of mediation that aim to get at the underlying psychological processes that drive self-presentational phenomena and their sequelae. It is important to note that it is not necessary for second-generation questions to be answered before third-generation questions, or even separately from third-generation questions. Nevertheless, we see a trend in sport and exercise psychology, similar to that observed in areas of social psychology (Zanna & Fazio, 1982), whereby mediator questions are addressed after moderator questions, if they are ever addressed at all (Baranowski, Anderson, & Carmack, 1998).

THE STATE OF SELF-PRESENTATION RESEARCH

A computerized search of published English-language studies was conducted (excluding dissertations and published abstracts) to identify studies that (a) addressed a self-presentational phenomenon in a physical activity context or (b) used a self-presentational approach or measures of self-presentation constructs to study a physical activity phenomenon. The studies were then grouped according to common themes and topics and coded to indicate if they addressed a first-, second-, or third-generation research question or a measurement question (see Table 6.1). Despite efforts to be comprehensive, it is possible that some studies were missed in our search. Nevertheless, our findings provide an overview of the landscape of self-presentation research in physical activity contexts. The following sections describe

Table 6.1 Number of Published English-Language Studies of Self-Presentation Topics in Sport and Exercise Contexts

	Generation			
Themes/Topics	1st	2nd	3rd	Measurement
Impression motivation and construction	19	3		4
Impression formation	8	5		
Social anxiety	3	1		
Sport competition anxiety	5	1		2
Social physique anxiety	36	13	2	13
Self-handicapping	10	8	3	7
Self-presentation confidence/efficacy	6	2		5

Note: For studies that have examined more than one generation of research question, the study is classified according to the highest generation question examined. Some measurement studies also addressed hypotheses regarding generational research questions. These studies were counted in both the Measurement column and the appropriate Generation column.

this landscape in greater detail as we discuss the generations of research addressed for each self-presentation topic identified in Table 6.1. In a subsequent section, we review measurement studies for each topic.

Impression Motivation and Construction

In 1990, Leary and Kowalski published a model delineating variables that affect impression management (see Figure 6.1). According to their two-component model, impression management involves two discrete processes: impression motivation and impression construction.

Impression motivation reflects the desire to create particular impressions. This desire is fueled by three situational determinants: the relevance of creating a particular impression in order to fulfill one's goals, the value placed on these goals, and the discrepancy between the image that one has already made (or believes has been made) and the image that one wants to make. In addition, dispositional tendencies can also influence impression motivation. For instance, people who are particularly attuned to others' perceptions of them (e.g., high in public self-consciousness), concerned with behaving in accordance with situational norms (e.g., high self-monitoring), or worried about social approval and disapproval (e.g., high fear of negative evaluation) may be particularly motivated to impression-manage.

Impression construction involves putting impression motivation into action, that is, choosing an impression to create and then utilizing tactics to convey it. This process is influenced by the self-concept (i.e., how people see themselves), ideas about what types of impressions are desirable and undesirable, role constraints, the perceived values and preferences of significant others (i.e., the types of impressions that are most likely to be met with approval or other desired outcomes), and beliefs about how one is

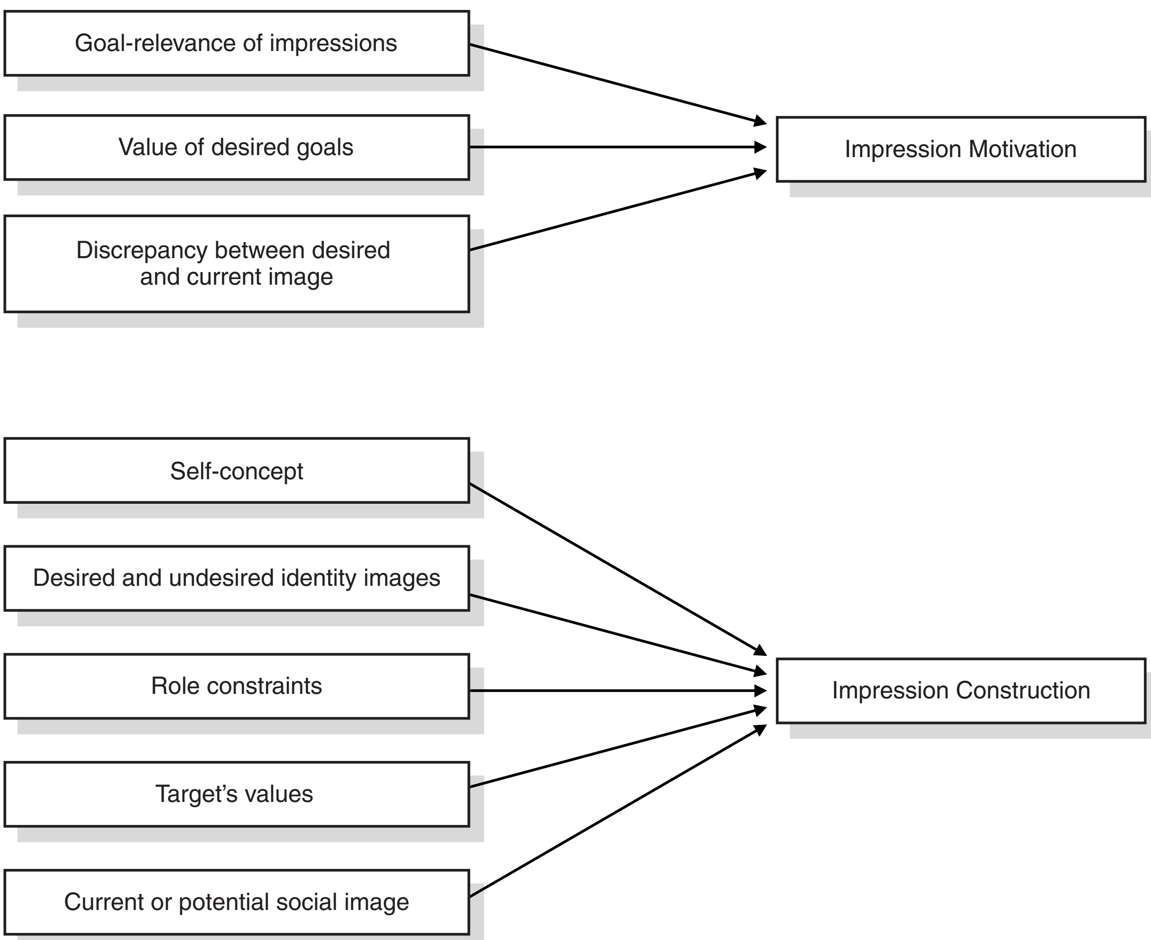


Figure 6.1 Schematic representation of Leary and Kowalski's (1990) two-component model of impression management.

currently perceived or could be perceived. Although impression construction is considered conceptually distinct from impression motivation, it is often difficult to tease apart these two processes in both real-world situations and experimental designs (Leary & Kowalski, 1990). Our literature review reflects this overlap.

Most of the physical activity research on impression motivation and construction has been conducted in exercise contexts. Of the few studies conducted in sport contexts, all have addressed first-generation research questions. In general, these studies have not directly measured impression motivation or construction; rather, they have used these processes to explain sport-related phenomena such as the home-field disadvantage (Baumeister & Steinhilber, 1984), sports fandom (Wann, Royalty, & Roberts, 2000), aggressive behavior (Wann & Porcher, 1998), and athletes' attributions for success and failure (Grove, Hanrahan, & McInman, 1991). For instance, Wann and Porcher found that college hockey and football teams who wore their names on their uniforms were more aggressive than teams who did not wear their names on their uniforms. To explain these findings, the authors suggested that athletes with names on their jerseys are more motivated to impression-manage than those without (because they are identifiable), and, as such, they use aggression as an impression-construction strategy to create valued identities.

A relationship between valued identities and sport participation has been shown in other first-generation studies. One study found that people's reasons for engaging in sport and their sport preferences were directly related to salient aspects of their identity. Respondents who placed greater importance on personal identity emphasized personal reasons for engaging in sports and preferred to participate in individual rather than team sports. In contrast, those who placed more importance on social aspects of identity more strongly endorsed social reasons for participating in sports and expressed a greater preference for team sports (Leary, Wheeler, & Jenkins, 1986). Furthermore, it seems that an important reason for sport participation is the motivation to claim the social identity of an athletic person (Grove & Dodder, 1982). This should not be particularly surprising, given that people can gain a great deal of attention, praise, and other social rewards for being athletic (Leary, 1992).

The specific types of impressions constructed by athletes can influence how other people respond to them. An international study found that athletes' self-presentational styles influenced the support and attention they received from sport physiotherapists (Ford & Gordon, 1997). Physiotherapists indicated that they preferred injured athletes who had a "balanced" self-presentational style, characterized as self-reliant and open with the therapists about their distress, rather than athletes who conveyed the impression of being cool and unaffected, withdrawn, or negative and pessimistic. The issue of athletes' self-presentational styles and their consequences is an intriguing matter that would benefit from further exploration. Self-presentational styles could have a profound impact on how athletes interact with other personnel, such as sport psychologists and coaches, and the assistance and support derived from these sources.

With regard to research conducted in exercise contexts, first-generation studies have examined the importance that people place on self-presentational reasons for exercise and have shown that impression motivation and construction function as both incentives and disincentives for physical activity. For example, the desire to convey the impression of being physically attractive or a person with an active lifestyle can motivate people to exercise regularly. Conversely, the desire to avoid making negative impressions, such as being out of shape or uncoordinated, can deter exercise (Martin, Leary, & O'Brien, 2001). Preliminary data suggest cross-cultural differences in the strength of these motives. One study found that American students were more likely than Irish students to exercise for self-presentational reasons (Martin Ginis, O'Brien, & Watson, 2003). Furthermore, the strength of self-presentational exercise motives are related to trait levels of impression motivation and monitoring. People who score high on measures of public self-consciousness, self-monitoring, and fear of negative evaluation are more likely to exercise or avoid exercise for self-presentational reasons than people who score low on these indices (Martin et al., 2001).

Trait levels of impression motivation have also been shown to predict future intentions to exercise when considered in conjunction with social pressure to exercise (Latimer & Martin Ginis, 2005). Specifically, in a second-generation study couched within the theory of planned behavior (Ajzen, 1985), fear of negative evaluation moderated the relationship between subjective norms and intentions. People with high fear of negative evaluation showed a significant positive relationship between subjective norms and intentions, whereas those with low fears showed no relationship between the constructs. These findings suggest that people who are highly fearful of negative evaluations are more likely to base their intentions to exercise on what they think other people want them to do (i.e., subjective norms) than those people who are not as concerned with what others think.

In addition to trait influences, first- and second-generation studies have addressed situational influences on impression motivation and construction. Several studies have shown that exercisers put forth greater effort when they know that other people are watching them (Rhea, Landers, Alvar, & Arent, 2003; Worringham & Messick, 1983) and, presumably, when they think that increased effort or exertion will create a desired impression (Leary, 1992). Other studies have shown that some situational factors can have the opposite effect, prompting exercisers to claim low levels of exertion in order to make a desired impression. For example, in exercise-testing situations involving very heavy workloads, men have been shown to report lower exertion when a woman conducts the test than when a man conducts the test (Boutcher, Fleischer-Curtian, & Gines, 1988). Likewise, people report lower ratings of perceived exertion when they exercise next to a person who gives the impression that the exercise is very easy than when they exercise alone (Hardy, Hall, & Prestholdt, 1986). It would seem that in situations where workloads (i.e., 75 to 85% of VO_2 max) can be sustained for longer periods because they are largely supplied by aerobic energy pathways, the desire to be perceived as physically fit prompts exercisers to claim that an objectively hard workout does not actually feel all that difficult.

Although both trait and state approaches have been used to examine impression motivation and construction in exercise, there has been little attempt to use interactionist (i.e., trait by state) methodologies. This criticism also applies to the approaches used in sport-related studies. Second- and third-generation studies are needed to identify variables that attenuate and drive relationships between self-presentation and physical activity-related thought, feelings, and behaviors. The concurrent examination of trait and state variables would aid such endeavors.

We also encourage further research into the dark side of impression motivation and construction. Martin Ginis and Leary (2004) have suggested that self-presentational motives can prompt athletes and exercisers to engage in a variety of potentially dangerous, health-damaging behaviors. For example, there is anecdotal evidence that professional hockey players often continue to play while they are injured, at the risk of further exacerbating their injury, because they want to avoid being perceived as a "wimp" who sits out games. In a similar vein, recreational weight lifters have admitted to attempting to lift more weight than they believe they can safely lift in order to impress other people in the gym (Martin & Leary, 2001). Surprisingly, few attempts have been made to apply a self-presentational perspective to study these types of health-damaging behaviors. We propose that a self-presentational approach would be valuable for explaining, and perhaps even assuaging, health-risk behaviors among athletes and exercisers.

Impression Formation

Whereas studies of impression motivation and construction focus on the actor's (i.e., the athlete's or exerciser's) thoughts, feelings, and behaviors, studies of impression formation focus on what the *observer* thinks of the actor. Impression formation is a complex cognitive process that involves combining new information about a person with existing information and beliefs (including stereotypes) to formulate an overall impression (Baron & Byrne, 1997). Studies of impression formation provide data regarding the implications of people's self-presentational tactics. For example, studies can indicate if dressing a particular way or conveying certain attitudes and beliefs influences how we are perceived by others.

With respect to sport, a number of first- and second-generation studies have examined inferences that people make about athletes who participate in certain sports. For example, in one study (Sadalla, Linder, & Jenkins, 1988), participants were asked to give their impressions of tennis, golf, snow skiing, bowling, and motocross racing athletes. In general, respondents' impressions of bowlers were least positive. Specifically, they found bowlers less active and daring compared to skiers and racers. Another study examined the stereotypes of female athletes who competed in one of five sports: basketball, golf, tennis, softball, and volleyball (Linder, Farrar, Sadalla, Sheets, & Bartholomew, 1992). Participants' perceptions of the targeted athletes differed in terms of both athleticism and attractiveness. Specifically, basketball players were deemed the most athletic, and golfers were deemed the least athletic. Tennis players were thought to be the most attractive. Perceptions of female athletes were also examined during interviews with 12 female professional boxers (Halbert, 1997). The interviews revealed that women pugilists are subject to numerous stereotype labels (e.g., husky, butch, ugly, and lesbian). Taken together, these studies indicate that information about one's sport participation can have a profound impact on how one is perceived by others.

Second-generation research has shown that both behavioral (e.g., body language, choice of clothing) and demographic (e.g., age, gender, race) characteristics of an athlete can moderate the effects of sport information on impression formation (Greenlees, Buscombe, Thelwell, Holder, & Rimmer, 2005; Stone, Perry, & Darley, 1997). For instance, in one study (Stone et al., 1997), White men and women evaluated a male basketball player while listening to a radio broadcast of the game. From the broadcast it was clear that the target athlete played well. Half of the participants were led to believe that the target player was White, and the other half were led to believe he was Black. Results showed that the Black target player was perceived to have more natural athletic ability but inferior court smarts and hustle. In contrast, the White target athlete was perceived to have superior court smarts and hustle but less athletic ability. This study provides convincing evidence that stereotypes based on athlete characteristics (particularly race) moderate the effects of performance information on impression formation. It is not known, however, if characteristics of the *observer* moderate impression formation. Indeed, it would be interesting to determine if these findings would hold if the study were replicated using Black rather than White observers.

There have not been any third-generation studies of impression formation in sport. An important third-generation research question is whether impression formation mediates the treatment of athletes. Halbert's (1997) study of female boxers suggests this may be the case. With findings reminiscent of scenes depicted in Clint Eastwood's *Million Dollar Baby,* Halbert reported that female pugilists face widespread discrimination at gyms from trainers and managers who refuse to assist them and at matches from spectators who issue verbal sexual harassment. Her findings also suggest that the use of self-presentational tactics may be mediated by a desire to bring others' impressions in line with the athlete's desired impression. For instance, female boxers reported deliberately wearing feminine uniforms in the ring, emphasizing feminine aspects of their appearance (e.g., wearing makeup and having long hair), and concealing information about their sexuality to avoid undesired impression formation.

With regard to exercise, a handful of first- and second-generation studies have examined the types of impressions associated with being an exerciser (e.g., Martin, Sinden, & Fleming, 2000; Martin Ginis, Latimer, & Jung, 2003). Borrowing a methodology used in stereotype studies, these investigations have involved presenting respondents with a written description of a male or female target. Information about the target's exercise habits is embedded in the description and manipulated across conditions (e.g., the target is described as an exerciser or a nonexerciser, or no exercise information is given). After reading the description, respondents rate the target on a series of physical (e.g., ugly/good-looking, physically sickly/healthy, underweight/overweight) and personality (e.g., sad/happy, afraid/brave, lazy/works hard) dimensions. Responses are compared across the conditions to determine the effects of exercise habit information on impression formation.

The results of these studies clearly indicate that there are self-presentational advantages associated with being an exerciser. Respondents consistently rate habitual exercisers more favorably than nonexercisers and control targets (i.e., targets for whom no exercise information is given) on a wide array of attributes. For example, on physical attribute ratings, Martin and colleagues (2000) found that exercisers were considered fitter, stronger, healthier, more muscular, and more physically attractive than both nonexerciser and control targets. In terms of personality attributes, they found that exercisers were considered more independent, braver, friendlier, kinder, happier, neater, more intelligent, and more sociable and to have more friends than nonexercisers. Exercisers were also considered to be more self-confident, to have greater self-control, and to be harder workers than both nonexercisers and controls.

Interestingly, many of the characteristics attributed to exercisers—such as being smarter, friendlier, and braver—are not directly influenced by physical activity participation. The tendency to rate exercisers favorably on activity-unrelated dimensions is indicative of a *halo effect* (Thorndike, 1920). The halo effect (also known as "halo error") reflects the tendency for raters' global impressions of a person to influence their evaluations of that person on individual, disparate attributes. Presumably, respondents hold generally good impressions of exercisers, and these impressions influence evaluations of exercisers on unrelated dimensions. By contrast, there seems to be a *devil effect* (Thorndike, 1920) for nonexercisers, such that respondents hold relatively unfavorable impressions of sedentary people, which taint subsequent evaluations along discrete dimensions.

Exercise-related halo and devil effects exist for both male and female targets and have been observed in samples of Canadian (Martin Ginis et al., 2003), American (Mack, 2003), and Swedish university students (Lindwall & Martin Ginis, 2006). These effects do not appear to be influenced by the rater's sex or exercise habits. However, people who are highly motivated to self-present as exercisers rate exercising targets more favorably on physical attributes (but not personality attributes) than those less motivated

(Lindwall & Martin Ginis, 2006). It is important to note that, to date, exerciser impression formation studies have utilized university-age participants. It is not yet clear whether other segments of the population, such as older adults or people who do not have particularly favorable attitudes toward exercise, form similar impressions of exercisers and nonexercisers. As well, research is needed to determine whether the halo and devil effects generalize beyond healthy, student-age targets to targets such as older adults or people with physical disabilities.

It is also unknown if the impression formation process mediates other behaviors. For example, prompting people to think about characteristics associated with exercisers and nonexercisers may elicit changes in their own exercise behavior, as they try to bring their exercise habits in line with their impressions of exercisers and nonexercisers. Impression formation may also mediate how one subsequently interacts or treats another person. For instance, health practitioners may interact differently with exercisers than with nonexercisers; they may devote less time to helping nonexercisers change their health habits if they have formulated the impression that sedentary people are lacking in self-control. These third-generation questions represent interesting avenues for future investigation.

Social Anxiety

When people are motivated to make a desired impression on others but are not certain that they will do so, they may experience social anxiety. Unlike other forms of anxiety (e.g., anxiety about flying in an airplane or being alone in the dark), social anxiety is precipitated by concerns about others' evaluations (Leary & Kowalski, 1995). In fact, social anxiety is sometimes referred to as "evaluation anxiety" (Beck & Emery, 1985). People who experience high levels of social anxiety may avoid participating in sport and exercise activities because they are worried about how others will perceive them (Pinto & Sarkin, 1996). Certain aspects of the exercise environment can even trigger social anxiety if they make people feel watched and evaluated by other exercisers or the exercise leader (Martin & Fox, 2001).

Because many physical activity settings provide opportunities for public scrutiny and evaluation (e.g., sport competitions, group exercise classes), a self-presentational perspective can be valuable for studying and understanding specific types of social anxiety that are experienced in these contexts. Indeed, in sport, a self-presentational perspective has been applied to study and understand *sport competition anxiety*. Using this perspective, competitive anxiety is conceptualized as a subclass of social anxiety that is specific to sport competition (Leary, 1992).

Sport Competition Anxiety

Insofar as first-generation research questions are concerned, James and Collins (1997) conducted a qualitative, retrospective study of male and female athletes to identify important sources or causes of anxiety experienced during a recent competition. They found that social evaluation and self-presentational concerns were one of eight general dimensions of sources of anxiety/stress. Likewise, quantitative studies have found that athletes experience a variety of self-presentational concerns relevant to sport competition, such as concerns about appearing fatigued, unable to handle stress, or being incompetent (M. Williams, Hudson, & Lawson, 1999; Wilson & Eklund, 1998). These descriptive studies indicate that self-presentational concerns are indeed a significant source of competitive anxiety.

In studies of the relationships between sport competition anxiety and measures of self-presentational constructs, competitive *trait* anxiety has been shown to correlate with social physique anxiety and physical self-presentation confidence, but only among female athletes (Martin & Mack, 1996). The moderating influence of sex has been attributed to differences in how men and women are socialized regarding the importance of physical appearance. Other studies have shown that self-presentational concerns are more strongly related to cognitive than somatic trait anxiety (Hudson & Williams, 2001; Wilson & Eklund, 1998). With regard to competitive *state* anxiety, a small study of young Alpine skiers showed that precompetitive cognitive state anxiety was positively correlated with concerns about social evaluations of one's performance, whereas somatic anxiety was positively correlated with concerns about social evaluations of nonperformance aspects of ski racing (Bray, Martin, & Widmeyer, 2000). Together, these studies fit nicely with Leary's (1992) conceptualization of competitive anxiety as a subclass of social anxiety. However, it must be acknowledged that not all sport anxiety is self-presentational in nature. For example, anxiety can sometimes stem from fears of being injured or, in the case of professional athletes, not winning enough money to pay the bills.

Other than the Martin and Mack (1996) study, we are unaware of any second-generation studies of moderators of the relationship between self-presentational concerns and competitive anxiety. Likewise, there have been no attempts to address the third-generation research question of why self-presentational concerns elicit sport anxieties. These questions require empirical scrutiny to advance knowledge and theory with respect to the role of self-presentational concerns in competitive sport anxiety and to develop interventions to allay the impact of self-presentation concerns on sport competition anxiety.

Social Physique Anxiety

Another form of social anxiety with relevance in physical activity contexts is *social physique anxiety* (SPA). Social physique anxiety is the anxiety experienced in response to the real or imagined evaluation of one's body by others (Hart, Leary, & Rejeski, 1989). As shown in Table 6.1, SPA is by far the most studied self-presentational concept in the sport and exercise psychology literature and is only one of two topic areas where all three generations of research questions have been examined. (For comprehensive reviews of the SPA literature, see Hausenblas, Brewer, & Van Raalte, 2004; Prapavessis, Grove, & Eklund, 2004.)

First-generation studies have examined a plethora of SPA correlates among athletes and exercisers. These correlates are summarized in Table 6.2. In most studies, SPA has been conceptualized as a trait variable and has shown fairly consistent associations with psychological constructs that capture thoughts and feelings about the self as well as risk factors for psychopathologies such as depression, eating disorders, and compulsive exercise. A few studies have conceptualized SPA as a state construct and have shown that characteristics of the exercise environment can elicit SPA, such as the presence of members of the opposite sex (Kruisselbrink, Dodge, Swanburg, & MacLeod, 2004).

In sport studies, most SPA research has focused on the relationship between trait SPA and eating disorder symptomatology. In general, these studies have shown that SPA is a significant, positive correlate of athletes' eating disorder tendencies. Second-generation studies have shown that sex, but not sport type, moderates this relationship. Specifically, Haase, Prapavessis, and Owens (2002) found SPA to be related to disordered eating attitudes in female athletes but not male athletes. However, in a study of women competing in three different types of sports—physique-salient, weight-restricted, and physique-nonsalient—sport type did not moderate the relationship between SPA and disordered eating attitudes (Haase & Prapavessis, 2001). Among men, SPA has been shown to be related to steroid use. A study of male competitive body builders found that those who used anabolic steroids had significantly less SPA than those who did not use steroids (Schwerin et al., 1996), indicating that some men use steroids as a strategy for dealing with self-presentational concern about their body.

In exercise studies, much of the SPA research focus has been on the relationship between trait SPA and exercise behavior. Initially, cross-sectional investigations produced a mixed bag of findings, with some studies showing a positive relationship between SPA and exercise, other studies showing a negative relationship, and others showing no relationship. These inconsistent findings prompted consideration of factors that may moderate the SPA-exercise relationship, such as sex, depression, and age. For instance, the results of a couple of second-generation studies suggest that age is a significant moderator, such that SPA is negatively correlated with exercise in younger adults but unrelated to exercise in older adults (Lantz, Hardy, & Ainsworth, 1997; Treasure, Lox, & Lawton, 1998). However, to complicate this issue, older women's SPA levels may be moderated by self-presentation efficacy. In one study, SPA was negatively correlated with activity among older women with high or moderate self-presentation efficacy for exercise, but was unrelated to activity in older women with low self-presentation efficacy (Woodgate, Martin Ginis, & Sinden, 2003). Together, these findings speak to the complexity of the SPA-physical activity relationship. To further elucidate the nature of this relationship, researchers need to focus their efforts on exploring demographic, dispositional, and situational moderators, rather than continuing to search for a seemingly nonexistent direct relationship between SPA and exercise.

There is also a need to explore the relationship between SPA and exercise at different stages of the exercise initiation-maintenance continuum. We suspect that SPA exerts its greatest influence on exercise adherence when people are contemplating and initiating exercise programs; during these critical junctures, SPA can be a significant exercise deterrent. But once people gain some experience with exercise equipment and skills, and after repeated exposure to the exercise environment, our hunch is that self-presentational concerns become less salient and other self-regulatory and experiential factors become more potent determinants of continued exercise participation (e.g., barrier self-efficacy, outcome satisfaction, enjoyment). This notion may help explain why SPA scores were lower in a convenience sample of undergraduate women who exercised regularly (Eklund & Crawford, 1994) when compared to undergraduate women who exercised much less (Crawford & Eklund, 1994).

Table 6.2 Correlates of Social Physique Anxiety Examined in Studies of Exercisers and Athletes

Variable	Relationship[a]
Demographics	
Age	–
Sex (female)	+
Body composition (body fat, BMI)	+
Exercise-Related Thoughts, Feelings, and Behaviors	
Exercise frequency/adherence	M[b]
Exercise intensity	+
Exercise commitment	–
Exercise enjoyment	–
Exercise avoidance	+
Exercising for health reasons	–
Exercising for appearance reasons	+
Self-presentational efficacy for exercise	–
Exercise Preferences	
Preference for exercising alone	+
Preference for exercising with others	–
Preference for exercising in same-sex environment	+
Preference for exercising in mixed sex environment	–
Preference for exercising at the back of the exercise class	+
Preference for wearing conservative exercise attire	M
Sport Participation	
Level of sport participation (elite)	–
Participation in physique-salient sports	M
Participation in physique-nonsalient sports	M
Psychopathology and Health Risk Behaviors	
Eating disorder symptomatology	+
Excessive exercise	+
Steroid use	–

Note: – = Negative association; + = Positive association; M = Mixed findings.

[a] Values in the Relationship column are based on tallies of observed relationships and do not take into account study sample sizes or the magnitude of observed correlations.

[b] The SPA-exercise relationship appears to be a moderated rather than direct relationship, which accounts for the mixed findings.

Another second-generation question that has received some research attention is whether SPA moderates psychological responses to exercise. The extant data indicate that self-concept and mood changes following aerobic exercise are unrelated to SPA levels (Focht & Hausenblas, 2001; McInman & Berger, 1993). However, women with high SPA may be more prone to experience anxiety during exercise if they work out in public rather than private settings (Focht & Hausenblas, 2003).

In terms of the effects of exercise on SPA, several studies have shown that participation in an exercise training program is associated with decreases in SPA (e.g., McAuley, Bane, Rudolph, & Lox, 1995; P. A. Williams & Cash, 2001). But given the lack of experiments utilizing randomly assigned, nonexercising control conditions, it is not yet possible to conclude that exercise causes reductions in SPA. Nevertheless, some training studies have attempted to identify mechanisms by which exercise might reduce SPA. These third-generation investigations have identified changes in objective and subjective measures of fitness and physical function as potential mediators of the effects of exercise training on SPA (Martin Ginis, Eng, Arbour, Phillips, & Hartman, 2005; McAuley, Bane, & Mihalko, 1995; McAuley, Marquez, Jerome, Blissmer, & Katula, 2002).

Summary

In reviewing the SPA literature, it is encouraging to see research activity at all three generational levels, but there is an obvious imbalance across the generations. Clearly, it is time for researchers to move beyond first-generation studies examining correlates of SPA and to examine second-generation questions regarding variables that moderate these relationships. A greater emphasis is also needed on the study of mechanisms by which exercise decreases trait SPA and the mechanisms by which aspects of the sport and exercise environment trigger state SPA. By addressing these questions, researchers can start to develop interventions to alleviate SPA and its impact on athletes and exercisers.

Self-Handicapping

In their classic 1978 study, Berglas and Jones demonstrated that people who were worried about failing on a personally meaningful task sometimes chose to impair their performance by ingesting performance-debilitating drugs. They labeled this phenomenon "self-handicapping" and defined it as "any action or choice of performance setting that enhances the opportunity to externalize (or excuse) failure and to internalize (reasonably accept credit for) success" (p. 406). By self-handicapping before a performance, people create a no-lose situation. On the one hand, if they perform poorly, then the failure can be attributed to the performance impediment rather than their ability or competence. On the other hand, if they perform well, they create the impression of being especially competent and talented because success was achieved despite obstacles. In short, self-handicaps blur the relationship between ability and performance and provide a strategy for protecting or even enhancing the performer's self- and public image.

When considering self-handicaps, it is important to note the distinction between behavioral and self-reported self-handicaps (Leary & Shepperd, 1986; Snyder, 1990). *Behavioral handicaps* refer to deliberate, overt acts that would make success on a task more difficult, such as ingesting drugs or alcohol, withholding effort, and choosing to perform in suboptimal conditions. Conversely, *claimed handicaps* are verbal claims about performance impediments such as being injured, ill, socially anxious, in a bad mood, or a victim of traumatic life events (cf. Prapavessis et al., 2004).

With respect to first-generation research questions in sport, several studies have examined the types of claimed self-handicaps most used by athletes. In a synthesis of these studies, Prapavessis et al. (2004) identified seven categories of self-reported impediments. School activity commitments followed by physical states, injury, and illness were the impediment categories most frequently reported, representing half of all self-handicapping claims.

Studies have also examined correlates of athletes' dispositional tendencies to self-handicap. Athletes' scores on the trait Self-Handicapping Scale (Jones & Rhodewalt, 1982) have been shown to correlate negatively with levels of team cohesion (Carron, Prapavessis, & Grove, 1994), practice effort (Rhodewalt, Saltzman, & Wittmer, 1984), and global self-esteem (Prapavessis & Grove, 1998) and to correlate positively with impression management concerns (Hudson, Williams, & Stacey, 1998), precompetitive state anxiety (Ryska, Yin, & Cooley, 1998), mood states (Prapavessis & Grove, 1994), and the use of emotion-oriented coping strategies (Prapavessis, Grove, Maddison, & Zillmann, 2003).

Field studies and controlled experiments have examined factors associated with the use of self-handicaps prior to competitive or evaluated events. These factors include lower self-efficacy and self-esteem (Martin & Brawley, 2002), high perceived event importance (Rhodewalt et al., 1984), and elevated competitive state anxiety (Ryska at al., 1998). It is not clear, however, what effects (if any) self-handicapping has on athletic performance. In the only study to examine this issue, self-handicapping had a positive impact on running performance among children in a physical education class who had relatively low self-confidence, but not children with high self-confidence (Ryska, 2002).

With regard to second-generation studies, some experiments have looked at variables that moderate self-handicapping. For example, Rhodewalt et al. (1984) found that high levels of trait self-handicapping were related to reduced practice effort and attendance among competitive golfers, but only when an upcoming competitive event was perceived as important. Other second-generation studies have shown that self-handicaps are most likely to occur in competitive situations when athletes expect their performance to be compared with others (Coudevylle & Famose, 2005; Thill & Cury, 2000). For example, in an experiment couched in achievement motivation theory, experienced basketball players performed an evaluated basketball drill either in a private *mastery climate* that emphasized personal accomplishments and improvements, or a public *performance climate* that emphasized competition and performance social comparisons (Coudevylle & Famose, 2005). Prior to performing the drill, players were given the opportunity to take as many practice shots as they desired and to indicate any possible performance impediments. Analyses indicated that players in the performance climate took significantly fewer practice shots (a behavioral self-handicapping strategy) and listed significantly more performance impediments (a claimed self-handicapping strategy) than players in the mastery climate. These effects were moderated by sex; compared to women, men were more likely to use behavioral (i.e., reduced practice time) but not claimed self-handicaps. Coudevylle and Famose's findings speak to the potential moderating effects of both individual and situational factors on self-handicapping.

In a similar vein, from a third-generation research question perspective, researchers examined whether threat to self-esteem mediated the effects of task involvement goals versus social comparison goals on self-handicapping prior to a golf putting task (Thill & Cury, 2000). They found that task involvement goals were negatively related to self-handicapping and social comparison goals were positively related to self-handicapping, but neither of these relationships was mediated by a threat to self-esteem. In contrast, Prapavessis and Grove (1994) examined the mediating effects of self-esteem on the relationship between trait self-handicapping and the use of claimed self-handicaps (i.e., potential impediments to competitive performance). In male competitive golfers, self-esteem served as a negative mediator between the trait of self-handicapping and potential handicaps. Together, these findings suggest that among golfers with a dispositional tendency to handicap, the actual use of self-handicaps is driven by low self-esteem. However, threat to self-esteem does not appear to underlie the use of self-handicaps in situations with mastery versus performance climates.

With regard to self-handicapping in exercise contexts, we are aware of only three studies that have examined this issue, and two dealt with measurement. Shields and colleagues (Shields, Paskevich, & Brawley, 2003) identified a variety of self-handicapping claims that were used by exercisers. Interestingly, these were qualitatively similar to self-handicaps employed by athletes, for example, claims about scheduling problems, compromised health and physical functioning, and exercise facility barriers. Overall, exercisers used self-handicaps infrequently, and the incidence of self-handicapping was unrelated to age, sex, or preferred exercise setting. In one study, self-handicapping had virtually no impact on exercise performance (J. A. Smith, Hauenstein, & Buchanan, 1996), but it may influence other exercise-related outcomes such as social anxiety and mood states (cf. the effects of self-handicapping in sport contexts).

To characterize the self-handicapping literature as a whole, this topic has the most third-generation research (albeit with just three third-generation studies) and the best balance across the first-and-second research generations. Nevertheless, there are still several important first-generation questions that have not been adequately addressed. One such question is whether the use of claimed and behavioral self-handicaps affect athletic performance. Presumably, behavioral handicaps would impede performance to a greater extent than claimed handicaps, but this assumption has not yet been verified. Another important question is whether self-handicaps affect performance-related variables such as self-efficacy and anxiety. Given that self-presentational concerns are a significant source of competitive anxiety (Wilson & Eklund, 1998), and self-handicapping is used to manage self-presentational concerns, it makes sense that self-handicapping could help to alleviate sport competition anxiety (or, at least, those aspects of anxiety that reflect self-presentational concerns). First-generation questions such as these have significant implications for interventionists. If self-handicapping is detrimental to an athlete's psychological readiness and performance, then sport psychologists must devote efforts to preventing it. But if self-handicapping is beneficial, then there may be no need to intervene.

The mix of trait, situational, and interactionist approaches is also a noteworthy feature of the self-handicapping literature. Initially, sport researchers focused on establishing relationships between dispositional self-handicapping tendencies and various sport-related phenomena. But it soon became clear that these relationships were weak at best. Sport investigators then moved relatively quickly to develop methodologies to facilitate the study of situation-specific uses of self-handicaps. These methodologies also facilitated the study of situational factors that might elicit self-handicapping or interact with trait variables to produce self-handicapping. The relatively brisk shift from trait to situational and interactionist approaches may explain why this area of research has made the best progress across the three generations of research.

Self-Presentational Efficacy and Confidence

When people are motivated to impression-manage, they have an expectancy regarding the likelihood of conveying desired impressions to others (Leary & Kowalski, 1995). For example, an athlete who wants to impress a new coach will have a sense of the likelihood of presenting herself as a fit, competent team player. Perceptions of one's self-presentational capabilities have been defined as both *self-presentational efficacy* (Leary & Kowalski, 1995) and *self-presentation confidence* (Ryckman, Robbins, Thornton, & Cantrell, 1982).

Couched in the broader frameworks of self-efficacy and social cognitive theory (Bandura, 1997), self-presentational efficacy (SPE) reflects expectations about one's ability to perform the behaviors or present the images that lead to desired outcomes (Maddux, Norton, & Leary, 1988). As with other types of self-efficacy, SPE is considered situation-specific. By comparison, self-presentation confidence, at least in the physical domain, has been conceptualized as a trait construct and reflects one's level of confidence in displaying physical skills and having these skills evaluated by others (Ryckman et al., 1982).

Research on physical self-presentation confidence (PSPC) and SPE has addressed both first- and second-generation research questions in sport and exercise. With regard to PSPC, it has been shown that team sport athletes show greater self-presentation confidence than individual sport athletes (Wong, Lox, & Clark, 1993) and that PSPC can be enhanced through exercise training interventions (Lox, McAuley, & Tucker, 1995). However, it is not known why or how the sport context and exercise participation influence self-presentation confidence. Likewise, although it has been shown that greater PSPC is associated with greater persistence and endurance on a running task (Tenenbaum et al., 2005), it is not yet known how self-presentational confidence influences these behaviors.

With regard to SPE, first-generation studies have shown that prior to a physical fitness test, lower SPE is associated with lower levels of general and physical self-esteem, lower task self-efficacy, and greater use of claimed self-handicaps (Martin & Brawley, 2002). In exercise settings, lower levels of SPE for exercise are associated with higher levels of SPA, greater appearance anxiety and social anxiety, and lower exercise frequency (Gammage, Hall, & Martin Ginis, 2004; Gammage, Martin Ginis, & Hall, 2004). Physique-salient exercise environments, the presence of a male observer in the exercise setting, and "perfect-looking" exercise instructors have all been shown to decrease SPE for exercising in public settings. A couple of second-generation studies have examined prior exercise experience as a moderator of exercise environmental influences on SPE, but the results have been equivocal (Fleming & Martin Ginis, 2004; Gammage, Martin Ginis, et al., 2004).

Although research on SPE is still in its infancy, we suspect that like the broader self-efficacy construct from which it was derived (cf. Bandura, 1997), SPE will emerge as an important construct in second- and third-generation research. Indeed, as previously noted, SPE has already been identified as a significant moderator of the relationship between SPA and exercise frequency (Woodgate et al., 2003), and it could moderate other trait influences on affective and behavioral responses to physical activity. Given the potential for interactionist (trait by state) approaches to explain self-presentational phenomena in physical activity contexts (cf. Martin Ginis & Leary, 2004), we encourage further study of SPE as a situation-specific moderator. For example, SPE could moderate the effects of fear of negative evaluation on sport competition anxiety; people with greater evaluative fears and lower SPE may be more likely than fearful people with high SPE to experience sport competition anxiety. We also encourage third-generation research to address whether SPE mediates the effects of situational factors (e.g., the presence of an evaluative audience, physique-salient environments) on self-presentational outcomes (e.g., impression construction, social anxiety). In a similar vein, it would be worthwhile to examine whether exercise-induced changes in SPE mediate the effects of exercise interventions on trait self-presentation measures such as SPA and PSPC.

MEASUREMENT

The availability of valid and reliable measures of self-presentation constructs is crucial for the advancement of knowledge. As shown in Table 6.1, a considerable number of sport and exercise studies have dealt with measurement issues. In this section, we review studies that have attempted to develop, test, and refine indices of self-presentational constructs for use in physical activity contexts, critically evaluate this literature, and suggest some future directions.

Impression Motivation and Construction

There have been no attempts to develop a measure of impression motivation or construction for use in sport contexts. The four measurement studies cited in Table 6.1 pertain to the Self-Presentation in Exercise Questionnaire (SPEQ; Conroy, Motl, & Hall, 2000). Using the two-component model as its conceptual framework, the SPEQ was designed to assess impression motivation and impression construction with regard to exercise. Conroy et al. found that an 11-item, two-factor measurement model demonstrated closer fit to their data observations than their originally proposed 14-item, two-factor model. More recent studies have proposed a 9-item, two-factor model (Conroy & Motl, 2003) or different versions of an 8-item, two-factor model (Gammage et al., 2004; Lindwall, 2005). Some of these studies have also found support for partial or tight cross-validity, sex invariance of the factor structure, and slightly higher latent mean scores for men than women on one or both dimensions (Conroy & Motl, 2003; Lindwall, 2005). To date, the SPEQ has undergone minimal construct validation. Extant data indicate that SPEQ scores are weakly correlated with theoretically meaningful constructs such as social physique anxiety, physical self-presentation confidence, and exercise behavior (Conroy et al., 2000; Lindwall, 2005) but moderately correlated with exerciser identity (Lindwall, 2005).

Critique

Although a two-factor, 8-item model of the SPEQ has been upheld in two studies (Gammage et al., 2004; Lindwall, 2005), there are concerns about the face and construct validity of the Impression Motivation (IM) and Impression Construction (IC) subscales that emerged from these analyses. Specifically, most of the IC items tap into both a behavior and an underlying motive (e.g., "I wear exercise clothes that are flattering or revealing so others can tell that I am fit and/or attractive"). Because the IC items are confounded by IM, people's responses to the items could reflect their reaction to the impression construction component of the item (e.g., *wearing* flattering or revealing clothes) or the impression motivation component (e.g., wearing the clothes *to look fit and attractive to others*). Another concern is that IC items assess only a single impression construction strategy: altering one's physical appearance to make one look like an exerciser. In fact, three of the four IC items pertain to wearing athletic attire. Impression construction can take many other forms (e.g., verbal self-descriptions, choices of activities), but these are not measured. With regard to construct validity, it is not yet clear whether the SPEQ subscales measure what they are purported to measure. Overall, they have not been shown to be as strongly related to theoretically meaningful constructs as might be expected.

Summary and Recommendations

With the SPEQ, Conroy and his colleagues (2000) have provided a nice demonstration of how to develop a measure by linking a conceptual model with a measurement model and empirical observations. Nevertheless, concerns remain about the SPEQ's face and content validity. It is very difficult to tease apart, operationalize, and measure impression motivation and construction (Leary & Kowalski, 1990); unfortunately, these difficulties have not yet been overcome by psychometricians working with the SPEQ. Further work is needed to improve the scale's content validity. With the two-component model as its conceptual foundation, researchers can use the model as a basis for making decisions regarding scale improvement. These efforts should be followed by factorial and construct validation of the scale in various populations. When possible, we also encourage investigators to compare latent mean differences when conducting between-groups comparisons of SPEQ scores in order to yield a more accurate picture of between-groups differences (Lindwall, 2005).

Anxiety

In this section, we examine measures of self-presentational concern as they relate first to sport competition anxiety, and then social physique anxiety.

Self-Presentation Concerns and Sport Competition Anxiety

Two questionnaires have been used to assess self-presentational concerns in sport. Both are based on Leary's (1992) conceptualization of sport competition anxiety as a special form of social anxiety. The Self-Presentation in Sport Questionnaire (SPSQ) is an exploratory instrument that Wilson and Eklund (1998) created to test their hypotheses about the relationship between self-presentational concerns and competition anxiety. Factor analyses of the SPSQ items yielded four factors interpreted as self-presentational concerns about (1) performance/composure inadequacies, (2) appearing fatigued/lacking energy, (3) physical appearance, and (4) appearing athletically untalented. The SPSQ scores were moderately correlated with fear of negative evaluation and sport competition anxiety. Similarly, the Competitive Self-Presentation Concern Inventory (CSPCI; M. Williams et al., 1999) measures (a) concerns about others' impressions, (b) fear of appearing incompetent, (c) fear of appearing unable to cope with pressure, and (d) concern over current form. The a priori specified four-scale structure was supported by confirmatory factor analyses, and the subscales demonstrated acceptable internal consistency and test-retest reliability over 5 weeks. Correlations between scale scores and other measures of self-presentation concern were very weak.

Critique. By attempting to measure a variety of self-presentational concerns among athletes, the SPSQ and CSPCI represent important attempts to broaden conceptualizations of self-presentation anxiety beyond the concept of social physique anxiety. Both measures have a robust conceptual foundation and provide a clear link between theory and data. Their primary limitation is a lack of published psychometric evaluation. Factor structures have been validated only for university and college students in one country, and construct validation has been minimal. Furthermore, because Wilson and Eklund (1998) created the SPSQ specifically for their study (and not necessarily as a generic research tool), the SPSQ will require additional psychometric testing before it can be used to address other investigators' research questions.

Summary and Recommendations. The SPSQ and CSPCI are in the early stages of development and need to be used in more studies and tested on a more diverse range of populations before conclusions can be made about their psychometric integrity. We also note some overlap between the questionnaires (i.e., two subscales of the CSPCI seem to measure concepts similar to those measured by two of the SPSQ subscales). Perhaps a combination of SPSQ and CSPCI items and scales would result in a psychometrically stronger measure of self-presentational concerns than either instrument alone.

Social Physique Anxiety

The Social Physique Anxiety Scale (SPAS; Hart et al., 1989) measures people's dispositional tendencies to become anxious when others observe or evaluate their physique. In their original paper, Hart et al. proposed a 12-item, unidimensional scale. Some researchers subsequently proposed a two-factor model (e.g., McAuley & Burman, 1993), but this model was largely an artifact of negatively worded, inappropriate scale items. More recent studies support a unidimensional 9-item (Martin, Rejeski, Leary, McAuley, & Bane, 1997) or 7-item model in both adult and adolescent English-speaking (Motl & Conroy, 2000b; A. L. Smith, 2004) and non-English-speaking populations using translated versions of the SPAS (Isogai et al., 2001; Lindwall, 2004). Yet, although the 7-item model seems to provide the closest fit to the data, there is not yet consensus regarding *which* 7 items best fit the data, as different investigators have provided support for different 7-item models.

Researchers have also begun to look at the sex invariance of the SPAS factor structure and sex-differences in SPAS scores using latent means rather than observed means. Studies of English-speaking samples have found the factor structure of the 7-item model to be invariant across men and women (Motl & Conroy, 2001). In contrast, using a Swedish translation of the SPAS, Lindwall (2004) found that the factor structure for the 7-item Motl and Conroy model differed between men and women, suggesting the need for more studies on the sex invariance of translated versions of the SPAS. With regard to construct validity, as shown in Table 6.2, research has demonstrated SPAS scores to be correlated with a variety of theoretically relevant constructs.

Critique. The SPAS is the most widely used and investigated self-presentational instrument in sport and exercise psychology research. Its considerable development and refinement have resulted in a generally robust and psychometrically sound scale. But despite several studies reporting a consistent pattern of dimensionality and ideal number of items (i.e., a unidimensional scale of 7 items), results are inconsistent regarding *which* items should be included in a 7-item SPAS. Such inconsistencies are largely due to the use of data-driven model modification processes rather than conceptual and theory-driven processes. Ideally, adjustments to any scale should be consistent with the scale's underlying theoretical rationale, but the SPAS conceptual framework has never been clearly delineated. The lack of a conceptual blueprint for guiding measurement refinements (along with differences in study samples and translations of the SPAS) likely contributes to differences in the proposed 7-item models. Furthermore, very few psychometric studies have investigated samples other than physically active adolescents and college-age students. Little is known about the SPAS's psychometrics in other populations, such as the elderly, low-socioeconomic-status groups, or sedentary samples.

It should also be noted that the SPAS assesses only the cognitive manifestations of SPA. Presumably, like other forms of social anxiety, SPA also has somatic manifestations. For instance, people who experience high levels of SPA may blush or experience an increase in their heart rate or breathing rate in situations where they believe their body to be scrutinized by others. These types of symptoms are not captured by the SPAS.

Summary and Recommendations. Inconsistencies in the observed item structure of the 7-item models can leave researchers wondering just which 7 items they should administer to assess social physique anxiety. Given the lack of consensus, we recommend continued use of the 9-item version of the SPAS to prevent the exclusion of items that may be relevant for a particular sample. Research is still needed to validate and cross-validate the SPAS in different populations and cultures, and until that time, it seems premature to discard items that may be pertinent for a particular group. Consideration should also be given to expanding the SPAS to include items that tap into the somatic manifestations of SPA. We encourage continued efforts to translate the SPAS into other languages and to validate it outside of North America, as such psychometric advances will facilitate cross-cultural studies and expand our knowledge of cultural influences on SPA. When possible, latent means are recommended for comparing group differences in SPAS scores.

There is also a need to further examine whether SPA is best conceptualized and measured as a trait or state phenomenon in physical activity settings. Many researchers forget that the SPAS was developed as a generic, trait measure of social physique anxiety; it was not designed specifically to assess physique anxiety in sport and exercise contexts. Like other forms of social anxiety (e.g., sport competition anxiety), physique anxiety levels can vary across situations. Measures of SPA that are specific to sport and exercise situations, or that assess physique anxiety as a state variable, may provide stronger predictive and explanatory power in studies of physical activity phenomena than the generic SPAS. In recognition of this issue, some researchers have attempted to modify the original SPAS to measure state SPA (e.g., Kruisselbrink et al., 2004). This measurement approach appears promising, but further psychometric evaluation is needed.

Self-Handicapping

The Self-Handicapping Scale (SHS; Jones & Rhodewalt, 1982) was developed in academic achievement settings to measure dispositional tendencies toward making excuses and reducing effort as self-handicapping strategies. Unfortunately, the SHS was shown to lack reliability and validity when used to measure self-handicapping in sport and exercise settings (e.g., Martin & Brawley, 1999; Shields & Paskevich, 2001). As a remedy, some sport researchers have combined an open-ended approach with a standard psychometric approach to tap athletes' use of self-handicaps. For example, participants may be asked to list any disruptive events to training or preparation for competition that occurred over the past week and then to rate the strength of each impediment and the importance of each impediment for the person and for the team as a whole (Carron et al., 1994). Other researchers have measured claimed self-handicapping through a 7-item scale where participants indicate the extent to which seven different impediments (e.g., being tired, injured, having a sore body, or being untrained) are present and will interfere with their performance (Coudevylle & Famose, 2005; Martin & Brawley, 2002).

In the exercise domain, the Self-Handicapping Exercise Questionnaire (SHEQ; Shields et al., 2003) was developed to measure three types of claimed self-handicaps: inability to incorporate exercise into one's routine, discomfort or difficulty with training in exercise facilities, and poor health and physical functioning. Minimal psychometric data have been generated for these sport- and exercise-specific measures.

Critique. Although studies indicate that the sport self-handicapping indices are sensitive to manipulations of known antecedents of self-handicapping, the primary limitation of these measures is the lack of published psychometric data. With regard to the SHEQ, the preliminary psychometrics are promising, with a reasonable fit between measurement model and data. Yet, as its developers acknowledge, it has passed only the first testing stage and needs refinement. The lack of a clear conceptual foundation could be a barrier to this objective.

Summary and Recommendations. The different approaches used to measure self-handicapping in sport and exercise reflect the absence of a single, psychometrically sound instrument for measuring the construct. The varied approaches may also reflect the multifaceted nature of self-handicapping and a need to understand and assess it from different measurement perspectives. Continued psychometric testing should be a priority for all of the sport and exercise self-handicapping measures. With regard to the SHEQ in particular, having survived the first stage of development, its psychometric properties should be tested among different samples, and its three-factor structure needs to be cross-validated with larger samples.

Self-Presentational Confidence and Self-Efficacy

The Physical Self-Efficacy Scale (PSES; Ryckman et al., 1982) consists of two subscales purported to measure perceived physical ability and physical self-presentation confidence. In recent years, the scale has been criticized for its factor structure, content validity, and failure to measure self-efficacy at a situation-specific level (e.g., Hu, McAuley, & Elavsky, 2005; Motl & Conroy, 2000a). To address the last concern, some researchers have created measures of self-presentational efficacy for use in specific experimental contexts, such as physical fitness tests (Martin & Brawley, 2002) and group exercise classes (Gammage et al., 2004). These measures were designed according to Maddux and colleagues' (1988) recommendations, with self-efficacy and social anxiety theoretical frameworks at their foundation.

Critique

The PSES has been criticized for violating the basic tenets of self-efficacy scale construction (Bandura, 1997) and the key assumption that self-efficacy is situation- or task-specific. For example, PSPC items such as "I am never intimidated by the thought of a sexual encounter" and "Sometimes my laugh embarrasses me" do not assess self-presentational efficacy with specific reference to physical activity contexts, nor do they tap hierarchical levels of self-efficacy in the face of difficulties or aversive stimuli. Furthermore, several PSPC items do not assess any self-presentational construct whatsoever, let alone self-efficacy (e.g., "I find that I am not accident prone"; "I am sometimes envious of those better looking than myself").

With regard to the situation-specific self-presentational efficacy scales, these measures have demonstrated good internal consistency and generated some evidence of construct validity. Their primary limitation is that new situation-specific scales have to be developed and pilot-tested for use in new experimental situations. This can be a deterrent to investigators looking for a quick and dirty measurement solution. It should be noted, however, that Gammage and her colleagues (2004) have created a 5-item scale for measuring self-presentational efficacy among exercisers, which has been modified for different exercise research contexts simply by changing the instruction set. For example, prior to completing the scale, Fleming and Martin Ginis (2004) asked participants, "Think about yourself participating in physical exercise activities such as aerobics, jogging, cycling, hip-hop dancing, and strength-training," whereas Woodgate et al. (2003) instructed study participants to "think about exercising with a group of older adults" before responding to the scale items. In both studies, the scale demonstrated strong internal consistency and significant correlations with theoretically meaningful constructs.

Summary and Recommendations

Given the weaknesses of the PSES, alternative approaches are needed to measure self-presentation confidence. But despite our criticisms of the PSES, there may be some value in measuring general confidence in the ability to make desired impressions regarding one's physical capabilities. To measure general confidence, investigators will have to start from scratch and carefully consider both underlying conceptual and measurement models as they develop a new measure. Also, the situational self-efficacy scales would benefit from further psychometric testing, particularly with regard to discriminant validity. It would be reassuring to demonstrate that they do not overlap with more global measures of aspects of the self such as physical self-concept and self-esteem.

PULLING IT ALL TOGETHER

Overall, the sport and exercise self-presentation research can be characterized as first-generational. The vast majority of studies have addressed first-generation research questions, with most topic areas showing just a couple of studies at the second-generation level. Social physique anxiety and self-handicapping are the only topic areas where research questions have been examined across all three generations. It is no coincidence that these two areas have also generated the greatest number of measurement studies. This pattern speaks to the importance of valid and reliable research tools for advancing knowledge.

Chaos in the Brickyard?

Self-presentation is a hot topic among sport and exercise psychologists. Our review indicated a linear increase in the number of self-presentation studies published over the past 20 years. But an increase in research activity does not necessarily mean an increase in substantive, cumulative knowledge about the role of self-presentation in sport and exercise. In contemplating this issue, we are reminded of Bernard Forscher's (1963) allegorical tale of scientist "brickmakers" who forget that a primary goal of science is to construct edifices (or theories) and who instead become obsessed with making large quantities of individual bricks that do not fit with other bricks to build anything substantial. When the research landscape consists of one-off studies that fail to make systematic linkages and fail to build on existing knowledge, the terrain will more closely resemble a chaotic brickyard than a functional structure. Self-presentation researchers must take stock when designing their studies and determine if they are contributing to theory development or simply tossing bricks into the brickyard.

Theory Development in the Self-Presentation Literature

Theories provide a systematic view of a phenomenon by specifying relations among variables to explain and predict events. Much of the research in sport and exercise psychology should be concerned with constructing, refining, and testing theoretical frameworks, but unfortunately, most studies of self-presentational phenomena have been atheoretical.

This shortcoming may partly reflect the absence of formally defined theories of self-presentation. Although physical activity studies often make reference to "self-presentational theory" (e.g., Focht & Hausenblas, 2003; Marquez & McAuley, 2001), in actuality, no comprehensive theory of self-presentation exists. In fact, the self-presentational approach has been characterized more as a "metatheoretical framework within which one can formulate and seek answers to questions on the causes and consequences of human social behavior" rather than a theory in and of itself (Tetlock & Manstead, 1985, p. 62).

One example of a self-presentational framework is Jones and Pittman's (1982) taxonomy of strategic self-presentation strategies. Their taxonomy delineates five classes of self-presentational strategies, each linked with the type of impression desired by the person using the strategy (see Table 6.3). Jones and Pittman's objective was to provide a conceptual framework that would organize and relate self-presentational phenomena and provide a basis for theory-building research in the area. Their taxonomy was not conceived as a theory in and of itself.

Likewise, the goal of Leary and Kowalski's (1990) two-component model was to bring coherence to the self-presentation area by reducing myriad self-presentation variables to a small set of conceptually meaningful factors. As shown in Figure 6.1, their model delineates factors contributing to the underlying self-presentation processes of impression motivation and construction. The two-component model elegantly captures and organizes the many processes involved in impression-relevant behavior and is an excellent conceptual framework to use as a basis for self-presentation research. However, it does not yet provide (nor does it claim to provide) the predictive and explanatory powers associated with more fully developed and delineated theories.

As an alternative to self-presentational frameworks, some physical activity researchers have cast their studies in theories and models that are frequently used in sport and exercise psychology. For example, social cognitive theory (Bandura, 1997) has been applied to understand the relationship between exercise and social physique anxiety (McAuley et al., 2002; Woodgate et al., 2003). Achievement motivation theory (Ames, 1992) has been used to understand athletes' use of self-handicaps (Coudevylle & Famose, 2005). In addition, a few studies (e.g., Latimer & Martin Ginis, 2005; Marquez & McAuley, 2001) have attempted to integrate self-presentational concepts with theories such as the theory of planned behavior (TPB; Ajzen, 1985) and social cognitive theory. For example, Latimer and Martin Ginis (2005) showed that within the TPB, the relationship between subjective norms for exercise and intentions to exercise is moderated by level of impression motivation. It should be noted, however, that these types of integrative attempts have focused on using self-presentational concepts to advance a theoretical understanding of activity-related thoughts, feelings, and behaviors in general, rather than advancing theory regarding *self-presentation* in sport and exercise in particular.

Building Plans for the Future

As a starting point, we suggest that attention be devoted to synthesizing existing data. To date, there have been virtually no published attempts to compile comprehensive summaries of self-presentation data from sport and exercise studies. For instance, a plethora of first-generation studies have produced data on correlates of self-presentational phenomena, but this information has yet to be synthesized in a way that brings order and understanding.

Table 6.3 Jones and Pittman's (1982) Taxonomy of Self-Presentational Strategies

Strategy	Impression Sought	Negative Impression Risked	Emotion to Be Aroused	Prototypical Actions
Ingratiation	Likeable	Sycophant, conformist, obsequious	Affection	Self-characterization, opinion conformity, other enhancement, favors
Intimidation	Dangerous (ruthless, volatile)	Blusterer, wishy-washy, ineffectual	Fear	Threats, anger, breakdown
Self-promotion	Competent (effective, "a winner")	Fraudulent, conceited, defensive	Respect (awe, deference)	Performance claims, performance accounts, performances
Exemplification	Worthy (suffers, dedicated)	Hypocrite, sanctimonious, exploitive	Guilt (shame, emulation)	Self-denial, helping, militancy for a cause
Supplication	Helpless (handicapped, unfortunate)	Stigmatized, lazy, demanding	Nurturance (obligation)	Self-deprecation, entreaties for help

Adapted from "Toward a General Theory of Strategic Self-Presentation" (pp. 231–262), by E. E. Jones and T. S. Pittman, in *Psychological Perspectives on the Self,* J. Suls (Ed.), 2000, Hillsdale, NJ: Erlbaum. Copyright 1982 by Lawrence Erlbaum Associates. Adapted with permission.

Table 6.2 provides a very rudimentary catalogue of potential correlates of social physique anxiety. This information could be used as the framework for a proper meta-analytic synthesis of the correlates of SPA and other self-presentational phenomena. A meta-analysis was beyond the scope of this chapter, but it would allow researchers to take stock of the existing bricks in the self-presentational brickyard. We would then be able to see if any linkages exist between conceptually meaningful categories of correlates (e.g., behavioral, environmental, demographic) and different types of self-presentational phenomena. Identification of linkages would guide the selection of variables for studies of antecedents and consequences of self-presentation, which, in turn, would allow for the establishment of basic theoretical principles regarding causes and effects of self-presentation.

Data synthesis would also allow investigators to determine how best to proceed with theory development. For example, should we try to fit sport- and exercise-related self-presentational phenomena into existing self-presentation models (e.g., two-component model)? Should we develop new theories to explain phenomena specifically in the context of physical activity (e.g., a theory of self-handicapping in sport)? Or should we try to integrate sport- and exercise-related self-presentational processes into other theories (e.g., social cognitive theory)? Regardless of which approach is chosen, theory development must be a priority. Without theory, scientists do not have a blueprint to aid in study and measurement design, and practitioners do not have guidelines for developing effective interventions.

As well, we believe that it is time to move beyond first-generation research questions. Instead of merely assessing whether the correlation coefficient between self-presentation and some other variable is statistically significant, investigators must begin to treat these correlations as if they were any other dependent variable and determine what factors affect their strength (cf. Zanna & Fazio, 1982). The identification of moderating and mediating variables (i.e., second- and third-generation research questions) is a vital step in the process of theory development. Likewise, the continued development and assessment of sport- and exercise-relevant measures of self-presentation is crucial to the advancement of knowledge.

When taking these steps forward, it is imperative that investigators articulate the manner in which studies build on one another. For example, research reports should state explicitly how a given study advances what is currently known about a particular theory (cf. Weinstein & Rothman, 2005). Paying attention to the bigger self-presentation research picture will aid investigators in designing studies that answer vital questions and fill in knowledge gaps. This should be a priority for all sport and exercise researchers. After all, nobody wants to convey the impression of being a brick tosser.

REFERENCES

Ajzen, I. (1985). From intentions to action: A theory of planned behavior. In J. Kuhl & J. Beckmann (Eds.), *Action control: From cognition to behavior* (pp. 11–39). Heidelberg, Germany: Springer-Verlag.

Ames, C. (1992). Achievement goals, motivational climate, and motivational processes. In G. C. Roberts (Ed.), *Motivation in sport and exercise* (pp. 161–176). Champaign, IL: Human Kinetics.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York: Freeman.

Baranowski, T., Anderson, C., & Carmack, C. (1998). Mediating variable framework in physical activity interventions: How are we doing? How might we do better? *American Journal of Preventive Medicine, 15,* 266–297.

Baron, R. A., & Byrne, D. (1997). *Social psychology: Understanding human interaction* (7th ed.). Needham Heights, MA: Simon & Schuster.

Baumeister, R. F., & Steinhilber, A. (1984). Paradoxical effects of supportive audiences on performance under pressure: The home field disadvantage in sports championships. *Journal of Personality and Social Psychology, 47,* 85–93.

Beck, A. T., & Emery, G. (1985). *Anxiety disorders and phobias: A cognitive perspective.* New York: Basic Books.

Berglas, S., & Jones, E. E. (1978). Drug choice as a self-handicapping strategy in response to noncontingent success. *Journal of Personality and Social Psychology, 36,* 405–417.

Boutcher, S. H., Fleischer-Curtian, L. A., & Gines, S. D. (1988). The effects of self-presentation on perceived exertion. *Journal of Sport and Exercise Psychology, 10,* 270–280.

Bray, S. R., Martin, K. A., & Widmeyer, W. N. (2000). The relationship between evaluative concerns and sport competition state anxiety among youth skiers. *Journal of Sports Sciences, 18,* 353–361.

Carron, A. V., Prapavessis, H., & Grove, J. R. (1994). Group effects and self-handicapping. *Journal of Sport and Exercise Psychology, 16,* 246–257.

Conroy, D. E., & Motl, R. W. (2003). Modification, cross-validation, invariance, and latent mean structures of the Self-Presentation in Exercise Questionnaire. *Measurement in Physical Education and Exercise Science, 7,* 1–18.

Conroy, D. E., Motl, R. W., & Hall, E. G. (2000). Progress toward construct validation of the Self-Presentation in Exercise

Questionnaire (SPEQ). *Journal of Sport and Exercise Psychology, 22,* 21–38.

Coudevylle, G., & Famose, J. P. (2005). Le climat motivationnel comme déterminant principal des déclarations et des comportements d'auto-handicap en basketball [Motivational climate as a principal determinant of self-handicapping claims and behaviours in basketball]. *Actes du Congrès, Société Française de Psychologie du Sport, Congrès International,* 80–81.

Crawford, S., & Eklund, R. C. (1994). Social physique anxiety, reasons for exercise, and attitudes toward exercise settings. *Journal of Sport and Exercise Psychology, 16,* 70–82.

Eklund, R. C., & Crawford, S. (1994). Active women, social physique anxiety, and exercise. *Journal of Sport and Exercise Psychology, 16,* 431–448.

Fleming, J. C., & Martin Ginis, K. A. (2004). The effects of commercial exercise video models on women's self-presentational efficacy and exercise task self-efficacy. *Journal of Applied Sport Psychology, 16,* 92–102.

Focht, B. C., & Hausenblas, H. A. (2001). Influence of quiet rest and acute aerobic exercise performed in a naturalistic environment on selected psychological responses. *Journal of Sport and Exercise Psychology, 23,* 108–121.

Focht, B. C., & Hausenblas, H. A. (2003). State anxiety responses to acute exercise in women with high social physique anxiety. *Journal of Sport and Exercise Psychology, 25,* 123–144.

Ford, I. W., & Gordon, S. (1997). Perspectives of sport physiotherapists on the frequency and significance of psychological factors in professional practice: Implications for curriculum design in professional training. *Australian Journal of Science and Medicine in Sport, 29,* 34–40.

Forscher, B. K. (1963). Chaos in the brickyard. *Science, 142,* 3590.

Gammage, K. L., Hall, C. R., & Martin Ginis, K. A. (2004). Self-presentation in exercise contexts: Differences between high and low frequency exercisers. *Journal of Applied Social Psychology, 34,* 1638–1651.

Gammage, K. L., Hall, C. R., Prapavessis, H., Maddison, R., Haase, A., & Martin, K. A. (2004). Re-examination of the factor structure and composition of the Self-Presentation in Exercise Questionnaire (SPEQ). *Journal of Applied Sport Psychology, 16,* 82–91.

Gammage, K. L., Martin Ginis, K. A., & Hall, C. R. (2004). Self-presentational efficacy: Its influence on social anxiety in an exercise context. *Journal of Sport and Exercise Psychology, 26,* 179–190.

Goffman, E. (1959). *The presentation of self in everyday life.* New York: Anchor Books.

Greenlees, L., Buscombe, R., Thelwell, R., Holder, T., & Rimmer, M. (2005). Impact of opponents' clothing and body language on impression formation and outcome expectations. *Journal of Sport and Exercise Psychology, 27,* 39–52.

Grove, J. R., & Dodder, R. A. (1982). Constructing measures to assess perceptions of sport functions: An exploratory investigation. *International Journal of Sport Psychology, 13,* 106.

Grove, J. R., Hanrahan, S. J., & McInman, A. (1991). Success failure bias in attributions across involvement categories in sport. *Personality and Social Psychology Bulletin, 17,* 93–97.

Haase, A. M., & Prapavessis, H. (2001). Social physique anxiety and eating attitudes in female athletic and non-athletic groups. *Journal of Science and Medicine in Sport, 4,* 396–405.

Haase, A., Prapavessis, H., & Owens, R. G. (1999). Perfectionism and eating attitudes in competitive rowers: Moderating effects of body mass, weight classification, and gender. *Psychology and Health, 14,* 643–657.

Halbert, C. (1997). Tough enough and woman enough: Stereotypes, discrimination, and impression management among women professional boxers. *Journal of Sport and Social Issues, 21,* 7–36.

Hardy, C. J., Hall, E. G., & Prestholdt, P. H. (1986). The mediational role of social-influence in the perception of exertion. *Journal of Sport Psychology, 8,* 88–104.

Hart, E. A., Leary, M. R., & Rejeski, W. J. (1989). The measurement of social physique anxiety. *Journal of Sport and Exercise Psychology, 11,* 94–104.

Hausenblas, H. A., Brewer, B. W., & Van Raalte, J. L. (2004). Self-presentation and exercise. *Journal of Applied Sport Psychology, 16,* 3–18.

Hu, L., McAuley, E., & Elavsky, S. (2005). Does the Physical Self-Efficacy Scale assess self-efficacy or self-esteem? *Journal of Sport and Exercise Psychology, 27,* 152–170.

Hudson, J., & Williams, M. (2001). Associations between self-presentation and competitive A-trait: A preliminary investigation. *Social Behavior and Personality, 29,* 1–9.

Hudson, J., Williams, M., & Stacey, P. (1998). Impression management and self-handicapping in middle-distance runners. *Journal of Sport Sciences, 16,* 390–391.

Isogai, H., Brewer, B. W., Cornelius, A. E., Komiya, S., Tokunaga, M., & Tokushima, S. (2001). Cross-cultural validation of the Social Physique Anxiety Scale. *International Journal of Sport Psychology, 32,* 76–87.

James, B., & Collins, D. (1997). Self-presentational sources of competitive stress during performance. *Journal of Sport and Exercise Psychology, 19,* 17–35.

Jones, E. E., & Pittman, T. S. (1982). Toward a general theory of strategic self-presentation. In J. Suls (Ed.), *Psychological perspectives on the self* (pp. 231–262). Hillsdale, NJ: Erlbaum.

Jones, E. E., & Rhodewalt, F. (1982). *The Self-Handicapping Scale.* Available from F. Rhodewalt, University of Utah, Department of Psychology, Salt Lake City.

Kruisselbrink, L. D., Dodge, A. M., Swanburg, S. L., & MacLeod, A. L. (2004). Influence of same-sex and mixed-sex exercise settings on the social physique anxiety and exercise intentions of males and females. *Journal of Sport and Exercise Psychology, 26,* 616–622.

Lantz, C. D., Hardy, C. J., & Ainsworth, B. E. (1997). Social physique anxiety and perceived exercise behavior. *Journal of Sport Behavior, 20,* 83–93.

Latimer, A. E., & Martin Ginis, K. A. (2005). The importance of subjective norms for people who care what others think of them. *Psychology and Health, 20,* 53–62.

Leary, M. R. (1992). Self-presentational processes in exercise and sport. *Journal of Sport and Exercise Psychology, 14,* 339–351.

Leary, M. R. (1995). *Self-presentation: Impression management and interpersonal behavior.* Boulder, CO: Westview.

Leary, M. R., & Kowalski, R. M. (1990). Impression management: A literature review and two-component model. *Psychological Bulletin, 107,* 34–47.

Leary, M. R., & Kowalski, R. M. (1995). *Social anxiety.* New York: Guilford Press.

Leary, M. R., & Shepperd, J. A. (1986). Behavioral self-handicapping versus self-reported handicaps: A conceptual note. *Journal of Personality and Social Psychology, 51,* 1268.

Leary, M. R., Wheeler, D. S., & Jenkins, T. B. (1986). Aspects of identity and behavioral preference: Studies of occupational and recreational choice. *Social Psychology Quarterly, 49,* 11–18.

Linder, D. E., Farrar, D., Sadalla, E. K., Sheets, V., & Bartholomew, J. (1992, June). *Stereotypes of female athletes.* Paper presented at the meeting of the North American Society for the Psychology of Sport and Physical Activity, Pittsburgh, PA.

Lindwall, M. (2004). Factorial validity and invariance testing of the Swedish Social Physique Anxiety Scale: Arguments for gender-specific scales. *Journal of Sport and Exercise Psychology, 26,* 492–499.

Lindwall, M. (2005). Examining the validity of a Swedish version of the Self-Presentation in Exercise Questionnaire. *Measurement in Physical Education and Exercise Science, 9,* 113–134.

Lindwall, M., & Martin Ginis, K. A. (2006). Moving towards a favourable image: The self-presentational benefits of exercise and physical activity. *Scandinavian Journal of Psychology, 47,* 209–217.

Lox, C. L., McAuley, E., & Tucker, R. S. (1995). Exercise as an intervention for enhancing subjective well-being in an HIV-1 population. *Journal of Sport and Exercise Psychology, 17,* 345–362.

Mack, M. G. (2003). Does exercise status influence the impressions formed by college students? *College Student Journal, 37,* 483–489.

Maddux, J. E., Norton, L. W., & Leary, M. R. (1988). Cognitive components of social anxiety: An investigation of the integration of self-presentation theory and self-efficacy theory. *Journal of Social and Clinical Psychology, 6,* 180–190.

Marquez, D. X., & McAuley, E. (2001). Physique anxiety and self-efficacy influences on perceptions of physical evaluation. *Social Behavior and Personality, 29,* 649–659.

Martin, K. A., & Brawley, L. R. (1999). Is the Self-Handicapping Scale reliable in non-academic achievement domains? *Personality and Individual Differences, 27,* 901–911.

Martin, K. A., & Brawley, L. R. (2002). Self-handicapping in physical achievement settings: The contributions of self-esteem and self-efficacy. *Self and Identity, 1,* 337–351.

Martin, K. A., & Fox, L. D. (2001). Group and leadership effects on social anxiety experienced during an exercise class. *Journal of Applied Social Psychology, 31,* 1000–1016.

Martin, K. A., & Leary, M. R. (2001). Self-presentational determinants of health risk behavior among college freshmen. *Psychology and Health, 16,* 17–27.

Martin, K. A., Leary, M. R., & O'Brien, J. (2001). Role of self-presentation in the health practices of a sample of Irish adolescents. *Journal of Adolescent Health, 28,* 259–262.

Martin, K. A., & Mack, D. (1996). Relationships between physical self-presentation and sport competition trait anxiety: A preliminary study. *Journal of Sport and Exercise Psychology, 18,* 75–82.

Martin, K. A., Rejeski, W. J., Leary, M. R., McAuley, E., & Bane, S. (1997). Is the Social Physique Anxiety Scale really multidimensional? Conceptual and statistical arguments for a unidimensional model. *Journal of Sport and Exercise Psychology, 19,* 359–367.

Martin, K. A., Sinden, A. R., & Fleming, J. C. (2000). Inactivity may be hazardous to your image: The effects of exercise participation on impression formation. *Journal of Sport and Exercise Psychology, 22,* 283–291.

Martin Ginis, K. A., Eng, J. J., Arbour, K. P., Phillips, S. M., & Hartman, J. W. (2005). Mind over muscle? Sex differences in the relationship between body image change and subjective and objective physical changes following a 12-week strength-training program. *Body Image, 2,* 363–372.

Martin Ginis, K. A., Latimer, A. E., & Jung, M. E. (2003). No pain no gain? Examining the generalizability of the exerciser stereotype to moderately active and excessively active targets. *Social Behavior and Personality, 31,* 283–290.

Martin Ginis, K. A., & Leary, M. R. (2004). Self-presentational processes in health damaging behavior. *Journal of Applied Sport Psychology, 16,* 59–74.

Martin Ginis, K. A., O'Brien, J., & Watson, J. D. (2003). The importance of self-presentational motives for exercise: A preliminary cross-cultural comparison of Irish and American students. *Irish Journal of Psychology, 24,* 46–57.

McAuley, E., Bane, S. M., & Mihalko, S. L. (1995). Exercise in middle-aged adults: Self-efficacy and self-presentational outcomes. *Preventive Medicine, 24,* 319–328.

McAuley, E., Bane, S. M., Rudolph, D. L., & Lox, C. L. (1995). Physique anxiety and exercise in middle-aged adults. *Journals of Gerontology Series B-Psychological Sciences and Social Sciences, 50,* 229–235.

McAuley, E., & Burman, G. (1993). The Social Physique Anxiety Scale: Construct-validity in adolescent females. *Medicine and Science in Sports and Exercise, 25,* 1049–1053.

McAuley, E., Marquez, D. X., Jerome, G. J., Blissmer, B., & Katula, J. (2002). Physical activity and physique anxiety in older adults: Fitness and efficacy influences. *Aging and Mental Health, 6,* 222–230.

McInman, A. D., & Berger, B. G. (1993). Self-concept and mood changes associated with aerobic dance. *Australian Journal of Psychology, 45,* 134–140.

Motl, R. W., & Conroy, D. E. (2000a). Confirmatory factor analyses of the Physical Self-Efficacy Scale with a college-aged sample of men and women. *Measurement in Physical Education and Exercise Science, 4,* 13–27.

Motl, R. W., & Conroy, D. E. (2000b). Validity and factorial invariance of the social physique anxiety scale. *Medicine and Science in Sports and Exercise, 32,* 1007–1017.

Motl, R. W., & Conroy, D. E. (2001). The Social Physique Anxiety Scale: Cross validation, factorial invariance, and latent mean structure. *Measurement in Physical Education and Exercise Science, 5,* 81–95.

Pinto, R. M., & Sarkin, A. J. (1996). Interpersonal deficits and time spent in exercise or active recreation. *Psychological Reports, 78,* 323–328.

Prapavessis, H. (Ed.). (2004). Self-presentation in exercise and sport [Special issue]. *Journal of Applied Sport Psychology, 16,* 1–2.

Prapavessis, H., & Grove, J. R. (1994). Personality variables as antecedents of precompetitive mood state temporal patterning. *International Journal of Sport Psychology, 25,* 347–365.

Prapavessis, H., & Grove, J. R. (1998). Self-handicapping and self-esteem. *Journal of Applied Sport Psychology, 10,* 175–184.

Prapavessis, H., Grove, J. R., & Eklund, R. C. (2004). Self-presentational issues in competition and sport. *Journal of Applied Sport Psychology, 16,* 19–40.

Prapavessis, H., Grove, J. R., Maddison, R., & Zillmann, N. (2003). Self-handicapping tendencies, coping, and anxiety responses among athletes. *Psychology of Sport and Exercise, 4,* 357–375.

Rhea, M. R., Landers, D. M., Alvar, B. A., & Arent, S. M. (2003). The effects of competition and the presence of an audience on weight lifting performance. *Journal of Strength and Conditioning Research, 17,* 303–306.

Rhodewalt, F., Saltzman, A. T., & Wittmer, J. (1984). Self-handicapping among competitive athletes: The role of practice in self-esteem protection. *Basic and Applied Social Psychology, 5,* 197–209.

Ryckman, R. M., Robbins, M. A., Thornton, B., & Cantrell, P. (1982). Development and validation of a physical self-efficacy scale. *Journal of Personality and Social Psychology, 42,* 891–900.

Ryska, T. A. (2002). Effects of situational self-handicapping and state self-confidence on the physical performance of young participants. *Psychological Record, 52,* 461–478.

Ryska, T. A., Yin, Z. N., & Cooley, D. (1998). Effects of trait and situational self-handicapping on competitive anxiety among athletes. *Current Psychology, 17,* 48–56.

Sadalla, E. K., Linder, D. E., & Jenkins, B. A. (1988). Sport preferences: A self-presentational analysis. *Journal of Sport and Exercise Psychology, 10,* 214–222.

Schlenker, B. R. (1980). *Impression management: The self-concept, social identity, and interpersonal relations.* Monterey, CA: Brooks/Cole.

Schwerin, M. J., Corcoran, K. J., Fisher, L., Patterson, D., Askew, W., Olrich, T., et al. (1996). Social physique anxiety, body esteem, and social anxiety in bodybuilders and self-reported anabolic steroid users. *Addictive Behaviors, 21,* 1–8.

Shields, C. A., & Paskevich, D. M. (2001). Examination of the Self-Handicapping Scale and its extension for use in exercise. *Avante, 17,* 1–10.

Shields, C. A., Paskevich, D. M., & Brawley, L. R. (2003). Self-handicapping in structured and unstructured exercise: Toward a measurable construct. *Journal of Sport and Exercise Psychology, 25,* 267–283.

Smith, A. L. (2004). Measurement of social physique anxiety in early adolescence. *Medicine and Science in Sports and Exercise, 36,* 475–483.

Smith, J. A., Hauenstein, N. M. A., & Buchanan, L. B. (1996). Goal setting and exercise performance. *Human Performance, 9,* 141–154.

Snyder, C. R. (1990). Self-handicapping processes and sequelae: On the taking of a psychological dive. In R. L. Higgins, C. R. Snyder, & S. Berglas (Eds.), *Self-handicapping: The paradox that isn't* (pp. 107–150). New York: Plenum Press.

Stone, J., Perry, Z. W., & Darley, J. M. (1997). "White men can't jump": Evidence for the perceptual confirmation of racial stereotypes following a basketball game. *Basic and Applied Social Psychology, 19,* 291–306.

Tenenbaum, G., Lidor, R., Lavyan, N., Morrow, K., Tonnel, S., & Gershgoren, A. (2005). Dispositional and task-specific social-cognitive determinants of physical effort perseverance. *Journal of Psychology, 139,* 139–157.

Tetlock, P. E., & Manstead, A. S. R. (1985). Impression management versus intrapsychic explanations in social-psychology: A useful dichotomy. *Psychological Review, 92,* 59–77.

Thill, E. E., & Cury, F. (2000). Learning to play golf under different goal conditions: Their effects on irrelevant thoughts and on subsequent control strategies. *European Journal of Social Psychology, 30,* 101–122.

Thorndike, E. L. (1920). A constant error in psychological ratings. *Journal of Applied Psychology, 4,* 25–29.

Treasure, D. C., Lox, C. L., & Lawton, B. R. (1998). Determinants of physical activity in a sedentary, obese female population. *Journal of Sport and Exercise Psychology, 20,* 218–224.

Wann, D. L., & Porcher, B. J. (1998). The relationship between players' names on uniforms and athlete aggression. *International Sports Journal, 2,* 28–35.

Wann, D. L., Royalty, J., & Roberts, A. (2000). The self-presentation of sports fans: Investigating the importance of team identification and self-esteem. *Journal of Sport Behavior, 23,* 198–206.

Weinstein, N. D., & Rothman, A. J. (2005). Commentary: Revitalizing research on health behavior theories. *Health Education Research, 20,* 294–297.

Williams, M., Hudson, J., & Lawson, R. J. (1999). Self-presentation in sport: Initial development of a scale for measuring athletes' competitive self-presentation concerns. *Social Behavior and Personality, 27,* 487–502.

Williams, P. A., & Cash, T. F. (2001). Effects of a circuit weight training program on the body images of college students. *International Journal of Eating Disorders, 30,* 75–82.

Wilson, P., & Eklund, R. C. (1998). The relationship between competitive anxiety and self-presentational concerns. *Journal of Sport and Exercise Psychology, 20,* 81–97.

Wong, E. H., Lox, C. L., & Clark, S. E. (1993). Relation between sports context, competitive trait anxiety, perceived ability, and self-presentation confidence. *Perceptual and Motor Skills, 76,* 847–850.

Woodgate, J., Martin Ginis, K. A., & Sinden, A. R. (2003). Physical activity and social physique anxiety in older women: The moderating effects of self-presentation efficacy. *Journal of Applied Biobehavioral Research, 8,* 116–127.

Worringham, C. J., & Messick, D. M. (1983). Social facilitation of running: An unobtrusive study. *Journal of Social Psychology, 121,* 23–29.

Zanna, M. P., & Fazio, R. H. (1982). The attitude-behavior relation: Moving toward a third generation of research. In M. P. Zanna, E. T. Higgins, & C. P. Herman (Eds.), *Consistency in social behavior* (pp. 283–301). Hillsdale, NJ: Erlbaum.

PART III

Sport Expertise

CHAPTER 7

Methodological Review and Evaluation of Research in Expert Performance in Sport

NICOLA J. HODGES, RAOUL HUYS, and JANET L. STARKES

Through an analysis of experts' performances and careers, the constraints on performance and the mechanisms and processes providing the expert advantage in sport can be appreciated. The study of domain experts provides insights into motor control and learning processes, enabling us to understand how high performance in motor skills is achieved and how to facilitate skill development. The study of expertise and skill acquisition has often been driven by advances in measurement. The aim of this chapter is to provide a review of sport expertise research, with a particular focus on how methods, technology, and measurement have developed to help address questions in the field. Advances in measurement have not necessarily been driven by technology; rather, new questions and a rephrasing of old ones have often led to the development of new methods to explore expertise-related issues.

This method-focused review is structured by three major themes that underpin research in expertise. The first theme is how expert athletes are able to make fast and accurate decisions, culminating in actions, compared to their less skilled counterparts. We first briefly review the various techniques that have successfully differentiated across skill levels and address particular questions relating to the measurement of decisions and the ecological validity of these techniques. These methods are then reviewed in relation to two overlapping, but what we evaluate as different research questions. The first question concerns the type of knowledge structures that underlie performance; the second question addresses the type of perceptual information affording the expert advantage. In the second theme we evaluate methods and measurement techniques that have been used to examine how skilled performers control their actions. Specifically, we explore characteristic movement features and control strategies that define expert performance across various levels of the motor system, including the examination of cognitive strategies and biomechanical/behavioral features. In the third theme we examine methods that have been used to explore how expertise is achieved across the careers of experts and how variables such as gender and age impact on the development and maintenance of high-performance skill. It is our goal to provide a comprehensive review of the methods that have been used to address fundamental questions in expertise research. Where space does not allow for in-depth discussion, we have provided references for further reading. In some sections more detailed reviews are provided than in others, which typically reflects the popularity of the measures as well as our wish to avoid duplication with other chapters in this book.

ASSESSING THE EXPERT ADVANTAGE IN DECISION MAKING

There is a multitude of good review chapters and a number of special journal issues on the issue of decision making in sport (e.g., McPherson, 1993; Ripoll, 1991; Starkes & Allard, 1993; Tenenbaum, 2003). Decision making in sports requires the actor to decide how to (re)act to environmental demands to achieve various performance goals, such as winning a point. Decision skills differentiate across

Support for writing this chapter was provided to the first author by the Social Sciences and Humanities Research Council of Canada (SSHRC Grant 410-05-0224) and to the third author by the Natural Sciences and Engineering Research Council of Canada (NSERC Grant 3700–2001).

skill levels among young children in tennis (McPherson & Thomas, 1989) and basketball (French & Thomas, 1987) and consistently among adult experts in sports such as field hockey (Starkes & Deakin, 1984), volleyball (Allard & Starkes, 1980), and soccer (Ward & Williams, 2003). In general, skilled performers make more accurate and faster decisions compared to less skilled players. Decision skills have been assessed using a number of different methods, summarized in Table 7.1. In the early research, decision accuracy was assessed through written responses following the presentation of static schematics or photographs from real games (e.g., Allard & Burnett, 1985; Starkes & Deakin, 1984), where athletes were required to watch and select the best move within time constraints. Dynamic video presentations are now commonly used for assessing decision skills (e.g., Ward & Williams, 2003; Williams, Hodges, North, & Barton, 2006), and efforts are under way to more closely simulate live game situations under controlled settings through 3D virtual reality (discussed later in the chapter).

Besides the method of presentation, the method of response has also evolved. Measurement of response outcomes (i.e., speed and accuracy), and the processes underpinning this outcome (i.e., how a decision was reached), began with written or verbal responses (e.g., Starkes & Deakin, 1984), including more recent situational probability methods whereby participants are asked to indicate the probability of an event, such as the best passing option in soccer (e.g., Alain & Sarrazin, 1990; Ward & Williams, 2003). More recently, measurement has been accomplished via a key-press response connected to a reaction timer (e.g., Franks & Hanvey, 1997); a voice-activated timer (e.g., Starkes & Deakin, 1984); a joystick response, enabling a measure of response corrections as the action unfolds (e.g., Savelsbergh, Williams, van der Kamp, & Ward, 2002); ground reaction time pads interfaced with switches for full body movements (e.g., Ward, Williams, & Bennett, 2002); and real-time analysis of movement and live game scenarios (e.g., Bootsma & van Wieringen, 1990; Rodrigues, Vickers, & Williams, 2002). Thus, over the years, the stimuli as well as the response modes have generally increased in ecological validity, leading to more sensitive measures of expert-novice differences.

The importance of ecological validity of the response mode was underscored by Oudejans, Michaels, and Bakker (1997), who found expert-novice differences in baseball catching judgments only when actual catching was required. The ecological validity of the perceptual stimulus also affects the observation of expert-novice differences in decisions. Féry and Crognier (2001) concluded that ball trajectories are harder to see in film clips than in real-life scenarios. It is likely that in two-dimensional presentations with a limited viewing angle, depth cues or peripheral information, which could be used in decision making, become obscured. The validity of stimulus presentations could be enhanced with virtual reality, which also affords more stimulus control than real-life game situations (see Williams & Ericsson, in press). A drawback of this method is the introduction of a time delay when coupled to the observer's action in real time. In a meta-analytic review of the expertise literature, J. R. Thomas, Gallagher, and Lowry (2003) showed that effect sizes tended to be larger when ecological

Table 7.1 Methods for Assessing Decision Accuracy and Speed according to the Type of Stimulus, Response, Measurement Validity, and Information about the Response, Including Speed, Accuracy, and the Decision Process

Stimulus/Response Mode	Ecological Validity	Outcome	Process
Stimulus Type			
2D static slides/schematics	Low		
2D dynamic video	Medium		
3D virtual reality	High		
Live game	High		
Response Type			
Verbal/written/situational probabilities	Low	Accuracy	Yes
RT timer (key press or microphone)	Low	RT and accuracy	No
Joystick response	Medium	RT, MT, and accuracy	Yes
Floor pads	High	RT, MT, and accuracy	No
3D body kinematics	High	RT, MT, and accuracy	Yes
Live game video analysis	High	MT and accuracy	Yes

Note: MT = Movement time; RT = Reaction time.

validity was high, although skill effects did not covary significantly with the degree of ecological validity.

One of the most valid methods of assessing the quality of expert decisions is to assess them during competitive play (in either concurrent observation or video analysis; French & Thomas, 1987; McPherson & Thomas, 1989). The appropriateness of a decision depends on many factors, and as such, assessing the accuracy of a decision is not trivial, particularly for team games. French et al. (1996) showed that a skill that cannot be performed would not be considered an option in a game. Therefore, assessing decision accuracy in the absence of knowledge of an individual's skills is misleading. Also, contextual information likely impacts future decisions, such that the inability to beat a defender in an earlier situation might dictate a better decision to pass on subsequent attempts. Coaches are typically asked to rate the best decisions under relatively unconstrained time conditions. Moreover, whether coaches are actually better decision makers than elite players is questionable (e.g., Franks, 1993). The quality of decisions has also been determined from the results of a particular game scenario, but even a desired result does not imply the action was the best (albeit sufficient) decision. One way to perhaps circumvent this problem is for players to reanalyze their own decisions (similar to situational probabilities).

Probing the Knowledge Structures That Underpin Expert Decisions/Actions

There have been a variety of methods over the past 30 years or so that have been used to determine what type of knowledge guides the decisions of experts. One of the simplest, in terms of equipment requirements at least, is that of questioning and analysis of verbal protocols. This has been an important tool for understanding when and what knowledge is accessed to aid performance as well as how it is organized. This method is particularly insightful when coupled with other methods such as categorization tasks. Perhaps the most popular approach has been the recall paradigm, whereby performers are given a limited period of time to observe and recall various game and non-game related scenarios. These various techniques are discussed in turn below.

Verbal Protocol Analysis

The mechanisms underpinning expert performance have been illuminated by think-aloud protocols, in which performers verbalize their thoughts and plans during or after an action. Verbalizations of skilled performers offer insights into the knowledge structures that are accessed and used to make decisions and perform tasks. This technique was popularized by de Groot (1965/1978), who required chess players to think aloud when deciding a chess move. Protocol analysis seems particularly suited to tasks that are not time-constrained and involve few if any motor skills, such as solving physics problems or playing board games. In sport, the seemingly automatic nature of decisions creates problems for analysis of explicit verbalizations, and it has been suggested that reports might be introspections, judgments, or wishes rather than representative cognitions (see K. T. Thomas & Thomas, 1994). Therefore, the methods to obtain verbal protocols, discussed in depth by Ericsson and Simon (1993), are important for obtaining valid data. The methods are designed to elicit thinking aloud either concurrently ("What are you thinking right now?") or retrospectively ("What were you thinking about while engaging in the task?") to uncover what is attended to as a performer plans and performs. The most appropriate measure is task-dependent. For example, if verbal reports significantly slow task performance, then it is more appropriate to elicit the thought processes after the play.

Much of the early work on protocol analysis in sports was conducted by McPherson, French, Thomas, and colleagues (see McPherson & Kernodle, 2003, for a recent review). Their aim was to understand the relationship between *knowing,* referred to as declarative knowledge (see Anderson, 1982), and *doing,* referred to as procedural knowledge. French and Thomas (1987) elicited the knowledge and skills underlying skilled performance in young basketball players through multiple-choice questions, observation, and open-ended interviews where players were asked to discuss possible outcome and decision alternatives for various basketball scenarios. Verbal reports were collected in situations where players were prompted with images about specific game instances and in between points to assess knowledge and future plans. Basketball knowledge related strongly to decision skills throughout the season, and both developed more quickly than motor skills (see also McPherson, 1999a, 1999b; McPherson & Thomas, 1989).

More recent research using verbal protocol analysis led McPherson and colleagues (see French & McPherson, 1999; McPherson & Kernodle, 2003) to differentiate action plans from current event profiles. Action plans are memory structures used to activate rule-based responses (i.e., condition-action mappings or if-then productions). Current event profiles enable features of the task and environment (e.g., opponent characteristics, the success of particular shots) to be incorporated into the action plans. Similarly, Sève, Saury, Theureau, and Durand (2002), from interview analysis of a table-tennis player during a World Cup match, showed how cognitively active the table-tennis player was in using past knowledge about the opponent's weaknesses and strengths to update and construct new knowledge both during and across games. This dynamic nature of decisions in relatively short-term scenarios questions earlier views about tight links between conditions and actions, at least at very high levels of skill.

Sorting Tasks and Categorization

An additional method for ascertaining the knowledge structures underpinning expert performance, introduced by Chi, Feltovich, and Glaser (1991), is through picture sorting or categorization tasks in conjunction with structured interviews. Performers group or categorize domain-related problems, presented in written or picture format, based on individually determined, shared characteristics. This method aims to provide a window into the depth of the domain knowledge and, by inference, the level of understanding of various problem situations. Because performers are not required to motivate their choices, this method provides insight into knowledge that might be less declarative or explicit than that ascertained through techniques such as protocol analysis and explicit recall. A common finding in these tasks is that skilled performers in sport, like experts in other domains, sort problems into categories that share functional similarities (such as techniques that result in similar outcomes), rather than sharing more superficial features (such as a similar number of players; e.g., Allard & Burnett, 1985).

In an attempt to further understand the tacit knowledge structures underpinning movement skills, not just general classes of movements, Schack and colleagues developed this grouping approach to analyze the knowledge representations of various sport skills, including tennis (Schack & Mechsner, in press), windsurfing (Schack, 1999), and volleyball (Engel & Schack, 2002). A psychometric analysis of the ordering and relations across key actions involved in a movement is conducted. The categorization of various action components is compared across skills and also with biomechanical models to determine how these components functionally relate. Engel and Schack found that skilled volleyball players were relatively consistent and hierarchical in the manner in which actions were represented, such that actions were matched to functional demands (i.e., the arms are lifted to increase height of a jump). This was not the case for less skilled athletes. This analysis is expected to aid in our understanding of the usually nondeclarative motor representations underlying expert performance in fast, complex coordinative actions and in identifying the problems novices encounter in understanding motor problems. It will be interesting to examine how well these statistically determined representations concur with verbal protocols and to investigate these representations before and after an action can be performed to determine whether "understanding" precedes or follows action development.

Recognition and Recall Paradigm

There have generally been two types of scenarios where measures of recall and recognition have been applied to assess expertise. Although the methods applied in both scenarios assess memory and hence cognitive skills, in game scenarios more emphasis is placed on perceptual skill than for movement sequencing skills such as dance. Recent attempts to differentiate across the types of knowledge which underpin expert performance have led to the recall paradigm being applied to assess memory for movement episodes and the procedures involved in action execution, which has produced some unexpected results.

Game Scenarios. One of the most commonly used methods to explore the knowledge structures underlying expert performance has been the recognition and recall paradigm. Here, performers' memory is tested following earlier presentation of domain-relevant information. Based on research in chess, in particular that of Simon and Chase (1973), researchers across a range of domains have consistently demonstrated a specific expert memory advantage for the recall and recognition of structured scenes or game plays (for reviews in sport, see Abernethy, Burgess-Limerick, & Parks, 1994; Starkes & Allard, 1993; Starkes & Ericsson, 2003; K. T. Thomas, 1994). This memory advantage is mostly domain-specific (but see Abernethy, Baker, & Côté, 2005; Smeeton, Ward, & Williams, 2004), and research has indicated that perceptual-cognitive skills are an integral component of motor-skill expertise (see Williams & Davids, 1995). Methods of recall have yielded insights into not only the size of the memory advantage (i.e., how many pieces or players are recalled), but also the perceptual organization (i.e., the type and size of units that are recalled). There is debate, however, concerning how memory for structured sequences is facilitated. Chase and Simon (1973) suggested that experts' "chunk" across units of information through pattern-recognition processes, enabled by a vast memory for domain-specific patterns (see also Gobet & Simon, 1996). Ericsson and Kintsch (1995) argued that the memory advantage results from an increased working memory capacity, achieved through superior encoding and retrieval mechanisms. Vicente and Wang (1998) argued that with experience, structural features of the stimulus become "automatically" linked to decisions or actions, known as the constraint-attunement hypothesis. Because these theories make similar predictions, it is difficult to distinguish among them empirically (see Weber & Brewer, 2003).

Much of the research using the recall and recognition paradigms in sport has been designed to uncover how expert performance is mediated by superior cognitive skills, under what conditions this advantage is seen, and how it is moderated by different demands. The major difference between board games like chess and sport skills is the physical nature of the response and the dynamic nature of the stimuli. Nevertheless, schematic representations elicit expert-novice differences in sports such as basketball and field hockey (Allard, Graham, & Paarsalu, 1980; Starkes & Deakin, 1984), but typically not as well as more ecologically valid representations (Williams & Davids, 1998). These findings suggest that similar processes are activated in artificial as in real-world scenarios. More recently, the conversion of video into dynamic point-light displays (PLDs; see North, Williams, Hodges, Ward, & Ericsson, 2006; Williams et al., 2006), allowing for easier manipulation of the display, has continued to differentiate across skill levels. However, PLDs are generally not as well recognized as video, probably due to the removal of non-game-relevant cues, and are less sensitive to manipulations of structure.

A problem with these methods is how to objectively quantify "structure." The finding that experts show advantages on slides, which are considered nonstructured, might be taken to suggest that a priori judgments of structure are not always valid (see Gobet & Simon, 1996). Typically, structure is determined by the experimenter before testing, through the selection of dynamic goal mouth plays rather than the positions of players at halftime, when the ball is out of play, or during warm-up. These latter, "unstructured" sequences, however, typically show some organization and are not as random as could be achieved through simulation (which awaits implementation). North et al. (2006) have attempted to minimize these problems by using only dynamic game scenarios that have been rated for structure by coaches and thereupon selected for use in the experiment. A more objective means to assess structure could be to analyze scenarios in terms of assumption-free, data-reduction techniques (see later discussion).

There is evidence that the memory advantage in experts reflects a deep level of understanding rather than only perceptual familiarity, as evidenced by recall advantages for players rather than fans, for example (Williams & Davids, 1998). However, Zoudji and Thon (2003) failed to show priming effects, that is, decision time advantages, on game scenarios that had been shown previously, when the structure remained the same but the image was mirror-reversed. Only when identical stimuli were presented were expert-based priming effects observed. These authors argued that incidental, or implicit, memory tests, where memory is unexpectedly tested following a viewing or decision phase, provides a more valid marker of the processes underpinning expertise in team game scenarios. This is because decisions are often arrived at in a dynamic manner and performers have little or no awareness of how past knowledge influences performance. Although there has been evidence to the contrary, and modified expert advantages under conditions where memory tests have been unexpected (e.g., North et al., 2006), there is also evidence that game-relevant information is perceived and encoded without deliberate intention to attend to particular features (e.g., Weber & Brewer, 2003), and hence that both explicit and implicit memory studies are valid indices of expertise.

Memory for Movement Sequences

Skilled performers in dance, martial arts, gymnastics, and figure skating have shown significant advantages in recognition and recall for nonrandom sequences of moves (e.g., Starkes, Deakin, Lindley, & Crisp, 1987; Tenenbaum, Tehan, Stewart, & Christensen, 1999), but also for random sequences of moves (Smyth & Pendleton, 1994; Starkes et al., 1987; Tenenbaum et al., 1999). Expert dancers, for example, are expected to frequently encounter scenarios that require intentional learning for later recall, and are therefore expected to show significant explicit memory advantages. Moreover, dancers, particularly in modern dance, are required to sequence together moves in a semi-random fashion, and hence this type of practice might aid performance on memory tests generally. Because of the additional temporal demands placed on recall of sequences (i.e., what was seen and when), additional insights are provided from these domains into the type of strategies engaged in aiding recall. As with experts in game scenarios, skilled dancers show evidence of chunking moves into units or phrases, and also primacy effects (Poon & Rogers, 2000; Starkes et al., 1987), whereby information presented earlier in a sequence is better recalled.

The nature of the recall process has also informed how skilled performers actively encode information. Experts showed a preference for both physically and verbally recalling actions in test phases, such that verbal labels acted as recall cues. The combining of interview techniques with recall procedures (e.g., Ferrari, 1999; Poon & Rodgers, 2000) has also shown that experts have more insight into the methods that aid recall than their less skilled counterparts, which might further aid recall for unusual moves and sequences. The expert memory advantage has been shown to be robust over time and less susceptible to interference than in novice performance (e.g., Poon & Rogers, 2000; Starkes et al., 1987; Tenenbaum et al., 1999), supporting the conclusion that long-term memory mediates performance in these tasks.

Advances in brain imaging technology, specifically functional magnetic resonance imaging (fMRI) have provided additional analysis of the mechanisms and brain pathways that underpin expert memory advantages. Although fMRI is limited in its applicability, in that only limited movement is allowed, this technology can be used to uncover the pathways that mediate expert decisions on visual tests. Calvo-Merino, Glaser, Grezes, Passingham, and Haggard (2004) presented video stills of dance moves in classical ballet and in Brazilian capoeira dance to experts and a nonexpert control group. A significant domain-specific skill effect was observed in terms of increased brain activation during observation in areas thought to reflect motor simulation/preparation, such as the premotor and parietal cortex (see Decety & Grezes, 1999; Rizzolatti, Fogassi, & Gallese, 2001). Moreover, areas associated with semantic categorization (i.e., middle temporal areas) rather than visual perceptual processing (i.e., occipital cortices) showed the expertise advantage.

Memory for Movement Episodes

One area of research where findings seem to conflict with the expert memory advantage is in memory for the mechanics or procedures involved in skill execution, or so-called expertise-induced amnesia. According to Beilock, Wierenga, and Carr (2002), skilled performers recall recent episodes and the procedures involved in action sequences less well than novices do, such that skilled golfers can remember their scores on the last 10 putts, but have difficulty recalling how these putts were executed. This effect is proposed to be attentional in nature and related to an automatic style of performance characterizing expertise. Recall for episodes involved in an action improved only under conditions that simulated a more novice type of performance control, through the introduction of an unusually shaped putter (see also Beilock & Carr, 2001). This research awaits additional empirical investigation. It might be that the conditions for performance in the laboratory environment by Beilock and colleagues were too simple (both the putting action and the course) to prompt recall, but under game conditions, where difficulty and variety dominate, the action-execution is attended to and better recalled. Moreover, in practice designed to improve performance, attention to the step-by-step aspects involved in the movement might be needed to improve, and hence facilitate recall (see also Gray, 2004).

Summary

Verbal protocol analysis appears to be one of the most useful and simple tools, at least in terms of cost and accessibility, though not necessarily analysis of the data, for gaining insight into how the expert advantage is achieved. The ability to elicit detailed process measures from real-world performance is currently unmatched by other techniques. Potential problems with this approach (e.g., the fact that explicit, verbalizable thoughts might be somewhat artificial in nature and could reflect expectations) have been addressed through the combining of a number of techniques, such as categorization and recall tasks, which help in understanding the more tacit or underlying organization of knowledge. Recall and recognition tests have significantly helped to uncover the knowledge structures underpinning expert performance in sport. There is consistent evidence that tests of memory discriminate across skill levels, and that the expert advantage is mediated by long-term memory structures. The fact that the expert advantage in memory and decision skills remains almost irrespective of the stimuli, the action, or how the stimuli were encoded provides evidence that at least some of the expert advantage can be captured in the laboratory, and hence allows for inferences about the knowledge and processes underlying these decisions. Notwithstanding this observation, skill-related differences come to the fore the more similar the stimuli and action are to what is required in real-world scenarios.

Understanding the Perceptual Information That Guides Expert Decisions and Actions

In this section, we further examine this decision characteristic of expert performance through analysis of the information that guides expert performance. This topic has been addressed by two theoretical approaches, particularly with respect to the distinction between decisions in action (i.e., during continuous play) and out of action (i.e., before or after a point). In the latter case, the information-processing perspective has been applied most extensively through chronometric measurements, that is, measures that indicate how long an action or decision takes, and hence provide an indirect measure of processing speed. In the former case, the information guiding movement, and the laws underlying this guidance, have been examined.

Eye Movement Data

Equipment for gaze tracking, or analysis of fixations and visual search, has become more affordable and practical in the past decade. Eye movement systems range from relatively basic digital video scene cameras, with eye movements superimposed over the scene, capturing data at 60 Hz, to high-speed cameras that can be used in relatively stationary environments (depending on the head-tracking hardware), enabling recordings up to 500 Hz. There have also been developments in mobile eye movement technologies, though these are often less precise and less technically sophisticated. One caveat on the interpretation of eye movement data is that looking and seeing cannot simply be equated. Looking at a location does not necessitate that information is being picked up from this location, and, conversely, optical information may be picked up from the parafoveal and peripheral regions (see Williams & Ericsson, in press). It is also possible that the relevant information is the *empty* space between players (McMorris & Graydon, 1997) rather than the players themselves, such that fixations inform about anticipation of future events.

A significant amount of research suggests that experts' gaze behavior differs from that of nonexperts, allowing them to make faster and more accurate decisions and actions. For instance, fixating certain regions early in the movement (such as body position before a pitch or serve in baseball and tennis; see Abernethy & Russell, 1984; Goulet, Bard, & Fleury, 1989) seems to be most important for task success. Experts typically reveal fewer, but longer, fixations than do novices (e.g., Abernethy & Russell, 1987; Ripoll, Kerlirzin, Stein, & Reine, 1995), perhaps allowing for more detailed processing of task-relevant information. However, the most effective pattern of fixations is likely to be codetermined by the task constraints. For example, Williams and Davids (1998) found that in various soccer scenarios, experts employed more fixations of shorter duration than novices did.

Visual search paths, and their consistency, have also been shown to vary as a function of skill (e.g., Ripoll, 1988; Ward et al., 2002). Search paths are expected to indicate strategies that skilled performers use to gain information about an unfolding event, and as such may provide hints as to the relevance of information from various sources. There is evidence that visual search proceeds in a more proximal (i.e., the trunk) to distal (i.e., the arm and racket) fashion among skilled performers in racket sports (Ward et al., 2002), whereas novices tend to fixate on distal regions and show less consistency in their search paths. Land and McLeod (2000) measured the eye movements of cricket batters during the approach of a ball to be batted. Compared to less skilled players, professional cricketers initiated faster and less variably their anticipatory saccade to the point where the ball was expected to bounce and also showed smooth pursuit tracking of the ball following the bounce. From the gaze recordings, in combination with a physical analysis of the ball trajectory, the authors pinpointed the importance of early information regarding the ball's delivery and bounce for successful batting. Similarly, Amazeen, Amazeen, and Beek (2001) measured the gaze paths of expert and intermediate jugglers during sustained one-ball catching and throwing to determine which part of the ball's trajectory was tracked. Experts used information earlier in the flight path to accommodate to changes in frequency of the throw, and both skill groups looked at the area around the ball's zenith. However, the timing of the eye movements for the skilled group was more variable than that of the intermediate group, suggesting that at elite levels of performance, flexible rather than rigid control and search define performance (see also Huys & Beek, 2002).

Visual Occlusion and Analysis of Errors

A complementary strategy to examine the information used by experts is through spatial and/or temporal occlusion of events (for reviews, see Abernethy, 1987a, 1987b; Williams, Davids, & Williams, 1999). As a rather primitive way to achieve occlusion, researchers have turned out the lights at the point when information was to be removed or covered a particular feature on a viewing screen (e.g., Abernethy & Russell, 1984). More recently, occlusion has been achieved by selectively editing video clips, such as a player in a game or an area on a player's body, and replacing this with background information (see Williams et al., 2006).

In a study of soccer goalkeepers, temporal occlusion was achieved through the removal of vision at four successive periods around ball kick, corresponding to specific events (Williams & Burwitz, 1993). In the preimpact conditions, experts outperformed novices, suggesting that they are better able to use information in an anticipatory fashion. Similarly, Tenenbaum, Sar El, and Bar Eli (2000) examined the moment of information pick-up enabling anticipation of different tennis strokes (serve type and difficulty) across different skill and age groups. The expert advantage was again most pronounced in the early portion of the tennis stroke, particularly for strokes performed near the net. Spatial occlusion techniques, where specific sources of information are removed, have been used to examine performance in racket sports by Abernethy and Russell (1987) and Abernethy (1990, 1993). These techniques have shown that experts are able to use information from the arm movements of their opponents to aid accuracy, whereas novices only show decrements in accuracy when information pertaining to the ball or racket is removed. Occlusion has also been achieved through the transformation of an image into points of light representing joint locations. For example, Abernethy (1993) and Ward et al. (2002) have used this method to show that the perceptual anticipatory advantage remains when structural, body-related information is removed. This finding supports the conclusion that one expert advantage in sports is based on kinematic information and perhaps the relations between body segments, rather than specific features of the body. Further manipulations to PLDs (e.g., in terms of lower or upper body) will help to isolate more exactly the sources of information underpinning this advantage (see Hodges, Hayes, Breslin, & Williams, 2005).

There have also been attempts to occlude visual information under live conditions, such as in tennis (Farrow & Abernethy, 2003; Singer, Cauraugh, Chen, Steinberg, & Frehlich, 1996), volleyball (Starkes, Edwards, Dissanayake, & Dunn, 1995), and juggling (van Santvoord & Beek, 1994), using liquid crystal occlusion goggles. This equipment allows the experimenter to turn vision on and off at any point in the action. Occlusion of vision before or after ball contact on a serve differentiated across skill groups in a way similar to that observed under video manipulation conditions, supporting the validity of these off-court scenarios. However, Farrow and Abernethy found skill-based differences only when a physical rather than a verbal response was required (see also Féry & Crognier, 2001; Oudejans, Michaels, Bakker, & Dolne, 1996).

Obviously, visual occlusion methods (through goggles or otherwise) are not always feasible in situ, in view of methodological and ethical (concerning participants' safety) limitations. An interesting method to determine what information is most useful for performance, using these goggles, was introduced by van Santvoord and Beek (1994). Skilled jugglers wore goggles that rhythmically opened and closed during three-ball cascade juggling. Through adjustments to the frequency and phasing of the juggling, the participants could self-select which part of the ball trajectories they preferred to look at. Participants were able to sustain juggling under these rhythmic conditions, showing flexibility in their sampling and use of information. Juggling performance was most stable in trials where there was a phase locking between the ball trajectories and the opening of the goggles, allowing for the zenith of the ball flight to be observed. Recently, there have been attempts to tie visual occlusion manipulation to specific kinematic events. In basketball, Oudejans, van de Langenberg, and Hutter (2002) used an opto-electronic device to record and synchronize the opening and shutting of the goggles with real-time movement kinematics (i.e., when the arms passed a particular point). The ability to more closely examine when and what information is used for decision accuracy and movement is afforded through these methods.

Summary

Measurement of eye movements, regardless of limitations inherent in their interpretation, as well as occlusion techniques have been successfully implemented to uncover differences in visual search patterns and the sources of information used in sports decisions as a function of skill. Although task-specific constraints prohibit general conclusions as regards expert behavior across sports, certain regularities within related sports have come to the fore. Furthermore, several studies suggest that expertise-dependent differences are more apparent with increasing ecological validity (both stimuli presentation and response type) and that although consistencies within expert groups have been observed, there is evidence that flexibility in search strategies might characterize elite performance.

WHAT IS CONTROLLED? MECHANISMS UNDERPINNING EFFECTIVE CONTROL OF ACTIONS

Related to the question of what information is used to achieve a high level of performance skill is the question of what control processes and strategies (conscious and nonconscious) underpin expert performance. For example, when a person becomes skilled at a sport task, does his or her attentional focus change? Does the use of feedback change? Does the organization of movements change? How are these aspects related? In most sport skills, unlike in cognitive skills, the motor component and the need to adapt to changing environmental demands as the movement unfolds are critical. In these perceptual-motor skills, experts not only make faster and better decisions, but also appear to move in a more stable, coordinated, and fluid manner. The question of how movement is controlled effectively has been addressed both from the dynamical framework, where the emphasis has been primarily on changes in movement stability and coordination across systems, and the cognitive framework, with its emphasis on knowledge structures and attentional processes enabling effective performance. These approaches are discussed next, along with the measures associated with the different approaches.

Attention and Dual-Task Protocols

Manipulation of attentional focus, or task demands, has been used to infer the control strategies of expert performers, either through attention-directing instructions or through secondary-task techniques, which distract attention from the primary task. These methods help us to understand how attention is allocated to specific aspects of performance (either movement- or environment-related), as well as general cognitive demands associated with performance, respectively. Leavitt (1979) examined how stick handling when moving and controlling a puck on the ice was affected by a secondary perceptual discrimination task across ice hockey players of various ages and skill levels. For novice players, in comparison to the older and more skilled players, stick handling deteriorated during secondary-task conditions. However, it was not possible to conclude whether the secondary task interfered at a perceptual level, preventing focus on the stick or the puck, or at a cognitive level, due to limits in processing capacity. This issue has been circumvented through auditory secondary-task manipulations, which do not require a physical change in attentional focus (e.g., Abernethy, 1988; Beilock, Wierenga, et al., 2002). Resource limitations, as a result of memory demands required of the primary task, have been observed following requirements to respond to an auditory stimulus.

Attention has been manipulated to determine how knowledge structures, and hence specific skill-related attention manipulations, affect the control of various sport skills in golf (Beilock, Carr, MacMahon, & Starkes, 2002), soccer (Beilock, Carr, et al., 2002; Ford, Hodges, & Williams, 2005), and baseball (Gray, 2004). In comparison to novice performers, only skilled players were affected when attention was directed to a component associated with the skill, such as the foot in soccer dribbling. In Figure 7.1 we have plotted the mean movement times (for soccer ball dribbling) and timing errors (for baseball batting) across the three laboratories where these skill-based attention manipulations have been examined. There is a consistent trend for skilled participants to be slower and make more errors under the skill-focus manipulations in comparison to the other attention conditions, which is not true of novice performers.

The authors explained these findings by claiming that effective control is achieved through structures that primarily function automatically. Bringing this knowledge into consciousness disrupts performance. Manipulations to the task instructions in terms of speed and accuracy have added further support for these ideas (Beilock, Bertenthal, McCoy, & Carr, 2004). There is also evidence that these performance effects are mediated by the locus of attentional focus (i.e., internal or external). Perkins-Cecatto, Passmore, and Lee (2003) showed that skilled golfers performed more variably under instructions that encouraged attention to the swing (i.e., internal) rather than the putt (i.e., external), whereas the reverse was true for novice performers (i.e., more variable under external versus internal instructions). Ford et al. (2005) showed that irrespective of whether skilled performers attended to the arm or the foot in soccer ball dribbling (both internal features, but only the foot being highly relevant to the skill), performance was disrupted in comparison to control and word-monitoring attention conditions. Despite the evidence that skill execution is more effective when attention is directed externally, or that skilled performance is characterized by this type of focus, research on performance control or coping strategies in running has shown that elite runners adopt internal monitoring strategies in comparison to less skilled runners, who show a tendency to focus on external, nonrelevant features of the run (Nietfeld, 2003). There is clearly a need to understand how knowledge and attentional focus interact with task demands to determine when and how an inward focus on skill-execution processes are harmful or potentially beneficial to performance.

In addition to attempts examining how a skill is controlled online, there have been attempts to examine what is controlled and how subsequent movements are planned. There is evidence to suggest that actions are planned (i.e., selected and initiated) in terms of their end effects or sensory consequences (see Koch, Keller, & Prinz, 2004, for a recent review and implications for sport). Although end-effect control has been discussed in sport, there has been little empirical investigation (but see Ford, Hodges, Huys, & Williams, in press; Hodges, Hayes, Eaves, Horn, & Williams, 2006, who have examined the role of ball trajectory information in planning, executing, and acquiring soccer-related skills).

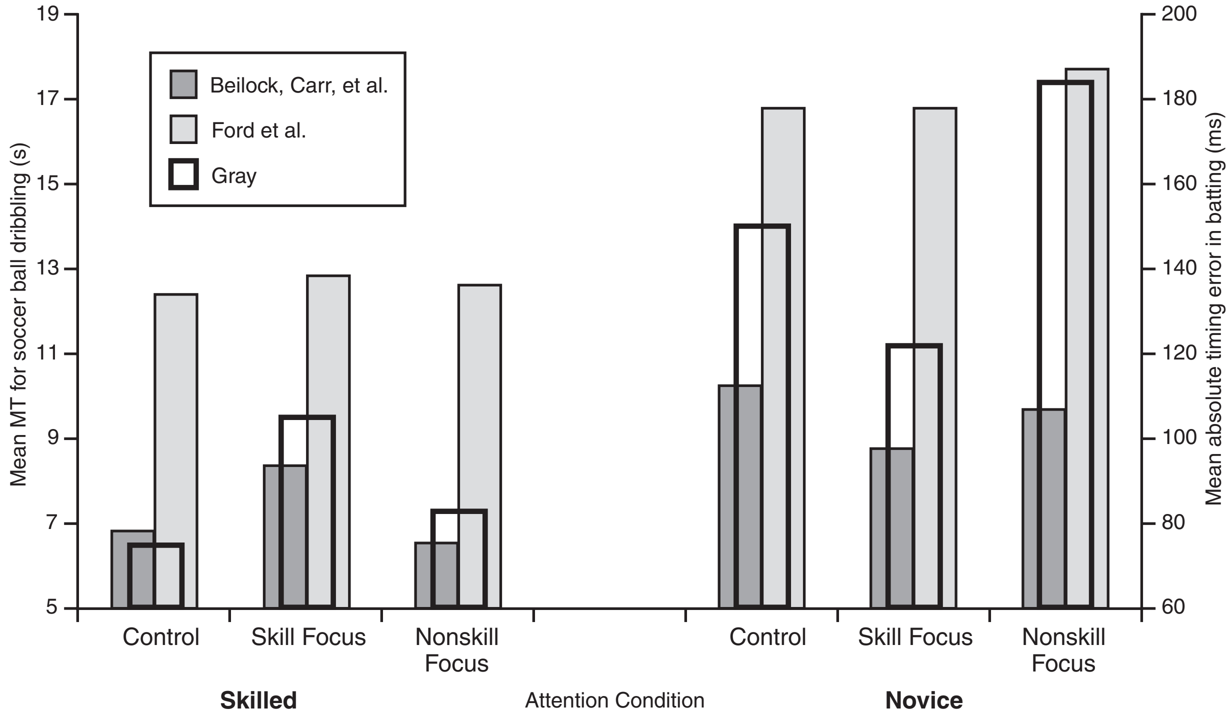


Figure 7.1 Soccer dribbling times (Beilock, Carr, et al., 2002; Ford et al., 2005) and timing errors in baseball batting (Gray, 2004) as a function of attention condition across skilled and less skilled performers.

Occlusion and Perturbations to Visual Information

The processes underlying the control of movement have often been examined through manipulations to the sensory feedback about the movement. If removal of or perturbations to visual feedback have little effect on skilled performance, then one interpretation is that at high levels of skill actions are controlled by "motor programs" that are prepared before the action and can be run without the need to monitor vision (R. A. Schmidt, 1975; R. A. Schmidt & McCabe, 1976). Alternatively, it might be argued that skilled performance is achieved through monitoring of a different source of sensory information, such as proprioception (e.g., Adams, 1971). Under laboratory conditions, where performance on aiming tasks has been examined after a few (200) or many (2,000) trials, there is evidence that with increasing skill, a dependency on vision emerges (e.g., Proteau & Cournoyer, 1990). This has been termed the specificity of practice hypothesis. Despite support for this hypothesis in the laboratory (see Khan & Franks, 2004; Proteau, 1992), real-world experts performing gymnastic skills (Robertson, Collins, Elliott, & Starkes, 1994) or power-lifting (Bennett & Davids, 1995) have been less affected by manipulations to online visual feedback (achieved through occlusion goggles) than have novice performers. Because the way the movement is performed changes when vision is removed, for example, an increase in speed in traversing the balance beam, it has been argued that experts are flexible in their ability to use other sources of feedback to control their movement, rather than perform in a programmed fashion. Indeed, knowledge as to whether vision will be available during practice or performance affects the movement-control strategies that participants adopt (see Khan, Elliot, Coull, Chua, & Lyons, 2002). If performance is required under consistent sensory conditions, then it is likely that a reliance on this sensory information will be seen as a function of practice and increasing skill. However, when the conditions of performance vary and multiple information sources could be used to control the action, then it is likely that skilled performance will be characterized by flexible control strategies (see Huys & Beek, 2002).

Visual Gaze

Eye movement recording techniques have also been employed to gain an understanding of how skilled performers effectively allocate physical attention to prepare and control movement execution, particularly in the face of performance pressures. There is evidence that in comparison to less skilled performers, skilled athletes maintain consistency in their search under anxiety manipulations (Rodrigues et al., 2002; Williams & Elliott, 1999). However, both novices and experts in karate have been found to focus more on peripheral body features under conditions of high stress, although this behavior was more pronounced in novices (Williams & Elliot, 1999). There is also evidence that the spatial and temporal characteristics of gaze during the preparation and execution of skills is related to the expert advantage. Skilled and successful performers have shown a consistent visual gaze phenomenon, termed "quiet eye" (Vickers, 1996; Vickers & Adolphe, 1997). Accordingly, before an action is undertaken, such as a basketball free throw or jump shot (Oudejans et al., 2002; Vickers, 1996), a table-tennis serve (Rodrigues et al., 2002), or golf putt (Vickers, 1992), successful performers steady their gaze onto the target (such as the rim of the basketball net or the golf ball) just before executing the shot. The quiet eye period is believed to reflect cognitive processing activities that take place before the shot. Consistent duration of fixations, as well as consistent fixation points, differentiate across skill class and, more informatively, across successful and less successful shots. Oudejans et al. have suggested that the optimal duration of a fixation is linearly related to execution time.

Measurement of Coordination and Synergies

The qualification and quantification of coordination has often been approached in terms of Bernstein's (1967) degrees-of-freedom problem (i.e., how does control arise in systems with many degrees of freedom). Bernstein sought the answer to this problem in the concept of synergies, or coordinative structures, commonly defined as "a group of muscles often spanning a number of joints that is constrained to act as a single functional unit" (Kugler, Kelso, & Turvey, 1980, p. 17). Traditionally, degrees of freedom were understood in the anatomical/(bio)mechanical sense. Correspondingly, various researchers examined simultaneously the amplitudes of, and degree of coordination between, joints or limb motion (e.g., Temprado, Della-Grasta, Farrell, & Laurent, 1997; Vereijken, van Emmerik, Whiting, & Newell, 1992). For example, Temprado et al. examined the coordination of the shoulder-elbow-wrist linkage during the execution of a volleyball serve across novice and expert players through the cross-correlation function. This is a technique that quantifies the degree of similarity between two time-series as a function of a time lag. A higher degree of skill was accompanied by a lower degree of coordination between joints (indicated by smaller cross-correlations).

With the establishment of coordination dynamics as an approach to the study of coordination, synergies were looked for and examined in terms of collective variables, such as the relative phase between action components, and their stability (Haken, Kelso, & Bunz, 1985; Kelso, 1995; Turvey, 1990). Relative phase reflects the relative timing between two processes. It became established as an important variable capturing coordination after Kelso (1984) showed that when participants cycle their limbs in antiphase and gradually increase their cycling frequency, an abrupt, spontaneous switch to in-phase coordination occurs. In lay terms, this is the shift that occurs when index fingers moving quickly as windshield wipers (antiphase) show an increase in relative phase variability and automatically transit to moving in symmetry (in-phase). The findings of differential stability of these movements and the transitions between them have been observed in the coordination between joints (e.g., Haken et al., 1985) and postural sway (e.g., Bardy, Marin, Stoffregen, & Bootsma, 1999) and visually mediated coordination between persons (e.g., R. C. Schmidt, Carello, & Turvey, 1990). Bardy et al. had gymnasts and nongymnasts track a stimulus oscillating with increasing frequency with their head. Initial in-phase coordination between ankle and hip rotations gave way to an antiphase pattern at a certain frequency. This occurred at a higher frequency for the gymnasts than the nongymnasts, interpreted as a training effect. Larger hip movements, which are penalized by gymnast judges, may occur during antiphase coordination, such that the gymnasts had learned to resist a more natural coordination mode.

The strength of patterns of coordination and the fluidity of movement, often indicative of skilled performance, has also been captured by spectral analysis. Spectral analysis highlights temporal patterning in a continuous movement such as rowing or running, whereby the time series is transformed into the frequency domain, resulting in a power spectral density estimate (Stocia & Moses, 1997). From estimations of the spectral densities of the ball trajectories in three-ball cascade juggling, Huys and Beek (2002) showed that the degree of coordination among the juggled balls was higher in expert jugglers than in intermediate jugglers. A drawback of spectral analysis is that information over time is lost, which sometimes can be of pivotal importance. For instance, during rowing, certain frequency relations between the legs and breathing rates are often observed, especially in well-trained athletes (Bramble & Carrier, 1983; Siegmund et al., 1999). However, these relations are not always fixed during an entire race (or trial). To study the transitions in frequency relations between the movement of the rowing handle on a rowing ergometer and breathing, Daffertshofer, Huys, and Beek (2004) computed spectrograms of the handle force and respiration data from a simulated 2 km race by well-trained rowers. These were obtained by calculating spectral density estimates over a window that was repetitively shifted in time (as illustrated in Figure 7.2). Transitions from a 1 : 1 to a 1 : 2 frequency-locking ratio between the rowing action and breathing were observed through this technique.

One drawback of the methods outlined here is that their scope is limited to pairwise comparisons. Excellent performance in real-world settings most often comes about through the coordination and cooperation of a variety of components. One technique that has successfully been applied to capture the degree of coordination among numerous components is principal component analysis (PCA; see Daffertshofer, Lamoth, Meijer, & Beek, 2005; Haken, 1996). In general, a finite number of time series can be effectively described by fewer (temporal) structures. For instance, Haas (1995) studied whole-body movements of people as they learned to ride the pedalo, an odd contraption allowing "gait on wheels." Early in learning, this could effectively be described as a 5-dimensional system. At the end of learning, the learner's dynamics could effectively be described by a 2-dimensional system. This study and others (e.g., Huys, Daffertshofer, & Beek, 2003) suggest that with increasing skill the control structure's dimensionality decreases, with control becoming more effective. However, there is evidence that direction of change in dimensionality is task- or skill-dependent (see Newell & Vaillancourt, 2001).

Principal component analysis allows examination of the structure of variance in a skill; however, due to the makeup of the perceptual-motor system, sport goals may be achieved in various manners. Scholz and Schöner (1999) introduced the uncontrolled manifold (UCM) to address this. In this method, the variability across multiple motor executions is decomposed into two distinct subspaces. The variability in one subspace, the UCM, does not affect task performance and may thus be released from control. In contrast, the variability in the other subspace is critical for task performance, and as such requires control. Scholz and Schöner decomposed the variability in a shooting task into two distinct subspaces (the uncontrolled and the controlled manifold). A skilled marksman can adopt a range of joint combinations, which

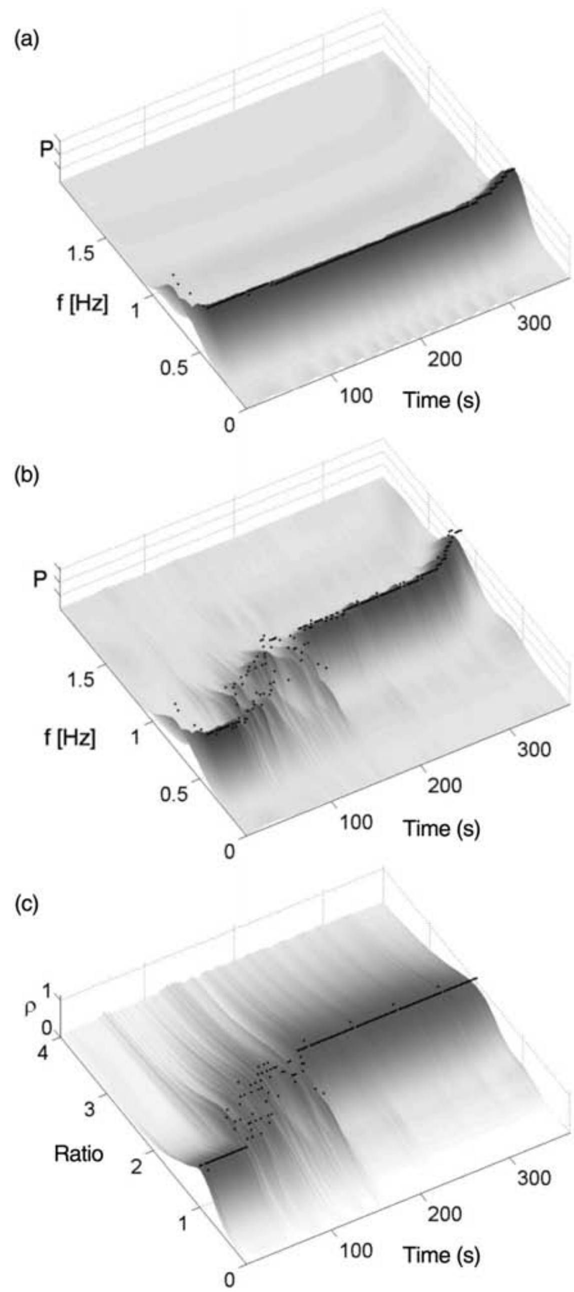


Figure 7.2 Spectrograms for the force data (a) and respiration (b) of a single participant (data from Siegmund et al., 1999). The power spectral density was estimated over consecutive time windows of 10 s. Panel (c) depicts the scaled-cross integral as a function of time. In all panels, time (s) is displayed on the x-axis. In (a) and (b), frequency, f (Hz), is displayed on the y-axis and the spectral power, P (dimensionless), on the z-axis. In (c), the frequency-locking ratio is displayed on the y-axis, and the frequency-locking strength on the z-axis. The relationship between the frequencies with the maximal spectral power, fstroke and fresp, reflect the frequency-locking ratio. Initially, fstroke: fresp = 1;1, and a switch to fstroke: fresp = 1;2 can be observed.

across trials constitutes a space of variability, which leaves unaltered the alignment of the barrel of the gun to the target. The insight that not all variance requires control obviously has important theoretical consequences for the understanding of learning, expertise, and motor control in general. Indeed, it may be worthwhile to examine not just the overall degree of variability, but also the structure within the variability in relation to attainment of a specific goal. One would expect that an expert would have restructured the skill's execution such that the component of the variance that most affects task performance is decreased, at least relative to that of the variance in the UCM. To date, however, the approach has not been applied in expertise research, although a few learning studies that have adopted the UCM approach do point in this direction (Kang, Shinohara, Zatsiorsky, & Latash, 2004; Yang & Scholz, 2005). The strength of the UCM is that it allows for an objective test of explicit hypotheses regarding controlled variables; a limitation of the approach is that to determine the UCM throughout a movement, a continuous goal-state has to be introduced. Reaching the ultimate (task) goal, however, may not require following this time-continuous goal state throughout the movement.

Summary

A number of process measures and techniques can give insights into how movement is controlled at high levels of skill. These range from attention manipulations, to eye movement recording, to whole-body movement kinematics. The sophistication of statistical techniques and methods available to analyze these data is continually growing, allowing for a more holistic, task-relevant description and insight into the variables that enable effective and efficient movements. Although the issue of movement control is complicated when flexible characteristics of performance are considered, there do appear to be general, stable strategies that define skilled performance, including stability in eye movements in the moments before a skill is executed; coordination across subsystems of the body, such as breathing and stroke handling during rowing; decreased variability in components of the movement most related to goal attainment; and a decreased focus on features and rules involved in skill execution.

DETERMINING THE MECHANISMS UNDERPINNING THE LONG-TERM DEVELOPMENT OF EXPERTISE

In this final section we discuss research examining the long-term mechanisms underpinning expertise. In sport, the theory of deliberate practice proposed by Ericsson, Krampe, and Tesch-Römer (1993) significantly impacted the study of expert performance and was in part responsible for the change in emphasis from talent identification (i.e., a search for abilities and characteristics that differentiate across skill levels) to the measurement and evaluation of practice (see also Durand-Bush & Salmela, 2001, for a historical review of this trend). Originally basing their research on musicians, Ericsson et al. devised methods to demonstrate the necessary and, in their view, sufficient role of sustained, effortful, domain-relevant practice for the attainment of high levels of performance. In sports, where physical differences across athletes seem to promote attributions for performance in terms of innate talent, the deliberate practice hypothesis has received much attention (for reviews, see Starkes, Deakin, Allard, Hodges, & Hayes, 1996; Ward, Hodges, Williams, & Starkes, 2004).

The Deliberate Practice Framework and Initial Empirical Evidence

Ericsson et al. (1993) collected retrospectively recalled practice estimates from musicians of various levels of competency in the Berlin Music Academy. The musicians were asked to recall, using interview-based questioning, the number of hours per week they spent practicing alone on either the piano or violin in yearly intervals across their playing careers. They also estimated the time spent on various everyday and musical activities and rated these according to their relevance to improving performance, the effort required, and their enjoyment, independent of the results. Additionally, the musicians kept activity diaries, subsequently organized in terms of the activities just discussed. Practice alone was judged to be most relevant for improving performance and was rated as pleasurable, although not significantly so. Generally, the activities judged to be the most relevant were also the most effortful. Weekly practice alone differentiated the musicians training to be international soloists from those training to be teachers (deemed less skilful). The weekly estimates of practice correlated highly with the diary methods, although participants tended to overestimate. When career retrospective estimates were examined, the number of hours accumulated by age 18 showed a difference of approximately 2,000 hours between groups; the best violinists alone reported 7,500 hours of practice.

The early deliberate practice research in sport was designed to and was able to distinguish across skill groups based on career practice estimates across domains such as Olympic-style wrestling (Hodges & Starkes, 1996), field hockey and soccer (Helsen, Starkes, & Hodges, 1998), figure skating (Starkes et al., 1996), and karate (Hodge & Deakin, 1998). As in music, the skilled athletes consistently engaged in more weekly practice than their less skilled counterparts (either alone or with a team, which was sport-dependent). Although these findings support the claim that practice is necessary for high-level performance, they do not indicate that practice is sufficient. For instance, being young and talented may correlate with practice investment and involvement. Other research and methods are needed to show that domain-specific practice causes, or at least is sufficient for, expertise.

A more valid, more sensitive predictor of performance would be achieved if practice amounts could differentiate at the individual rather than merely the group level. Indeed, Ericsson et al. (1993) reliably differentiated across individual musicians through practice amounts. In sport research, few such attempts have been made because of the need to have an objective measure of performance within a skill domain (which is a challenge even in music). Track events and swimming, however, are good sport environments for evaluating across performers at this more refined level. Hodges, Kerr, Starkes, Weir, and Nananidou (2004) examined the practice histories of club-level through international-level athletes in swimming and triathlon and found a significant linear relationship between performance times and practice factors, at least for the longer distance events. However, the relationship between practice amounts and performance times was similar to that between skill category and practice. Further research in sports enabling this type of predictive analysis is needed to determine how much variance in performance (times) can be captured by practice. On a more practical level, this analysis may provide an index of the amount of practice needed to improve performance (times) by a specific amount (see Sloboda, Davidson, Howe, & Moore, 1996; Starkes et al., 1996).

Quantitative Practice Issues: Counting Deliberate Practice Hours

Retrospective practice estimates are obviously prone to inaccuracies in recall. As the career length increases, the estimate's reliability diminishes. Practice estimates are inflated when athletes recall their weekly practice hours from the start of their career to their most recent year, although this problem is partly overcome by asking people to give estimates for their current year first (see Hodges et al., 2004). A number of reliability and validity measures have been used in combination with practice estimates ascertained through interviews and questionnaires to determine the accuracy of these data (for a recent review, see Côté, Ericsson, & Law, 2005). Diary-based methods have been the most popular, showing moderate to high correlations with questionnaire estimates, although athletes, like the musicians, tend to overestimate in questionnaires (e.g., Helsen et al., 1998; Hodges et al., 2004). Helsen et al. additionally readministered the retrospective questionnaire over a 6-month period, finding test-retest reliability to be quite high. These methods are adequate for examining the reliability of practice estimates for the current year, but not for retrospective recall. Starkes, Weir, and Young (2003) obtained career-long training logs from athletes, which are excellent career checks but difficult to obtain for large samples. The best method to overcome the problems associated with retrospective recall is to collect longitudinal data from aspiring athletes, hoping that some make it to the highest level and that attrition is low. A quasi-longitudinal approach, as adopted by Ward, Hodges, Williams, and Starkes (2006), involving comparison of current and retrospective estimates of eight different age groups of athletes (from 9 to 18 years), is one of the most comprehensive methods available for cross-checking across ages and estimates. However, the young elite may not become adult elite players, and, across age groups, the practice amounts needed to attain expert levels increase (see Ericsson & Lehmann, 1996).

Qualitative Practice Issues: Defining and Capturing Deliberate Practice

To determine more precisely which activities are counted as deliberate practice, researchers have used time-motion analysis (see Starkes, 2000; Starkes et al., 1996). The practice sessions of athletes are recorded and subjected to time and content analysis to determine whether the quality of practice differs across skill levels (e.g., effortful, not inherently enjoyable). Time-motion analysis also allows a reliability assessment of reported weekly practice hours. Across studies (e.g., Deakin, Starkes, & Allard, 1998; Starkes, 2000), skaters, ice hockey players, and wrestlers were found to spend a significant proportion of time practicing already well-learned skills but not performance-improving skills. Ward et al. (2004) suggested that effortful practice on difficult skills might need to be balanced with practice that reinforces a person's belief in his or her abilities. Indeed, skill specificity appears to characterize many elite performers who have trademark moves or skills (e.g., the inch-perfect free kicks of the English soccer player David Beckham). Ericsson (2003) has discussed the development of expertise as the overcoming of various performance goal states, or constraints, associated with different stages of a performer's career. Because the aspects of performance requiring improvement or the most practice are dynamic, the development of expertise may be characterized by skill-specific practice at different stages. Further research and other methods are needed to determine which features of practice change and how this is related to performance (especially as ratings concerning the relevance of various practice activities have typically not differentiated across skill class). For example, although Durand-Bush and Salmela (2002) reported that international athletes notice a shift in their training activities from increasing quantity to better quality, there is little understanding of what quality training entails (but see Côté et al., 2005).

Time-motion analysis has also shown that skilled performers utilize time more efficiently when at practice than less skilled athletes. Deakin and colleagues (Deakin & Cobley, 2003; Starkes et al., 1996) observed that elite figure skaters spent approximately 20% more time practicing jumps, considered most relevant to improving performance, than the less skilled test skaters. Moreover, the elite skaters rested for approximately 14% of each on-ice practice period, in comparison to 46% for the test skaters. Therefore, in terms of the amount of time actually spent practicing, the overestimation in retrospective estimates of practice is more pronounced for less skilled than for skilled athletes.

The quality of practice, and specifically its effortful nature, has also been assessed using measures of sport periodization, indicating how practice is structured throughout the year in terms of time and intensity. Baker, Côté, and Deakin (in press) have used heart rate measures to quantify the intensity of exercise at specific periods throughout a competition year. Similarly, as detailed in Ward et al. (2004), training periods for triathletes were sustained longer and at a reported higher intensity (as determined through questionnaires) for the fastest compared to the slowest athletes. These attempts to measure the effortful nature of practice may also help determine how much practice time should be considered deliberate and whether there are consistencies and limits in the amount of physically effortful deliberate practice that can be sustained in a practice session or across a training year before factors associated with fatigue, injury, boredom, and perhaps burnout set in (see also Ericsson et al., 1993; Starkes, 2000).

One final issue that has prompted debate is that of the enjoyable nature of deliberate practice. Because practice alone was not rated significantly pleasurable in the original research with musicians, practice was defined as a noninherently enjoyable activity, one that is engaged in to improve performance. In subsequent sport studies, nearly all practice activities have received high ratings for enjoyment (see Helsen et al., 1998; Hodge & Deakin, 1998; Starkes et al., 1996). However, there have been inconsistencies in the methods used to assess enjoyment, which appears to mediate the ratings of the activity. When activities have been rated generally, such as running rather than a specific running instance, they receive high ratings for enjoyment and relevance to improving performance. However, when specific instances of activities have been rated, as in a diary, the ratings are moderated and not consistently related to the relevance rating (see Hodges et al., 2004; Ward et al., 2006). Thus, consistent and reliable methods for assessing enjoyment need to be ascertained before statements about the enjoyment of relevant, performance-improving practice can be made. Ward et al. found that younger athletes tended to evaluate their enjoyment of an activity in terms of the actual session itself, whereas older athletes tended to rate enjoyment in terms of its result. Differences like these may have resulted in discrepancies across domains with respect to practice estimates (see also Hodges et al., 2004, who distinguished enjoyment from satisfaction).

Measurement of Other Variables That Contribute to High Performance Skill

There have been two major variables which have been examined with respect to expert performance, that of gender and age. Methods used to explore deliberate practice theory have also been adopted to explore how these variables mediate the attainment of skill.

Gender

Competition performance is nearly always differentiated on the basis of gender, and it is rare to find a sport where women perform at the same standard as or better than males (see Åstrand, Rodahl, Dahl, & Strømme, 2003). In the past, it has been difficult to measure exactly how gender limits performance. Although some chromosomally mediated effects are expected to be enduring (e.g., body shape, strength, height), it has been proposed that most gender effects are mediated by differential opportunities to practice for males and females (see Wells, 1991). Deliberate practice methodology is a useful tool for investigating the contribution of practice amount in accounting for gender differences, or conversely, how much variance in performance times can be accounted for by gender once practice is controlled. Hodges et al. (2004) compared male and female athletes across different events and sports that emphasize either endurance and aerobic fitness (for longer distance events) or anaerobic capacities (for short-distance, sprint events). Significant evidence exists that there are genetic limits with respect to anaerobic activities, but less consistent evidence for limits in aerobic capacities (e.g., Bouchard et al., 1990; Simoneau et al., 1986). Analyses of swimmers and triathletes showed that for the longer events, practice was significantly related to performance times, but that gender did not make a significant contribution to the regression model. However, examination of the sprint events in swimming showed that although 20% to 30% of the variance in these events could be accounted for by practice, it was not a significant predictor. Gender accounted significantly for 30% to 40% of the variance in performance times even after controlling for practice. The fact that gender predicted performance for athletes in the two fastest events suggests that enduring physical differences between individuals, as a result of gender, limit performance for activities with high anaerobic demands that appear to be less amenable to training.

Other efforts to examine gender differences have been conducted by Duffy, Baruch, and Ericsson (2004) in a sport that ostensibly appears to have very little physical attribute advantages, that is, darts. Despite controlling for variables such as arm length, age, years of experience, and the size of the recruitment pool where men and women were selected, performance differences across male and female players were observed. It was concluded that, barring other variables, such as spatial abilities, practice time and quality are the main variables that differentiate gender, although no specific examination of this hypothesis was conducted. The examination of the developmental profiles of athletes as a function of gender might help to uncover differences in the types of practice and experiences of these athletes across the developmental continuum. It would appear most useful to start at a point where performance differences do not differentiate across gender. For example, in sports such as archery, croquet, and ten-pin bowling, samples of women who are matched for equivalent performance to samples of men have been found (e.g., P. R. Thomas, Schlinker, & Over, 1996). It may be that practice experiences as a function of gender are both quantitatively and qualitatively different, with the demands and amount of practice for women athletes being more stringent than those for men to attain a similar level of performance. Moreover, it might be that the relationship between practice and performance changes following puberty, when differences in body proportions, size, and weight more clearly distinguish across gender.

Age

An aging population worldwide has meant a dramatic increase in the number of masters athletes (generally athletes over 35 years, although age of eligibility varies by sport). Deliberate practice methodologies combined with multiple regression techniques have been used to examine the contribution of age-related factors to declines in performance. It is well established that many variables change linearly with age until approximately 60 years, after which the rate of change accelerates and becomes more quadratic (Salthouse, 1992; Stones & Kozma, 1981). The rate of change has typically been greater in cross-sectional (i.e., different age groups) than longitudinal (i.e., performance across an athlete's career) samples, thus painting a less optimistic picture of the aging process (e.g., Weir, Kerr, Hodges, McKay, & Starkes, 2002). Figure 7.3 shows males' performance times for the 10 K run as a function of age from cross-sectional and longitudinal data. The straighter line for longitudinal data suggests that performance is better retained and does not increase in rate of decline until after age 65 (Young & Starkes, in press). Assessment of practice of these master athletes shows that they maintain a large amount of practice to stave off declines, but they

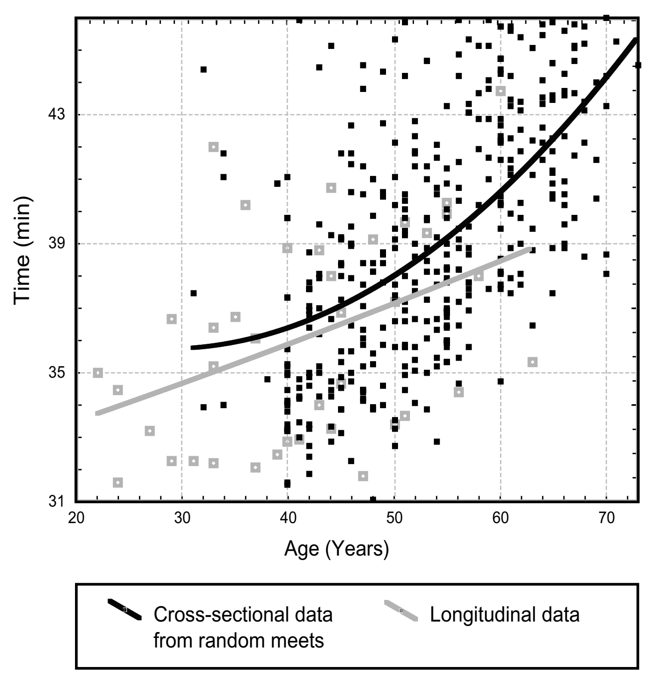


Figure 7.3 Relationship between age and performance for the 10 K race, as demonstrated by cross-sectional versus longitudinal data (Young & Starkes, in press).

may also change the type of practice, engaging in more aerobic activities, potentially to overcome declines in cardiac power (Weir et al., 2002).

There has also been considerable research concerning the type and amount of practice during childhood that best engenders later high-level performance. Following on from the earlier interview-based, case study research of Bloom (1985) with "talented teenagers," Côté and colleagues (Baker, Côté, & Abernethy, 2003; Côté, 1999) have used specialized structured interview techniques to uncover the career paths and the types of early practice that are related to later success. Côté proposed that early involvement in a sport was best characterized by three stages: sampling (6 to 12 years), specializing (13 to 15 years), and investing (16+ years). In contrast to deliberate practice activities, proposed to be effortful and engaged in to improve performance, the sampling years were characterized by engagement in "fun" activities (so-called deliberate play; see Côté & Hay, 2002). Since this initial proposal, Côté and colleagues (e.g., Baker et al., 2003) have shown that the sampling years characterize the career profiles of elite performers and that early specialization, and hence early accrual of deliberate practice hours, is not a necessity for elite performance.

In view of transfer of (psychomotor) skills across sports, the issue of early specialization versus diversification (or sampling) may have important implications for the requirement of many hours of deliberate practice and hence deliberate practice theory. The strong relationship between the amount of deliberate practice and performance suggests that early specialization is important to accrue the necessary practice hours to succeed (Ericsson et al., 1993). However, Baker et al. (2003) have shown a negative correlation between the number of sporting activities an individual has been involved in and the amount of sport-specific training needed to achieve expert levels (in ice hockey, netball, and basketball), suggesting positive transfer from cross-training and diverse sport involvement. In contrast, questionnaire-based findings from Ward et al. (2006) failed to show evidence that elite soccer players from the ages of 8 to 19 are or were involved in more sports than their less elite counterparts; in fact, a trend for the opposite was observed. Although only practice-related activities differentiated across skill levels, examination of soccer-related games and activities primarily engaged in for fun showed that both elite and subelite soccer players showed a steady increase in the amount of hours in playful activities until the age of 15. Indeed, in comparison to individual practice, team practice, and match play separately, more hours were spent in playful activities. The degree of early specialization may in part be a function of culture, as well as the sport's culture and history, and any early advantage likely depends on the degree of skill transfer the sport allows as well as the length of the sport's competitive history. For instance, in women's gymnastics, where performance peaks just after puberty, athletes are forced to specialize early because the overall competitive career length is short.

Summary and Conclusions

The deliberate practice framework for examining the development of elite performance has helped to deepen our understanding of the importance of practice time and has provided some interesting insights into the effects of age and gender on performance in sports. Although the framework was designed to capture the types of practice that best predict performance, this area still requires further attention. Findings indicating that much of practice involves refining existing skills, not just acquiring new skills, suggest that task-relevant practice may involve both motivating activities that reinforce one's sense of competence and more effortful practice designed to improve one's current level. Employing methods that involve multiple measures of performance and abilities (such as speed, decision times, lung capacity, height and weight) are likely to provide a more informative view of performance limits, inasmuch as it will be possible to determine how practice influences these factors at different stages of an athlete's career (see also Côté et al., 2005). Quasi-longitudinal approaches, involving both retrospective and cross-sectional comparisons, are expected to be most informative in this regard.

CONCLUSION

In this chapter, we have discussed a great variety of techniques that have been used to address the three main themes of expert performance in sports. The characteristics of expert decision making and the information and knowledge structures underlying it have been addressed for a range of methods, most notably verbal protocol analysis, recall and recognition tests, eye movement recordings, and visual occlusion techniques. Despite certain, most likely task-specific exceptions in terms of skill-related differences, most evidence suggests that experts make faster, more accurate decisions that are based on different knowledge structures than nonexperts. Experts often search differently for information, and accordingly use different information than the less skilled. Such skill-dependent differences come more clearly to the fore the more ecologically valid the stimulus presentation and response. Indeed, researchers should continue the challenge to create experimental settings that most validly represent the situations in which expertise in situ reveals itself. Skill-related differences are also apparent in the control and planning of movements and actions, which has been addressed through attention manipulations, brain imaging techniques, eye-movement recording, and a variety of time-series analysis techniques. It appears that, to maximize performance, experts better direct their attention to the behavioral goal, whereas the less skilled need to focus inwardly to the manner of goal achievement, suggesting that experts' motor execution has become more automatic. In addition, experts coordinate their movements more stably, yet flexibly, than nonexperts to achieve their goal. Recent evidence also suggests that experts have learned to distinguish between control variables that are relevant versus those that are less relevant in order to achieve task success. These theoretically interesting notions require further investigation and development of appropriate techniques. As indicated, expert performance most often consists of a variety of components, and as such its understanding will benefit from multitask approaches.

The examination of the careers of experts within the deliberate practice framework, mainly studied via quasi-longitudinal approaches and retrospective reports, indicates that experts invest more time, and perhaps better quality time, in developing their skill than the less skilled. Because practice estimates account for less than half the variance in performance, it has been suggested that other, nonpractice factors, such as an athlete's genotype, may play a role in determining performance limits. Evaluation of practice and performance histories across the developmental continuum, in addition to assessment of physical characteristics, will help to elucidate the role of practice in overcoming potential constraints to performance expertise.

REFERENCES

Abernethy, B. (1987a). Review: Selective attention in fast ball sports: Pt. I. General principles. *Australian Journal of Science and Medicine in Sport, 19,* 3–6.

Abernethy, B. (1987b). Review: Selective attention in fast ball sports: Pt. II. Expert-novice differences. *Australian Journal of Science and Medicine in Sport, 19,* 7–15.

Abernethy, B. (1988). Visual search in sport and ergonomics: Its relationship to selective attention and performer expertise. *Human Performance, 1,* 205–235.

Abernethy, B. (1990). Expertise, visual search, and information pick-up in squash. *Perception, 19,* 63–77.

Abernethy, B. (1993). Searching for the minimal essential information for skilled perception and action. *Psychological Research, 55,* 131–138.

Abernethy, B., Baker, J., & Côté, J. (2005). Transfer of pattern recall skills may contribute to the development of sport expertise. *Applied Cognitive Psychology, 19,* 1–14.

Abernethy, B., Burgess-Limerick, R., & Parks, S. (1994). Contrasting approaches to the study of motor expertise. *Quest, 46,* 186.

Abernethy, B., & Russell, D. G. (1984). Advance cue utilization by skilled cricket batsmen. *Australian Journal of Science and Medicine in Sport, 15,* 2–10.

Abernethy, B., & Russell, D. G. (1987). The relationship between expertise and visual search strategy in a racquet sport. *Human Movement Science, 6,* 283–319.

Adams, J. A. (1971). A closed-loop theory of motor learning. *Journal of Motor Behavior, 3,* 111–150.

Alain, C., & Sarrazin, C. (1990). Study of decision-making in squash competition: A computer simulation approach. *Canadian Journal of Sport Sciences, 15,* 193–200.

Allard, F., & Burnett, N. (1985). Skill in sport. *Canadian Journal of Psychology, 39,* 294–312.

Allard, F., Graham, S., & Paarsalu, M. E. (1980). Perception in sport: Basketball. *Journal of Sport Psychology, 2,* 14–21.

Allard, F., & Starkes, J. L. (1980). Perception in sport: Volleyball. *Journal of Sport Psychology, 2,* 22–33.

Amazeen, E. L., Amazeen, P. G., & Beek, P. J. (2001). Eye movements and the selection of optical information for catching. *Ecological Psychology, 13,* 71–85.

Anderson, J. R. (1982). Acquisition of a cognitive skill. *Psychological Review, 89,* 369–406.

Åstrand, P.-O., Rodahl, K., Dahl, H. A., & Strømme, S. B. (2003). *Textbook of work physiology: Physiological bases of exercise* (4th ed.). Windsor, Ontario, Canada: Human Kinetics.

Baker, J., Côté, J., & Abernethy, B. (2003). Sport specific training, deliberate practice and the development of expertise in team ball sports. *Journal of Applied Sport Psychology, 15,* 12–25.

Baker, J., Côté, J., & Deakin, J. (in press). Expertise in ultra-endurance triathletes: Early sport involvement, training structure and the theory of deliberate practice. *Journal of Applied Sport Psychology.*

Bardy, B. G., Marin, L., Stoffregen, T. A., & Bootsma, R. J. (1999). Postural coordination modes considered as emergent phenomena. *Journal of Experimental Psychology: Human Perception and Performance, 25,* 284–301.

Beilock, S. L., Bertenthal, B. I., McCoy, A. M., & Carr, T. H. (2004). Haste does not always make waste: Expertise, direction of attention and speed versus accuracy in performing sensorimotor skills. *Psychonomic Bulletin and Review, 11,* 372–379.

Beilock, S. L., & Carr, T. H. (2001). On the fragility of skilled performance: What governs choking under pressure? *Journal of Experimental Psychology: General, 130,* 701–725.

Beilock, S. L., Carr, T. H., MacMahon, C., & Starkes, J. L. (2002). When paying attention becomes counterproductive: Impact of divided versus skill-focused attention on novice and experienced performance of sensorimotor skills. *Journal of Experimental Psychology: Applied, 8,* 6–16.

Beilock, S. L., Wierenga, S. A., & Carr, T. H. (2002). Expertise, attention, and memory in sensorimotor skill execution: Impact of novel task constraints on dual-task performance and episodic memory. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology, 55,* 1211–1240.

Bennett, S. J., & Davids, K. (1995). The manipulation of vision during the powerlift squat: Exploring the boundaries of the specificity of learning hypothesis. *Research Quarterly for Exercise and Sport, 66,* 210–218.

Bernstein, N. A. (1967). *The coordination and regulation of movement.* London: Pergamon Press.

Bloom, B. S. (1985). *Developing talent in young people.* New York: Ballantine.

Bootsma, R. J., & van Wieringen, P. C. (1990). Timing an attacking forehand drive in table tennis. *Journal of Experimental Psychology: Human Perception and Performance, 16,* 21–29.

Bouchard, C., Boulay, M. R., Dionne, F. T., Perusse, L., Thibault, M. C., & Simoneau, J. A. (1990). Genotype, aerobic performance and response to training. In G. Beunen, J. Chesquiere, T. Reybrouch, & A. L. Claessens (Eds.), *Children and exercise* (pp. 124–135). Stuttgart, Germany: Ferdinand Enke Verlag.

Bramble, D. M., & Carrier, D. R. (1983). Running and breathing in mammals. *Science, 219,* 251–256.

Calvo-Merino, B., Glaser, D. E., Grezes, J., Passingham, R. E., & Haggard, P. (2004). Action observation and acquired motor skills: An fMRI study with expert dancers. *Cerebral Cortex, 15,* 1243–1249.

Chase, W. G., & Simon, H. A. (1973). Perception in chess. *Cognitive Psychology, 4,* 55–81.

Chi, M. T. H., Feltovich, P. J., & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. *Cognitive Science, 5,* 121–152.

Côté, J. (1999). The influence of the family in the development of talent in sport. *Sport Psychologist, 13,* 395–417.

Côté, J., Ericsson, K. A., & Law, M. P. (2005). Tracing the development of athletes using retrospective interview methods: A proposed interview and validation procedure for reported information. *Journal of Applied Sport Psychology, 17,* 1–19.

Côté, J., & Hay, J. (2002). Children's involvement in sport: A developmental perspective. In J. M. Silva & D. Stevens (Eds.), *Psychological foundations in sport* (pp. 484–502). Boston: Merrill.

Daffertshofer, A., Huys, R., & Beek, P. J. (2004). Dynamical coupling between locomotion and respiration. *Biological Cybernetics, 90,* 157–164.

Daffertshofer, A., Lamoth, C. J., Meijer, O. G., & Beek, P. J. (2005). PCA in studying coordination and variability: A tutorial. *Clinical Biomechanics, 19,* 415–428.

Deakin, J. M., & Cobley, S. (2003). A search for deliberate practice: An examination of the practice environments in figure skating and volleyball. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 115–135). Champaign, IL: Human Kinetics.

Deakin, J. M., Starkes, J. L., & Allard, F. (1998). *The microstructure of practice in sport* (Technical report). Ottawa, Ontario, Canada: Sport Canada.

Decety, J., & Grezes, J. (1999). Neural mechanisms subserving the perception of human actions. *Trends in Cognitive Science, 3,* 172–178.

de Groot, A. D. (1978). *Thought and choice in chess.* The Hague, The Netherlands: Mouton. (Original work published 1965)

Duffy, L. J., Baruch, B., & Ericsson, K. A. (2004). Dart performance as a function of facets of practice amongst professional and amateur men and women players. *International Journal of Sport Psychology, 35,* 232–245.

Durand-Bush, N., & Salmela, J. (2001). The development of talent in sport. In R. N. Singer, H. A. Hausenblas, & C. M. Janelle (Eds.), *Handbook of sport psychology* (2nd ed., pp. 269–289). New York: Wiley.

Durand-Bush, N., & Salmela, J. H. (2002). The development and maintenance of expert athletic performance: Perceptions of world and Olympic champions. *Journal of Applied Sport Psychology, 14,* 154–171.

Engel, F., & Schack, T. (2002). Knowledge and performance in volleyball. In K. Koskolou, N. Geladas, & V. Klissouras (Eds.), *Proceedings of the 7th annual Congress of the European College of Sport Science* (p. 607). Athens, Greece: ECSS.

Ericsson, K. A. (2003). Development of elite performance and deliberate practice: An update from the perspective of the expert performance approach. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 49–83). Champaign, IL: Human Kinetics.

Ericsson, K. A., & Kintsch, W. (1995). Long-term working memory. *Psychological Review, 102,* 211–245.

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review, 100,* 363–406.

Ericsson, K. A., & Lehmann, A. C. (1996). Expert and exceptional performance: Evidence of maximal adaptation to task constraints. *Annual Review of Psychology, 47,* 273–305.

Ericsson, K. A., & Simon, H. A. (1993). *Protocol analysis: Verbal reports as data.* Cambridge, MA: MIT Press.

Farrow, D., & Abernethy, A. (2003). Do expertise and the degree of perception-action coupling affect natural anticipatory performance? *Perception, 32,* 1127–1139.

Ferrari, M. (1999). Influence of expertise on the intentional transfer of motor skill. *Journal of Motor Behavior, 31,* 79–85.

Féry, Y., & Crognier, L. (2001). On the tactical significance of game situations in anticipating ball trajectories in tennis. *Research Quarterly for Exercise and Sport, 72,* 143–149.

Ford, P., Hodges, N. J., Huys, R., & Williams, A. M. (in press). Skilled performance and end-effects information in the performance of a sports skill. *Motor Control.*

Ford, P., Hodges, N. J., & Williams, A. M. (2005). Online attentional-focus manipulations in a soccer-dribbling task: Implications for the proceduralization of motor skills. *Journal of Motor Behavior, 37,* 386–394.

Franks, I. M. (1993). The effects of experience on the detection and location of performance differences in a gymnastic technique. *Research Quarterly for Exercise and Sport, 64,* 227–231.

Franks, I. M., & Hanvey, T. (1997). Cues for goalkeepers: High-tech methods used to measure penalty shot response. *Soccer Journal, 42,* 30–33.

French, K. E., & McPherson, S. L. (1999). Adaptations in response selection processes used during sport competition with increasing age and expertise. *International Journal of Sport Psychology, 30,* 173–193.

French, K. E., Nevett, M. E., Spurgeon, J. H., Graham, K. C., Rink, J. E., & McPherson, S. L. (1996). Knowledge representation and problem solution in expert and novice youth baseball players. *Research Quarterly for Exercise and Sport, 67,* 386–395.

French, K. E., & Thomas, J. R. (1987). The relation of knowledge development to children's basketball performance. *Journal of Sport Psychology, 9,* 15–32.

Gobet, F., & Simon, H. A. (1996). Recall of random and distorted chess positions: Implications for the theory of expertise. *Memory and Cognition, 24,* 493–503.

Goulet, C., Bard, C., & Fleury, M. (1989). Expertise differences in preparing to return a tennis serve: A visual information processing approach. *Journal of Sport and Exercise Psychology, 11,* 382–398.

Gray, R. (2004). Attending to the execution of a complex sensorimotor skill: Expertise differences, choking, and slumps. *Journal of Experimental Psychology: Applied, 10,* 42–54.

Haas, R. (1995). *Bewegungserkennung und Bewegungsanalyse mit dem synergetischen computer.* Aachen, Germany: Shaker-Verlag Universität Stuttgart.

Haken, H. (1996). *Principles of brain functioning: A synergetic approach to brain activity, behavior, and cognition.* Berlin, Germany: Springer.

Haken, H., Kelso, J. A. S., & Bunz, H. (1985). A theoretical model of phase transitions in human hand movements. *Biological Cybernetics, 51,* 347–356.

Helsen, W. F., Starkes, J. L., & Hodges, N. J. (1998). Team sports and the theory of deliberate practice. *Journal of Sport and Exercise Psychology, 20,* 12–34.

Hodge, T., & Deakin, J. M. (1998). Deliberate practice and expertise in martial arts: The role of context in motor recall. *Journal of Sport and Exercise Psychology, 20,* 260–279.

Hodges, N. J., Hayes, S. J., Breslin, G., & Williams, A. M. (2005). An evaluation of the minimal constraining information during observation for movement reproduction. *Acta Psychologica, 119,* 264–282.

Hodges, N. J., Hayes, S. J., Eaves, D., Horn, R., & Williams, A. M. (in press). End-point trajectory matching as a method for teaching kicking skills. *International Journal of Sport Psychology.*

Hodges, N. J., Kerr, T., Starkes, J. L., Weir, P., & Nananidou, A. (2004). Predicting performance from deliberate practice hours for triathletes and swimmers: What, when, and where is practice important? *Journal of Experimental Psychology: Applied, 10,* 219–237.

Hodges, N. J., & Starkes, J. L. (1996). Wrestling with the nature of expertise: A sport specific test of Ericsson, Krampe, and Tesch-Römer's (1993) theory of deliberate practice. *International Journal of Sport Psychology, 27,* 400–424.

Huys, R., & Beek, P. J. (2002). The coupling between point-of-gaze and ball movements in three-ball cascade juggling: The effects of expertise, pattern, and tempo. *Journal of Sports Sciences, 20,* 171–186.

Huys, R., Daffertshofer, A., & Beek, P. J. (2003). Learning to juggle: On the assembly of functional sub-systems into a task-specific dynamical organization. *Biological Cybernetics, 88,* 302–318.

Kang, N., Shinohara, M., Zatsiorsky, V. M., & Latash, M. L. (2004). Learning multi-finger synergies: An uncontrolled manifold analysis. *Experimental Brain Research, 157,* 336–350.

Kelso, J. A. S. (1984). Phase transitions and critical behavior in human bimanual coordination. *American Journal of Physiology: Regulatory, Integrative, and Comparative Physiology, 15,* R1000–R1004.

Kelso, J. A. S. (1995). *Dynamic patterns: The self-organization of brain and behavior.* Cambridge, MA: MIT Press.

Khan, M. A., Elliot, D., Coull, J., Chua, R., & Lyons, J. (2002). Optimal control strategies under different feedback schedules: Kinematic evidence. *Journal of Motor Behavior, 34,* 45–57.

Khan, M. A., & Franks, I. M. (2004). The utilization of visual feedback in the acquisition of motor skills. In A. M. Williams & N. J. Hodges (Eds.), *Skill acquisition in sport: Research, theory, and practice* (pp. 45–62). London: Routledge.

Koch, I., Keller, P., & Prinz, W. (2004). The ideomotor approach to action control: Implications for skilled performance. *International Journal of Sport and Exercise Psychology, 2,* 362–372.

Kugler, P. N., Kelso, J. A. S., & Turvey, M. T. (1980). On the concept of coordinative structures as dissipative structures: Pt. I. Theoretical lines of convergence. In G. E. Stelmac & J. Requin (Eds.), *Tutorials in motor behavior* (pp. 3–45). Amsterdam: North-Holland.

Land, M. F., & McLeod, P. (2000). From eye movements to actions: How batsmen hit the ball. *Nature Neuroscience, 3,* 1340.

Leavitt, J. L. (1979). Cognitive demands of skating and stickhandling in ice hockey. *Canadian Journal of Applied Sport Sciences, 4,* 46–55.

McMorris, T., & Graydon, J. (1997). The effect of exercise on cognitive performance in soccer-specific tests. *Journal of Sports Sciences, 15,* 459–468.

McPherson, S. L. (1993). Knowledge representation and decision-making in sport. In J. L. Starkes & F. Allard (Eds.), *Cognitive issues in motor expertise* (pp. 159–188). Amsterdam: North-Holland/Elsevier Science.

McPherson, S. L. (1999a). Expert-novice differences in performance skills and problem representations of youth and adults during tennis competition. *Research Quarterly for Exercise and Sport, 70,* 233–251.

McPherson, S. L. (1999b). Tactical differences in problem representations and solutions in collegiate varsity and beginner female tennis players. *Research Quarterly for Exercise and Sport, 70,* 369–384.

McPherson, S. L., & Kernodle, M. W. (2003). Tactics, the neglected attribute of expertise: Problem representations and performance skills in tennis. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 137–167). Champaign, IL: Human Kinetics.

McPherson, S. L., & Thomas, J. R. (1989). Relation of knowledge and performance in boys' tennis: Age and expertise. *Journal of Experimental Child Psychology, 48,* 190–211.

Newell, K. M., & Vaillancourt, D. E. (2001). Dimensional change in motor learning. *Human Movement Science, 20,* 695–715.

Nietfeld, J. L. (2003). An examination of metacognitive strategy use and monitoring skills by competitive middle distance runners. *Journal of Applied Sport Psychology, 15,* 307–320.

North, J. S., Williams, A. M., Hodges, N. J., Ward, P., & Ericsson, K. A. (2006). *The role of higher-order relations when perceiving patterns of play in soccer.* Manuscript submitted for publication.

Oudejans, R. R. D., Michaels, C. F., & Bakker, F. C. (1997). The effects of baseball experience on movement initiation in catching fly balls. *Journal of Sports Sciences, 15,* 587–595.

Oudejans, R. R. D., Michaels, C. F., Bakker, F. C., & Dolne, M. A. (1996). The relevance of action in perceiving affordances: Perception of catchableness of fly balls. *Journal of Experimental Psychology: Human Perception and Performance, 22,* 879–891.

Oudejans, R. R. D., van de Langenberg, R. W., & Hutter, R. I. (2002). Aiming at a far target under different viewing conditions: Visual control in basketball jump shooting. *Human Movement Science, 21,* 457.

Perkins-Cecatto, N., Passmore, S. R., & Lee, T. D. (2003). Effects of focus of attention depend on golfers' skill. *Journal of Sports Sciences, 21,* 593–600.

Poon, P. P. L., & Rodgers, W. M. (2000). Learning and remembering strategies of novice and advanced jazz dancers for skill level. *Research Quarterly for Exercise and Sport, 71,* 135.

Proteau, L. (1992). On the specificity of learning and the role of visual information for movement control. In L. Proteau & D. Elliott (Eds.), *Vision and motor control* (pp. 67–103). Amsterdam: North-Holland.

Proteau, L., & Cournoyer, J. (1990). Vision of the stylus in a manual aiming task: The effects of practice. *Quarterly Journal of Experimental Psychology, 42A,* 811–828.

Ripoll, H. (1988). Analysis of visual scanning patterns of volleyball players in a problem solving task. *International Journal of Sport Psychology, 19,* 9–25.

Ripoll, H. (1991). The understanding action process in sport: The relationship between the semantic and the sensorimotor visual function. *International Journal of Sport Psychology, 22,* 221–243.

Ripoll, H., Kerlirzin, Y., Stein, J., & Reine, B. (1995). Analysis of information processing, decision-making, and visual strategies in complex problem solving sport situations. *Human Movement Science, 14,* 325–349.

Rizzolatti, G., Fogassi, L., & Gallese, V. (2001). Neurophysiological mechanisms underlying the understanding and imitation of action. *Nature Reviews Neuroscience, 2,* 661–670.

Robertson, S., Collins, J., Elliott, D., & Starkes, J. (1994). The influence of vision on dynamic balance. *Journal of Motor Behavior, 26,* 333–339.

Rodrigues, S. T., Vickers, J. N., & Williams, A. M. (2002). Head, eye and arm coordination in table tennis. *Journal of Sports Sciences, 20,* 187–200.

Salthouse, T. A. (1992). *Mechanisms of age-cognition relations in adulthood.* Hillsdale, NJ: Erlbaum.

Savelsbergh, G. J. P., Williams, A. M., van der Kamp, J., & Ward, P. (2002). Visual search, anticipation and expertisein soccer goalkeepers. *Journal of Sports Sciences, 20,* 279–287.

Schack, T. (1999). Relation of cognitive representation and performance in extreme-surfing. In I. Wachsmuth & B. Jung (Eds.), *KogWis99 Proceedings der 4: Fachtagung für*

Kognitionswissenschaft, 28 (S207–S212). Sankt Augustin, Germany: Infix.

Schack, T., & Mechsner, F. (in press). Representation of motor skills in human long-term-memory. *Neuroscience Letters.*

Schmidt, R. A. (1975). A schema theory of discrete motor skill learning. *Psychological Review, 82,* 225–260.

Schmidt, R. A., & McCabe, J. F. (1976). Motor program utilization over extended practice. *Journal of Human Movement Studies, 2,* 239–247.

Schmidt, R. C., Carello, C., & Turvey, M. T. (1990). Phase transitions and critical fluctuations in the visual coordination of rhythmic movements between people. *Journal of Experimental Psychology: Human Perception and Performance, 19,* 397–415.

Scholz, J. P., & Schöner, G. (1999). The uncontrolled manifold concept: Identifying control variables for a functional task. *Experimental Brain Research, 126,* 289–306.

Sève, C., Saury, J., Theureau, J., & Durand, M. (2002). Activity organization and knowledge construction during competitive interaction in table tennis. *Cognitive Systems Research, 3,* 501–522.

Siegmund, G. P., Edwards, M. R., Moore, K. S., Tiessen, D. A., Sanderson, D. J., & McKenzie, D. C. (1999). Ventilation and locomotion coupling in varsity male rowers. *Journal of Applied Physiology, 87,* 233–242.

Simon, H. A., & Chase, W. (1973). Skill in chess. *American Scientist, 61,* 394–403.

Simoneau, J. A., Lortie, G., Boulay, M. R., Marcotte, M., Thibault, M. C., & Bouchard, C. (1986). Inheritance of human skeletal muscle and anaerobic capacity adaptations to high-intensity intermittent training. *International Journal of Sports Medicine, 7,* 167–171.

Singer, R. N., Cauraugh, J. H., Chen, D., Steinberg, G. M., & Frehlich, S. G. (1996). Visual search, anticipation, and reactive comparisons between highly-skilled and beginning tennis players. *Journal of Applied Sport Psychology, 8,* 9–26.

Sloboda, J. A., Davidson, J. W., Howe, M. J. A., & Moore, D. G. (1996). The role of practice in the development of performing musicians. *British Journal of Psychology, 87,* 287–309.

Smeeton, N. J., Ward, P., & Williams, M. (2004). Do pattern recognition skills transfer across sports? A preliminary analysis. *Journal of Sports Sciences, 22,* 205–213.

Smyth, M. M., & Pendleton, L. R. (1994). Memory for movement in professional ballet dancers. *International Journal of Sport Psychology, 25,* 282–294.

Starkes, J. L. (2000). The road to expertise: Is practice the only determinant? *International Journal of Sport Psychology, 31,* 431–451.

Starkes, J. L., & Allard, F. (1993). *Cognitive issues in motor expertise.* New York: North-Holland.

Starkes, J. L., & Deakin, J. M. (1984). Perception in sport: A cognitive approach to skilled performance. In W. F. Straub & J. M. Williams (Eds.), *Cognitive sport psychology* (pp. 115–128). Lansing, NY: Sport Science Associates.

Starkes, J. L., Deakin, J. M., Allard, F., Hodges, N. J., & Hayes, A. (1996). Deliberate practice in sports: What is it anyway? In K. A. Ericsson (Ed.), *Road to excellence: The acquisition of expert performance in the arts and sciences, sports, and games* (pp. 81–106). Hillsdale, NJ: Erlbaum.

Starkes, J. L., Deakin, J. M., Lindley, S., & Crisp, F. (1987). Motor versus verbal recall of ballet sequences by young expert dancers. *Journal of Sport Psychology, 9,* 222–230.

Starkes, J. L., Edwards, P., Dissanayake, P., & Dunn, T. (1995). A new technology and field test of advance cue usage in volleyball. *Research Quarterly for Exercise and Sport, 66,* 162–167.

Starkes, J. L., & Ericsson, K. A. (2003). *Expert performance in sports: Advances in research on sport expertise.* Champaign, IL: Human Kinetics.

Starkes, J. L., Weir, P. L., & Young, B. W. (2003). Retaining expertise: What does it take for older expert athletes to continue to excel? In J. L. Starkes & K. A. Ericsson (Ed.), *Expert performance in sports: Advances in research on sport expertise* (pp. 251–272). Champaign, IL: Human Kinetics.

Stocia, P., & Moses, R. L. (1997). *Introduction to spectral analysis.* Englewood Cliffs, NJ: Prentice-Hall.

Stones, M. J., & Kozma, A. (1981). Adult age trends in athletic performances. *Experimental Aging Research, 7,* 269–280.

Temprado, J., Della-Grasta, M., Farrell, M., & Laurent, M. (1997). A novice-expert comparison of (intra-limb) coordination subserving the volleyball serve. *Human Movement Science, 16,* 653–676.

Tenenbaum, G. (2003). Expert athletes: An integrated approach to decision-making. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sport: Advances in research on sport expertise* (pp. 191–218). Champaign, IL: Human Kinetics.

Tenenbaum, G., Sar El, T., & Bar Eli, M. (2000). Anticipation of ball location in low and high-skill performers: A developmental perspective. *Psychology of Sport and Exercise, 1,* 117–128.

Tenenbaum, G., Tehan, G., Stewart, G., & Christensen, S. (1999). Recalling a floor routine: The effects of skill and age on memory for order. *Applied Cognitive Psychology, 13,* 101–123.

Thomas, J. R., Gallagher, J., & Lowry, K. (2003, June). *Developing motor and sport expertise: Meta-analytic findings.* Paper presented at North American Society for the Psychology of Sport and Physical Activity, Savannah, GA.

Thomas, K. T. (1994). The development of sport expertise: From Leeds to MVP legend. *Quest, 46,* 199.

Thomas, K. T., & Thomas, J. R. (1994). Developing expertise in sport: The relation of knowledge and performance. *International Journal of Sport Psychology, 25,* 295–312.

Thomas, P. R., Schlinker, P. J., & Over, R. (1996). Psychological and psychomotor skills associated with prowess at ten-pin bowling. *Journal of Sports Sciences, 14,* 255–268.

Turvey, M. T. (1990). Coordination. *American Psychologist, 45,* 938–953.

van Santvoord, A. A. M., & Beek, P. J. (1994). Phasing and the pickup of optical information in cascade juggling. *Ecological Psychology, 6,* 239.

Vereijken, B., van Emmerik, R. E. A., Whiting, H. T. A., & Newell, K. M. (1992). Free(z)ing degrees of freedom in skill acquisition. *Journal of Motor Behavior, 24,* 133–142.

Vicente, K. J., & Wang, J. H. (1998). An ecological theory of expertise effects in memory recall. *Psychological Review, 105,* 33–57.

Vickers, J. N. (1992). Gaze control in putting. *Perception, 21,* 117–132.

Vickers, J. N. (1996). Visual control when aiming at a far target. *Journal of Experimental Psychology: Human Perception and Performance, 22,* 342–354.

Vickers, J. N., & Adolphe, R. A. (1997). Gaze behavior during a ball tracking and aiming skill. *International Journal of Sports Vision, 4*(1), 18–27.

Ward, P., Hodges, N. J., Williams, A. M., & Starkes, J. L. (2004). Deliberate practice and expert performance: Defining the path to excellence. In A. M. Williams & N. J. Hodges (Eds.), *Skill acquisition in sport: Research, theory and practice* (pp. 231–258). London: Routledge.

Ward, P., Hodges, N. J., Williams, A. M., & Starkes, J. L. (2006). *A life-span longitudinal approach to deliberate practice.* Manuscript submitted for publication.

Ward, P., & Williams, A. M. (2003). Perceptual and cognitive skill development in soccer: The multidimensional nature of expert performance. *Journal of Sport and Exercise Psychology, 25,* 93–111.

Ward, P., Williams, A. M., & Bennett, S. J. (2002). Visual search and biological motion perception in tennis. *Research Quarterly for Exercise and Sport, 73,* 107.

Weber, N., & Brewer, N. (2003). Expert memory: The interaction of stimulus structure, attention, and expertise. *Applied Cognitive Psychology, 17,* 295–308.

Weir, P. L., Kerr, T., Hodges, N. J., McKay, S. M., & Starkes, J. L. (2002). Master swimmers: How are they different from younger elite swimmers? An examination of practice and performance patterns. *Journal of Aging and Physical Activity, 10,* 41–63.

Wells, C. L. (1991). *Women, sport, and performance: A physiological perspective.* Champaign, IL: Human Kinetics.

Williams, A. M., & Burwitz, L. (1993). Advance cue utilization in soccer. In T. Reilly (Ed.), *Science and football II* (pp. 239–243). London: E. & F.N. Spon.

Williams, A. M., & Davids, K. (1995). Declarative knowledge in sport: A by-product of experience or a characteristic of expertise? *Journal of Sport and Exercise Psychology, 17,* 259–275.

Williams, A. M., & Davids, K. (1998). Visual search strategy, selective attention, and expertise in soccer. *Research Quarterly for Exercise and Sport, 69,* 111–128.

Williams, A. M., Davids, K., & Williams, J. G. (1999). *Visual perception and action in sport.* London: E. & F.N. Spon.

Williams, A. M., & Elliot, D. (1999). Anxiety, expertise, and visual search strategy in karate. *Journal of Sport and Exercise Psychology, 21,* 362–375.

Williams, A. M., & Ericsson, K. A. (in press). Perceptual-cognitive expertise in sport: Some considerations when applying the expert performance approach. *Human Movement Science.*

Williams, A. M., Hodges, N. J., North, J., & Barton, G. (2006). Identifying patterns of play in dynamic sport tasks: The minimal essential information underlying skilled performance. *Perception, 35,* 317–332.

Yang, J. F., & Scholz, J. P. (2005). Learning a throwing task is associated with differential changes in the use of motor abundance. *Experimental Brain Research, 163,* 137–158.

Young, B. W., & Starkes, J. L. (in press). Career-span analyses of track performance: Longitudinal data present a more optimistic view of age-related performance decline. *Experimental Aging Research.*

Zoudji, B., & Thon, B. (2003). Expertise and implicit memory: Differential repetition priming effects on decision-making in experienced and inexperienced soccer players. *International Journal of Sport Psychology, 34,* 189–207.

CHAPTER 8

Practice and Play in the Development of Sport Expertise

JEAN CÔTÉ, JOSEPH BAKER, and BRUCE ABERNETHY

There is a long history of interest across a range of skill domains in understanding and cultivating expert performance. Much of the interest has stemmed from attempts to determine the relative contribution of genetic and environmental/experiential factors to high-level human achievement—work that has emanated largely from the nature-nurture distinction first proposed by Sir Francis Galton in 1874. Work on the genetic basis of expert performance in sport is in its relative infancy, and it would be surprising if there were not some significant hereditary contribution to expert performance (e.g., see Bouchard & Malina, 1997; Singer & Janelle, 1999); nevertheless, most researchers accept that the type of experiences athletes have throughout their development is enormously influential in determining to what degree individual potential (or *talent;* Durand-Bush & Salmela, 2001) is realized and expertise is attained.

In this chapter, we examine the role that different developmental experiences play in the realization of exceptional performance in sport. We focus in particular on the respective contributions that both the amount and type of formal and informal learning opportunities may make to the development of expertise. To this end we draw a working distinction between learning activities that may be regarded as *practice* and those that may be more accurately regarded as *play.* We reserve the use of the term *practice* for organized activities in which the principal focus is on skill development and performance enhancement and use the term *play* to describe activities undertaken primarily for intrinsic enjoyment but that may nevertheless ultimately contribute to the acquisition of expertise.

Support for the writing of this chapter was given by the Social Sciences and Humanities Research Council of Canada (SSHRC Grants # 410-05-1949 and 410-04-1207).

The chapter is organized into five major sections. The first two sections examine, in turn, propositions regarding the links between practice and skill development, and play and skill development, introducing key concepts such as Ericsson, Krampe, and Tesch-Römer's (1993) notion of deliberate practice and Côté's (1999) notion of deliberate play. The third and major section of the chapter examines the respective contributions of practice and play to the development of sports expertise, drawing evidence from three major methods for obtaining retrospective profile information from experts: (1) qualitative interviews, (2) training questionnaires, and (3) quantitative interviews. The fourth section briefly discusses issues related to early specialization and early diversification. The fifth section reviews two environmental factors, relative age and birthplace, that have been associated with increased early exposure to sport and the achievement of elite performance. In the final section of the chapter a tentative framework is presented to help integrate existing knowledge on the role of practice and play and provide direction for future research endeavors.

PRACTICE AND SKILL DEVELOPMENT

Practice is uniformly regarded in the motor learning literature as the variable having the greatest singular influence on skill acquisition, yet there remains a host of unsatisfactorily answered questions as to how much and what type of practice is necessary and is best for the development of expertise. Much of the experimental work on the relationship between practice conditions, learning, and performance has been conducted using laboratory tasks in which the changes in performance are recorded over a relatively small number of trials and untrained individuals (novices) are used as participants. Such approaches have proven useful in addressing such issues as variability of practice (e.g., C. H. Shea & Kohl, 1991), distribution of practice (e.g., Stelmach, 1969), segmentation and fractionation of practice (e.g., Wightman & Lintern, 1985), and transfer and contextual interference (e.g., Lee & Magill, 1983; J. B. Shea & Morgan, 1979) for the learning of new skills (see Lee, Chamberlin, & Hodges, 2001, for a comprehensive review) and have also helped to determine the nature of the relationship between the quantum of practice and performance.

One of the most salient relationships in the behavioral sciences is the positive association between time spent in practice and improvement in proficiency. Although alternatives exist, one of the most empirically sound profiles of the relationship between practice and achievement is commonly referred to as the *power law of practice* (Newell & Rosenbloom, 1981). According to this position, the relationship between these two variables follows a power function where rapid increases in achievement are evident during initial stages of practice, but over time these increases become more difficult to sustain. Although practice eventually becomes asymptotic, longitudinal examinations of practice over time indicate that improvements continue even after years of involvement (e.g., Crossman, 1959).

Although laboratory studies of practice have contributed to our understanding of the early phases of acquisition of new skills, such studies have been constrained in what they can contribute to the understanding of expertise. This is largely because expertise may require literally millions of trials and typically a decade or more of regular, sustained practice to acquire (Chase & Simon, 1973)—a time frame that makes typical laboratory studies logistically difficult, if not impossible. Because experimental work examining acquisition of expertise in a prospective, longitudinal manner is fraught with logistical difficulties, the bulk of the knowledge regarding the relationship between practice quantity and type has come, by necessity, from studies in which the practice histories of experts are determined retrospectively. Much of this research has been profoundly influenced by the work of Anders Ericsson, which draws together a fundamental interest in memory performance (e.g., Ericsson, Chase, & Faloon, 1980) with an interest in exceptional performance in applied cognitive tasks such as those underpinning performance in chess and music.

In 1993, Ericsson, Krampe, and Tesch-Römer produced a seminal paper on the role of practice and expert development that shaped a great deal of the research that followed. Their position (based on the work of Simon & Chase, 1973, and others) was that with proper attention to what they called "deliberate practice" one could prevent performance improvements from leveling off, thus circumventing the asymptotic effects that underpin the power law of practice. Deliberate practice was operationalized as any training activity (a) undertaken with the specific purpose of increasing performance (e.g., not for enjoyment or external rewards), (b) requiring cognitive and/or physical effort, and (c) relevant to promoting positive skill development. Ericsson et al. suggested, on the basis of an intensive examination of the training and performance of elite musicians, that the relationship between time spent in deliberate practice and performance was monotonic (i.e., linear) rather than a power function. Moreover, they contended that the primary factor distinguishing performers at different skill levels was the number of hours spent in deliberate practice, thus attributing to deliberate practice a causal role in the attainment of expertise. For instance, in their examination of violinists, experts were shown to have accumulated more than 7,400 hours of deliberate practice by 18 years of age, compared to 5,300 hours for intermediate-level performers and 3,400 hours for lower-level performers.

Despite deriving the deliberate practice proposition primarily from data collected on musicians, Ericsson and his colleagues have repeatedly contended that it also applies to the development of expertise in other domains, including sport (for a recent review, see Ericsson, 2003). There is a growing body of evidence to support this contention from chess (e.g., Charness, Tuffiash, Krampe, Reingold, & Vasyukova, 2005), as well as from some sports (e.g., Deakin & Cobley, 2003; Helsen, Starkes, & Hodges, 1998; Hodges & Starkes, 1996; Starkes, Deakin, Allard, Hodges, & Hayes, 1996). There is, however, some controversy as to definitional aspects of deliberate practice, especially in relation to the contention that practice must be deliberate to be beneficial, and to the proposition that practice alone rather than in combination with other activities or hereditary factors sets the limits to performance (e.g., see Abernethy, Farrow, & Berry, 2003; Baker & Horton, 2004; Sternberg, 1996).

PLAY AND SKILL DEVELOPMENT

Recognizing that athletes tend to first experience sport through fun and playful games, Côté (1999) coined the term *deliberate play* to characterize a form of sporting activity that involves early developmental physical activities that are intrinsically motivating, provide immediate gratification, and are specifically designed to maximize enjoyment. Deliberate play activities such as street hockey and backyard soccer are regulated by rules adapted from standardized sport rules and are set up and monitored by the children or by an adult involved in the activity. Furthermore, it is a form of physical activity that differs from (a) the physical play activities of infancy and early childhood (Denzin, 1975; Pellegrini & Smith, 1998; Piaget, 1962), (b) the specific pedagogical games/play designed to improve performance (Griffin & Butler, 2005; Launder, 2001), (c) the "structured practice" activities typical of organized sport, and (d) deliberate practice activities (Ericsson, 2001; Ericsson et al., 1993).

Deliberate play shares the contextual characteristics of more primitive forms of physical activity play such as running, climbing, jumping, and rough-and-tumble play (Denzin, 1975; Pellegrini & Smith, 1998; Piaget, 1962), yet displays more organized and unique behavioral patterns. Pellegrini and Smith showed that physical activity play such as rough-and-tumble play in young children (a) improves control of specific motor patterns; (b) contributes to children's endurance, strength training, and economy of movement; and (c) contributes to children's regulation of emotions and cognitive performance. In the same way, the learning of motor skills through deliberate play can be illustrated with older children and more complex sport skills. For example, the availability of a basketball hoop in her driveway may incite a 7-year-old to pick up a ball and try to shoot the ball into the hoop. The first attempts at throwing the ball into the hoop will usually be unsuccessful; however, after a few attempts, the child will eventually be successful at shooting baskets. Subsequently, the child will simulate more complex play situations such as running and shooting to keep the activity enjoyable, challenging, and interesting. This playful activity will eventually evolve into more complex games such as shooting baskets with a friend and playing one-on-one and three-on-three basketball. Although not specifically designed to improve performance, learning occurs when children are involved in deliberate play activities, just as learning occurs in more primitive forms of physical activity play seen in younger children (Pellegrini & Smith, 1998).

When compared to organized sport practice and deliberate practice, the informality of deliberate play allows children to play sports with minimal equipment, in any kind of space, with any number of players, and with players of different ages and sizes. This kind of environment is easily created and does not require adult supervision, coaches, officials, specialized equipment, time limits, or uniforms that are characteristic of organized sport and structured practice. Deliberate play situations allow children the freedom to experiment with different movements and tactics and the opportunity to learn to innovate, improvise, and respond strategically. It also allows children to perfect skills that would not be practiced in organized situations where all the players are of similar size and skill level and where the playing surface does not present any natural obstacle. For example, playing a modified form of baseball in a backyard (a surface that is not always smooth) with opponents who are older may incite a child to develop speed, ball-handling skills, and creative moves that would allow the child to be successful and have fun.

Pellegrini and Smith (1998) proposed that in play, children recombine behaviors and develop flexible strategies. This flexibility and creativity become important factors in the development of elite athletes, especially in team sports settings (Côté, Baker, & Abernethy, 2003). From a skill acquisition perspective, deliberate play serves as a way for youth to explore their physical capacities in various contexts and at a minimal cost in terms of resources. Table 8.1 summarizes differences between deliberate play and deliberate practice in terms of disposition, context, and behaviors for children's involvement in sport. The definitions of deliberate play and deliberate practice provided in Table 8.1 were tabulated from the literature on play (Côté et al., 2003; Pellegrini & Smith, 1998; Rubin, Fein, & Vandenberg, 1983; Smith, Takhvar, Gore, & Vollstedt, 1986) and deliberate practice (Ericsson, 2003; Ericsson et al., 1993).

After considering the differences between deliberate play and deliberate practice, one may wonder about the importance of deliberate play in an athlete's development of skill. A recent study (Berry & Abernethy, 2003) focused on the early activities of Australian Rules football players, comparing 17 elite players classified as expert decision makers and 15 elite players classified as nonexpert decision makers. During childhood, the expert decision makers invested a greater amount of time in deliberate play activities compared to structured practice activities, which was not the case for the

Table 8.1 Differences between Deliberate Play and Deliberate Practice

Deliberate Play	Deliberate Practice
Done for its own sake	Done to achieve a future goal
Enjoyable	Not the most enjoyable
Pretend quality	Carried out seriously
Interest on the behavior	Interest on outcome of the behavior
Flexibility	Explicit rules
Adult involvement not required	Adult involvement often required
Occurs in various settings	Occurs in specialized facilities

nonexperts. Moreover, qualitative analyses allowed the authors some insight into the context in which deliberate play took place. For example, Berry and Abernethy reported the following quote from an expert decision maker:

> We used to play out in the backyard, backyard footy, backyard cricket, backyard basketball, and soccer. All types of sport you know, if someone's outside it would be one-on-one marking competition, stuff like that, where you do it, time and time again. (p. 52)

A key area where involvement in deliberate play and structured practice are considerably different is in the amount of time that youth spend actively engaged in the activity. Deliberate play activities involve an engagement of time in physical activities that is difficult to match with any kind of structured practice. When youth play street basketball two-on-two for 1 hour there are few periods of waiting or off-task time such as one would find in a structured practice. The athletes' time on task or actual engagement in physical activities in practice has been investigated in sports such as volleyball (Brunelle, Spallanzani, Tousignant, Martel, & Gagnon, 1989; McKenzie, 1986), ice hockey (Trudel & Brunelle, 1985), soccer (Boudreau & Tousignant, 1991), and tae kwon do (Brunelle et al., 1989). These authors reported that athletes' time-on-task rates varied between 25% and 54% of the total practice time. The time off task during practices usually included athletes waiting around to perform the next drill, coaches setting up equipment, or athletes transitioning from one drill to another. Although there are obvious advantages to having a coach who provides athletes with feedback about their performance, monitors success, and provides immediate instruction, it is unclear whether, during early stages of development, the benefits of this structured environment are superior to the benefits one gains from engagement in deliberate play activities.

From a motivational perspective, children get involved in deliberate play because of their own interest in the activity, as opposed to external reasons such as improving performance and winning medals (Soberlak & Côté, 2003). This type of early involvement in sport may help children become more self-directed in their participation in sport. Motivational theories based on self-regulation (Ryan & Deci, 2000; Vallerand, 2001) support this idea and predict that early, intrinsically motivating behaviors (e.g., play) have a positive effect over time on an individual's overall motivation and ultimately the individual's willingness to engage in more externally controlled activities (e.g., deliberate practice). In a retrospective longitudinal examination of baseball players' training, the amount of deliberate play from ages 6 to 12 was positively related to the amount of specific baseball training after age 13 (Gilbert, Côté, Harada, Marchbanks, & Gilbert, 2002). These results suggest that early deliberate play activities could be beneficial in the development of motivation to pursue intense training in a specific sport.

As reviewed by Pellegrini and Smith (1998), physical activity play during childhood establishes a range of cognitive, motor, and social experiences that have immediate and delayed benefits. As well, sport participation through deliberate play provides children with a broad foundation of motor skills that help them overcome the physical, cognitive, and social challenges of various sports, as well as their main sport (Côté et al., 2003). As sport around the world becomes more institutionalized and organized (De Knop, Engström, & Skirstad, 1996), it is important to provide youth with opportunities to get involved in deliberate play activities.

Because talent detection research has not been able to isolate variables that predict accurately which young athlete will eventually reach the highest level in sport (Durand-Bush & Salmela, 2001), elite athletes can be distinguished only after the fact. Consequently, retrospective studies that analyze playing activities and training patterns of elite athletes remain one of the primary sources of information to enhance our understanding of the development of talent in sport. These studies are reviewed next.

EVIDENCE ON THE RESPECTIVE ROLES OF PRACTICE AND PLAY IN SKILL DEVELOPMENT

Expertise researchers have used a variety of research approaches to trace the training activities and developmental pathways of elite-level athletes. Qualitative interviews, training questionnaires, and retrospective/quantitative interviews are three distinct approaches, each with unique strengths and limitations. A summary of research using these methods is provided in this section.

Qualitative Interviews

In their pioneering research, Bloom and colleagues (1985) interviewed elite tennis players and swimmers. They found that elite athletes started their involvement in sport by trying different sports in a playful and fun environment. This type of environment gradually changed to include specialization in the main sport and more practice time as the athlete moved from the early phases of involvement to the middle and later years. The athletes were provided with stimulating environments at home and with coaches who guided their development.

In a qualitative study of socialization into elite sport, Carlson (1988) analyzed the development of 10 elite tennis players in Sweden and compared their training activities with a control group of 10 subelite players. He found that the players in the control group specialized in tennis at a younger age (age 11) than the elite players (age 14). Furthermore, between the ages of 13 and 15 the players from the control group played more tennis than the elite players did. The elite players practiced more tennis only after the age of 15. Carlson concluded that early specialization and "professional-like training" in tennis did not favor the development of elite players; instead, an all-around sport engagement was more important before adolescence. Similar results were found in Stevenson's (1990) examination of international athletes from Canada and England and Hill's (1993) study of professional baseball players.

Similar to Bloom and colleagues (1985), Côté (1999) identified three stages of development specific to sport from childhood to late adolescence: the sampling years, the specializing years, and the investment years. The qualitative data obtained from athletes and parents were also consistent with sports socialization studies (Carlson, 1988; Hill, 1993; Stevenson, 1990), indicating that play and early diversification were important building blocks of children's physical, cognitive, and emotional development in sport. For a developmentally appropriate approach to elite performance in sport, Côté recommended a progression from play and involvement in various sports during the sampling years to more sport-specific practice activities during the specializing and investment years.

To gain more insight into the later years of elite athletes' training, Orlick and colleagues (McCaffrey & Orlick, 1989; Orlick & Partington, 1988) interviewed international-level athletes to assess their actual practice behaviors and perceptions of their training. The athletes consistently mentioned the need to focus on specific training goals and repeatedly emphasized the importance of "concentration" and "intensity" in practice. This activity, labeled "quality practice" by Orlick and Partington, shares many characteristics with deliberate practice, which was subsequently proposed by Ericsson et al. (1993). In a follow-up study, McCaffrey and Orlick reported that expert golfers' (i.e., professional tour golfers') current practice activities included elements of "quality practice" and were qualitatively different from the activities of other professional, but less skilled golfers (i.e., golf professionals at golf clubs).

In a study of elite athletes who won at least two gold medals at separate Olympics and World Championships, Durand-Bush and Salmela (2002) found early patterns of development that were similar to those found by Orlick and Partington (1988) and Côté (1999). Furthermore, Durand-Bush and Salmela proposed the "maintenance years" as a stage that followed Côté's investment years, in which athletes achieved the highest level in their sport (e.g., gold medal at Olympics). During the maintenance years, the athletes indicated that they focused their effort on improving small aspects of their performance instead of increasing the number of hours in practice.

Overall, qualitative studies on the development of elite athletes show distinct stages of development involving different types of activities and resources. More specifically, the early years of involvement for elite athletes were usually characterized by the introduction to various sports through playful activities that focused on elements of enjoyment and immediate reward. Following this stage was a period that focused more on sport-specific training and more objective measures of achievement and performance. Then a period of investment and maintenance was required, which usually was characterized by individuals' complete submersion in training activities and devotion to developing a high level of performance. Identification of these qualitatively different stages toward elite performance has facilitated more quantitative research investigating the type and structure of activities that elite athletes engage in during their development.

Training Survey Questionnaire

Starkes and colleagues (Hodges & Starkes, 1996; Starkes et al., 1996) initiated a line of research aimed at investigating more precisely the training patterns of athletes at different levels of achievement. To accomplish this task, they designed a retrospective questionnaire, based on Ericsson et al.'s (1993) deliberate practice framework, to gather detailed data on the past practice activities of athletes. In the questionnaire, athletes were asked to estimate how much time they engaged in practice-related activities during their development and to rate different aspects of a large number of specific practice and everyday activities. The activities were rated for "relevance to improving performance" and "how enjoyable the actual activity was" (Hodges & Starkes, 1996, p. 407). Athletes were also asked to rate the activities in terms of physical effort and mental concentration.

This questionnaire was used in studies of international wrestlers (i.e., World Championship or Olympic participants), club wrestlers (i.e., university or provincial-level participants), and members of the Canadian national and junior national figure skating teams (Hodges & Starkes, 1996; Starkes et al., 1996). The results showed that both international wrestlers and elite figure skaters increased their weekly amount of practice per week as they progressed into their careers. International wrestlers had accumulated significantly more practice time with others than club wrestlers at 6 years into their careers. Interestingly, activities that the wrestlers and figure skaters rated as highly relevant to improvement and highly effortful (i.e., concentration or physical effort) were also rated as highly enjoyable. Using a comparable questionnaire, similar patterns of training and ratings of practice activities were found in other individual sports, such as karate (Hodge & Deakin, 1998) and middle-distance running (Young & Salmela, 2002).

In a similar study of team sport athletes, Helsen et al. (1998) examined international-, national-, and provincial-level soccer and field hockey players. Athletes estimated the amount of time they spent practicing during their soccer and field hockey careers and rated sport-specific practice activities and everyday activities on their relevance to performance improvement, physical effort, mental effort, and enjoyment. Results for the soccer players demonstrated that at 15 years of age, total accumulated practice time could be used to distinguish between the international and provincial players, and between all three groups by 18 years of age. For the field hockey players, accumulated practice time could be used to distinguish between the international and provincial players from age 25 on, and between all three groups by age 27. Consistent with the earlier findings with wrestlers, figure skaters, runners, and martial artists, types of practice activities that were rated by the athletes as most relevant for improvement of performance tended to be judged as requiring more concentration and were also rated as being more enjoyable by both soccer and field hockey players.

Although the relationship between hours of training and level of attainment appears robust, Van Rossum (2000) used cross-sectional data of a large sample of elite Dutch field hockey players to demonstrate that estimating the number of hours of sport-specific practice may not be sufficient to account for different levels of performance in sport. Van Rossum highlighted the limitation of retrospective questionnaires that focus only on sport-specific practice activities as the sole determinant of expert performance in sport, an issue that had been previously raised from qualitative studies of elite athletes.

To address this methodological issue, Ward, Hodges, Williams, and Starkes (2004) used a questionnaire that assessed the contribution of organized practice, play, and other activities in the development of young elite and sub-elite soccer players (ages 9 to 18). Their findings showed that play and involvement in non-sport-specific activities did not discriminate between players' skill level; however, the amount of organized practice did. The results of Ward et al. suggest that early specialization with sole involvement in activities that are aimed at improving performance (i.e., deliberate practice) during preadolescence was the most effective path toward the development of elite performance in soccer. These results offer a different perspective from that of Van Rossum's (2000) and other qualitative studies that highlight the importance of play and involvement in other sports in the early development of elite performance in sport.

By focusing mostly on practice activities, retrospective questionnaire studies have provided consistent findings about the training activities of elite athletes that can be generalized across sports. First, athletes start their involvement in their main sport by practicing 2 to 5 hours per week, and this amount increases to approximately 25 to 30 hours a decade later. The consensus from questionnaire studies is that a monotonic relationship exists between the number of hours spent in relevant practice activities and the level of performance attained by the athlete. Second, when answering a retrospective questionnaire, athletes rated practice activities that are high in effort as also being high in enjoyment. Côté, Ericsson, and Law (2005) proposed that the contradictory ratings of enjoyment between these studies and Ericsson et al.'s (1993) study with musicians could be due to the differing methods that were used to elicit the information. Ericsson et al. asked their subjects to ignore the consequences of the activity and to focus on the inherent enjoyment, whereas the questionnaires used in the sport research typically instructed participants to evaluate the "enjoyment derived from the actual activity" (Helsen et al., 1998, p. 18). The latter instructions might measure a different construct, because participants might confuse the enjoyment of the results of the activity (improving performance) with the enjoyment of the activity itself (Ericsson, 1996). Results from a recent investigation by Hodges, Kerr, Starkes, Weir, and Nananidou (2004) support this conclusion.

Retrospective Quantitative Interviews

Because questionnaires may not prompt participants to think about an answer in a way that an interview question does, the responses on a questionnaire can become more reactive and less contextualized. This suggests that when obtaining information retrospectively, it is important to provide participants with cues that will facilitate their recollection of habitual, regulated behaviors represented as either extended events or lifetime periods. Côté et al. (2005) recently discussed these issues and proposed an interview procedure where questions could be adjusted to the particular background and development of the athletes studied, and yet the information would still be collected in a standardized manner. The design of the interview procedure was based on the original study of deliberate practice (Ericsson et al., 1993) and was further guided by the theoretical frameworks of deliberate practice (Ericsson, 1996, 2003) and the developmental model of sport participation (Côté, 1999; Côté et al., 2003; Côté & Hay, 2002). The purpose of this standardized interview approach is to collect retrospective longitudinal data on variables that athletes are known to be able to report accurately.

Using this method, Baker, Côté, and Abernethy (2003b) assessed the developmental activities that led to elite participation among a group of expert decision makers from Australian national teams and a comparative sample of nonexpert decision makers drawn from the same sports. They found that from age 5 to 12 both experts and nonexperts increased their participation in extracurricular activities; however, this was followed by a rapid decrease in other activities from approximately age 13 onward for the expert athletes, marking their entry into the specializing years. A comparable reduction of involvement in various activities after age 13 did not occur for the nonexpert athletes. The reduction of activities for the expert athletes continued until approximately age 17. After age 17, the expert decision makers were involved in an average of three sporting activities. Furthermore, Baker et al. showed that expert athletes accumulated hours of sport-specific training similar to that of nonexperts until approximately 10 years of involvement in their sport (around age 15, or the beginning of the investment years). After age 15, the rate of sport-specific practice accumulation by experts escalated dramatically beyond that accumulated by nonexperts. Consistent with Van Rossum's (2000) data with Belgium field hockey players, Baker et al. also found that the number of hours of reported sport-specific training by expert athletes (4,000 hours, on average) was far short of the 10,000 hours of deliberate practice reported for expert musicians by Ericsson et al. (1993). Baker et al. also indicated that participation in other sports (e.g., sports where dynamic decision making is necessary) during early phases of development may have augmented the physical and cognitive skills necessary for the athletes' primary sport.

The same Australian athletes were asked in a follow-up study to rate their training activities on a scale from 0 (no help) to 3 (very helpful) with respect to perceived usefulness in developing essential component skills in perception, decision making, movement execution, and physical fitness (Baker, Côté, & Abernethy, 2003a). Competition and video training were perceived by players as being the most relevant activities for developing the perceptual and decision-making skills necessary for expert performance in team sports; individual instruction with a coach and practice alone were considered the most relevant activities for developing movement execution skills; and aerobic training and competition were regarded as the most relevant for developing physical fitness. Organized training also ranked consistently as an important activity for developing all four components contributing to successful player performance in team ball sports. Practice alone, individual coach instruction, organized training, video training, and aerobic training are all highly relevant, structured activities that require large amounts of cognitive and/or physical effort and certainly satisfy most, if not all, of the criteria for deliberate practice activities in sport. One important point of contention, however, concerns the athletes' ratings of the significance of competition to skill development. The benefits of participation in competition have not been considered in the deliberate practice studies performed to date, yet in the Baker et al. study, competition (i.e., match play) was rated as the most helpful form of training for the development of perceptual and decision-making skills and was also ranked high for developing skill execution and physical fitness. Although competition does indeed require great amounts of cognitive and physical effort, it is not strictly designed (as deliberate practice is) with either the singular or principal purpose of improving specific components of performance.

Baker, Côté, and Deakin (2005) studied ultra-endurance triathletes, stratified into three groups based on previous finishing times: experts, middle of the pack, and back of the pack triathletes. The results did not support a monotonic relationship between training hours and performance. Instead, the relationship between practice and performance was more akin to a power function (Newell & Rosenbloom, 1981). For example, the middle of the pack and back of the pack athletes were separated by 2,000 hours of practice, and the middle of the pack athletes and experts were separated by 6,000 hours. Because the differences in performance across the groups were similar (i.e., approximately 2.5 hours of overall finishing time), these findings show that performance improvements become more difficult as one progresses in skill level. In addition, experts were not distinguishable from their nonexpert counterparts in terms of their practice hours until after approximately 20 years of age. This suggests that although the deliberate practice framework is quite capable of differentiating expert ultra-endurance triathletes from nonexperts based on total hours of sport-specific training, it is not capable of distinguishing them during early stages of development, at least based on retrospective estimates. The analysis of early stages of development for these athletes suggests a considerable depth of sport experience with the expert and middle of the pack triathletes performing around 5,500 hours of other sport participation and the back of the pack accumulating nearly 3,500 hours in other sports.

Contrary to findings for triathletes and team sport athletes, Law, Côté, and Ericsson (in press) found that two groups of elite rhythmic gymnasts (Olympic group, 2nd in the world, and international group, 17th in the world) were involved in few other sports and play activities throughout their development. The average accumulated hours of gymnastics training (including ballet, technique, routine, and conditioning) at age 16 was significantly higher for the Olympic group than for the international gymnasts. Elite rhythmic gymnasts engaged in long hours of practice at younger ages than subelite gymnasts. However, the cost of this intense training was reflected in the Olympic gymnasts experiencing lower levels of "fun" during training and reporting poorer health and more injuries than the International gymnasts. In sum, the elite gymnasts who specialized at younger ages experienced more negative outcomes in the form of physical injuries and less enjoyment than elite gymnasts who specialized at older ages.

Using a modified version of the Ericsson et al. (1993) interview procedure, Duffy, Baluch, and Ericsson (2004) investigated the training activities of professional and amateur dart players. Results showed that professional players invested significantly more time in solitary practice than did amateur players, and amateur players played league darts significantly more often than professional players. The authors suggested that deliberate practice was the sum of solitary practice and practice with a partner. However, the context of solitary practice and practice with a partner in darts was not described by the authors and may not have met the definitional criteria of deliberate practice.

To clarify athletes' involvement in play or practice throughout their development, Soberlak and Côté (2003) asked professional ice hockey players to define the different contexts of their involvement in the sport. The authors showed that, although professional ice hockey players spent more than 10,000 hours involved in sport and physical activity from age 6 to 20, approximately 3,500 of these hours were spent in play-like activities (deliberate play). In contrast, an average of only 3,072 hours was spent in structured practice hockey activities. Furthermore, these athletes spent approximately 2,300 hours playing other sports and just over 2,400 hours playing organized games. Soberlak and Côté showed that the majority of the athletes' involvement in structured practice activities occurred during the investment years (2,215 hours), and the highest number of hours in deliberate play activities and in other sports was during the sampling years (2,618 and 1,404 hours, respectively). More specifically, the majority of deliberate play hours was accumulated prior to the age of 15, whereas the majority of deliberate practice hours were accumulated after that point.

Ericsson et al. (1993) theorized that it would be impossible for a late starter to overcome the early advantage of someone who began deliberate practice at a young age and maintained a steadily increasing pattern of engagement. However, investment in activities that are high on effort and concentration and low on enjoyment at a young age may also lead to dropout (Baker, 2003; Wiersma, 2000). To further understand the impact of early activities on investment and dropout in training, Wall and Côté (in press) examined the early activities (ages 6 to 13) of two groups of elite ice hockey players; one group was still invested in ice hockey, whereas the other group of players had just withdrawn from participating. The authors interviewed the elite players' parents about their sons' involvement in organized practice, deliberate play, and other sports from ages 6 to 13. Results indicated that both the active and the dropout players enjoyed a diverse and playful introduction to sport. Furthermore, the active and dropout players invested similar amounts of time in organized hockey games, organized hockey practices, and specialized hockey training activities (e.g., hockey camps and hockey play). However, analysis revealed that the dropout players began off-ice training (for the purpose of improving hockey performance) at a younger age and invested significantly more hours per year in off-ice training at ages 12 to 13. These results, along with Carlson's (1988) study of tennis players in Sweden, indicate that engaging in more training activities at a young age may have negative implications for long-term sport participation and the development of expertise in sport.

In a review of retrospective interview studies, Côté et al. (2003) proposed that the structure of deliberate practice and other activities in sports changes qualitatively as a function of the age of the child athlete. Generally, activities associated with the best learning and motivational environment in the early years of an athlete's development are different from optimal learning and motivational activities in the later years. Consequently, it is important to examine the type of activities (i.e., play or practice) that athletes engaged in at various stages of their development and elicit the reasons (i.e., for enjoyment or to improve performance) that athletes engaged in these activities instead of asking for subjective ratings. Studies reviewed in this section show that reducing the acquisition of expert performance in sport to involvement in a single form of activity (i.e., deliberate practice) fails to acknowledge important developmental and motivational assets acquired from involvement in play and other sporting activities.

IMPLICATIONS FOR EARLY SPORT ACTIVITIES: TO SAMPLE OR TO SPECIALIZE?

Support for early involvement in organized practice and deliberate practice is based on two assumptions that have yet to be confirmed. The first is that during early stages of development, future experts distinguish themselves from future nonexperts with regard to training quantity and quality. However, retrospective studies that assess practice patterns throughout development generally indicate that differences between elite and subelite athletes do not occur until later in development. For instance, Hodges and Starkes (1996) found that training-based differences between elite and nonelite wrestlers did not occur until approximately 18 years of age. Further comparisons of expert and nonexpert athletes in soccer (Helsen et al., 1998), field hockey (Helsen et al., 1998), and triathlon (Baker et al., 2005) found that training-based differences did not occur until 13, 15, and 20 years of age, respectively. Prior to these ages, the groups appeared quite similar with respect to training exposure. Exceptions exist in Ward et al.'s (2004) study of young English soccer players and for sports where peak performance occurs at early ages (i.e., before biological maturation), such as women's gymnastics (Law et al., in press) and women's figure skating (Deakin & Cobley, 2003), which indicate differences in sport-specific training between elite and subelite athletes as early as age 7. However, as outlined earlier, this level of involvement during early periods of development can have significant negative consequences for continued sport participation.

A second assumption for promoting investment in sport-specific practice at a young age is that organized practice and deliberate practice are superior to play and involvement in other sporting activities. However, there is evidence from interview studies that some athletes who were involved in play activities and who had a diversified sport background still reached an elite level of performance in sport (e.g., Baker et al., 2003b, 2005; Bloom, 1985; Carlson, 1988). For instance, Baker et al. (2003b) found a significant negative relationship between athletes' involvement in additional sporting activities and the amount of sport-specific training needed to achieve expertise.

Our understanding of the mechanisms by which diversification and play influence skill development is limited, although transfer of learning and cross-training research provides some insight. Thorndike (1914) suggested that "identical elements" between tasks were transferable (see Singley & Anderson, 1989, for a more recent application of Thorndike's theory). On the other hand, a transfer-appropriate-processing view (Lee, 1988) suggests that positive transfer may occur when the processing requirements of the training and practice tasks are similar to those of the competition and performance environment. Schmidt and Wrisberg (2000) suggested that transferable elements could be categorized into movement, perceptual, and conceptual elements, although there is considerable evidence (e.g., Loy, Hoffman, & Holland, 1995) that a physical conditioning category should be added to this list of transferable performance elements (see Table 8.2). Researchers have also

Table 8.2 Classification of Elements That May Be Transferable across Sports

Elements	Transferable Aspects	Example
Movement	Biomechanical and anatomical actions required to perform a task.	Throwing a baseball overhand and an overhand serve in tennis.
Perceptual	Environmental information that individuals interpret to make performance-related decisions.	Field hockey and soccer both require participants to accurately interpret the actions of their opponents in order to be successful.
Conceptual	Strategies, guidelines, and rules regarding performance.	Gymnastics and diving share conceptual elements (e.g., similar rules).
Physical conditioning	Physiological adaptations across similar modes of training.	Short-term interventions of combined run-cycle training are as effective as running alone in increasing aerobic capacity.

Source: Motor Learning and Performance: A Problem-Based Learning Approach, by R. A. Schmidt, and C. A. Wrisberg, 2000, Champaign, IL: Human Kinetics. Reprinted with permission.

suggested that the effects of cross-training and transfer are most pronounced during early stages of involvement (Loy et al., 1995). For instance, any form of aerobic exercise can cause the general physiological adaptations that occur at the onset of a physical training program; however, the more trained an athlete becomes, the smaller the relative improvement from cross-training. By this reasoning, a variable participation during early stages of development may be equally beneficial to specific forms of training in achieving the physiological adaptations necessary for increases in cardiorespiratory fitness.

A diversified approach to early athlete development may not be at odds with monotonic or power profiles of the practice-proficiency relationship. During initial stages of development, increases in performance occur due to rapid improvement in general capabilities. With prolonged practice and training over time, improvements become much more specific in nature and more difficult to attain. During initial exposure to the task, however, the same general adaptations may be produced through similar activities that share the same elements. For instance, Abernethy, Baker, and Côté (2005) recently showed that experts from different sports consistently outperformed nonexperts in their recall of defensive player positions, suggesting that some selective transfer of pattern recall skills may be possible. From a physical conditioning point of view, childhood involvement in running or cycling will produce the same general physiological adaptations (e.g., increases in blood volume and maximal cardiac output) as sport-specific involvement. Once general cognitive or physical adaptations have been made through play and involvement in various sport activities during childhood, training should become more specific. A model of this relationship according to Côté's (1999) stages of sport participation is presented in Figure 8.1.

It is clear from retrospective studies of athletes' development that the amount and type of training performed throughout an expert athlete's development is dependent on the specific demands or capacities underlying performance in the sport as well as the age at which performance of these abilities reach their peak. Sports with abilities that peak later in development can allow greater flexibility during early development than sports with abilities that peak earlier. But eventually, all future expert athletes must adopt a program of training that focuses on deliberate practice, as it appears that without a long-term commitment to high-quality training, athletes will be unable to attain elite levels of performance. However, coaches and parents should consider the consequences of high levels of structured training during early development, as these experiences have a profound influence on involvement in sport and physical activity across the life span.

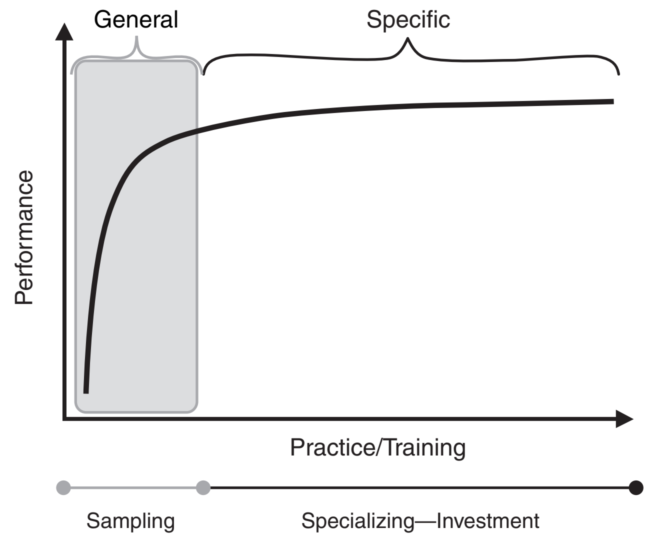


Figure 8.1 Proposed role of diversified early involvement in the development of sport expertise. The power law of practice proposed by A. Newell and Rosenbloom (1981) is represented by the solid line. During the sampling stage (i.e., the shaded area), adaptations are general in nature. Once these general adaptations have taken place, training should become more specific so that positive adaptations are perpetuated (i.e., during the specializing and investment stages). *Source:* "Shifting Training Requirements during Athlete Development: The Relationship among Deliberate Practice, Deliberate Play and Other Sport Involvement in the Acquisition of Sport Expertise" (pp. 93–110), by J. Baker and J. Côté, in *Essential Processes for Attaining Peak Performance,* D. Hackfort & G. Tenenbaum (Eds.), 2006, Oxford: Meyer & Meyer. Reprinted with permission.

The next section reviews environmental variables that have been linked to elite performance in sport and sheds some light on the type of environment that best promotes play and practice in the early years of an athlete's involvement in sport.

ENVIRONMENTAL FACTORS THAT ELICIT AND SUPPORT PRACTICE AND PLAY

Profiles of elite athletes have shown a pattern of training that changes throughout development. Important developmental changes that occur include the number of sporting activities athletes are involved in and the number of hours invested in deliberate play, structured practice, and deliberate practice. Some children will benefit from situations that provide them with more opportunities to get involved in sports at an early age. The relative age effect (see Musch & Grondin, 2001, for a review) and the size of the city or region in which an athlete develops (Côté, MacDonald, Baker, & Abernethy, in press; Curtis & Birch, 1987) are two contextual variables that have been associated with increased early exposure to sport and the achievement of expertise.

Relative Age Effect

The relative age effect shows that the older one is relative to one's peers in the same grouping or junior sport team (i.e., the greater one's *relative age*), the greater the probability of eventually becoming an elite athlete (Baxter-Jones & Helms, 1994; Dundink, 1994; Helsen, Hodges, Van Winckel, & Starkes, 2000). Studies examining birthdates of professional and elite athletes in baseball (Thompson, Barnsley, & Stebelsky, 1991), ice hockey (Barnsley & Thompson, 1988; Boucher & Mutimer, 1994), soccer (Barnsley, Thompson, & Legault, 1992; Dundink, 1994; Glamser & Vincent, 2004; Helsen, Van Winckel, & Williams, 2005), cricket (Edwards, 1994), swimming (Baxter-Jones, 1995), and tennis (Baxter-Jones, 1995) have shown a skewed birth date distribution favoring players that were born in the first half of the sport year.

The most compelling hypothesis about the relative age effect suggests that older children in a group will be provided with environments that facilitate the improvement of their skills early in their development because they are more mature or physically larger (Musch & Grondin, 2001). For example, bigger and more mature athletes may have an early advantage over smaller athletes in several sports because their physical abilities, such as running, throwing, and jumping, are better developed. Accordingly, a coach is likely to select these more mature athletes and put them in more decision-making roles (i.e., point guard, quarterback), where they get more opportunities for playing and practice. Furthermore, because of their early success, athletes that are born in the first quarter of their sport year may receive more encouragement, feedback, and support from parents, coaches, and peers. This type of social environment may motivate them to play and invest more in their sport outside of regular organized practice sessions. In sum, the relative age effect is a phenomenon that favors athletes born early in their sport year by providing them with additional time on task.

Although the relative age effect has been observed in several sports and at different levels of development, the effect has not been found in American and Canadian professional football (Daniel & Janssen, 1987), National Basketball Association players (Côté et al., in press; Daniel & Janssen, 1987), or American professional golfers (Côté et al., in press). Golf is a sport where age-related factors such as size and weight may be less likely to influence performance. In addition, the structure of youth golf in the United States does not have as strict age groupings as other organized youth sports, such as ice hockey and baseball. On the other hand, because American and Canadian football and basketball are sports where size, weight, strength, and coordination are critical elements of success, one would expect the relative age effect to be present. The organizational structure of youth football and basketball in the United States and Canada may explain the absence of a relative age effect in these sports. Typically, young American and Canadian football players are classified into different levels according to weight instead of chronological age, therefore eliminating the evidence of a relative age effect in football. The absence of a relative age effect in U.S. basketball may partially be explained by a "grade fail exemption" rule present in U.S. high school basketball. The grade fail exemption allows three older players per team to play with players of the same grade if they fail a grade. This exemption allows older players to play with younger players and may eventually eliminate the relative age effect in professional basketball. Finally, the beginning of organized play in American and Canadian football (and in golf) is likely to occur at an older age, which would limit the amount of time that footballers (and golfers) can benefit from a possible relative age advantage.

Birthplace Effect

Another environmental variable that has recently received attention in sport expertise research is the city size where elite athletes gain their formative experiences. This variable may have a significant influence on how athletes are first exposed to sports, which, like the relative age effect, can limit or benefit performance.

In his qualitative study of the development of tennis players in Sweden, Carlson (1988) concluded that elite players predominantly came from rural areas and that these areas provided the athletes unlimited opportunities to participate in sports. Another study by Curtis and Birch (1987) examined the city size of the birthplace of Canadian and U.S. Olympic hockey players and Canadian National Hockey League players. They found that for Canadian players, rural areas of fewer than 1,000 inhabitants and cities with more than 500,000 inhabitants were underrepresented in relation to the expected proportions of the population in the same age range. An analysis of the birthplace of 2,240 Canadian and American professional athletes in basketball, baseball, ice hockey, and golf also showed a birthplace bias toward smaller cities, with professional athletes being overrepresented in cities of fewer than 500,000 and underrepresented in cities of 500,000 and over (Côté et al., in press). The best odds of becoming a professional athlete in the United States were found for cities with populations between 50,000 and 99,999.

Drawing on the existing evidence about factors known to be important to expert development in sports, we can propose possible factors and mechanisms that may contribute to the birthplace effect (Côté et al., 2003; Ericsson et al., 1993). The effect could be primarily due to skill acquisition factors related to the quality and quantity of play and practice afforded by the physical environment of smaller cities. The quality of play and practice could be a key factor because the physical environment of smaller cities is more conducive to unstructured play activities between children and adults of different ages and to experimentation with various forms of sporting activities (Kytta, 2002). The quantity of play and practice in smaller cities could also be a factor because smaller cities present fewer safety concerns, easier access to open spaces, and fewer competing sources of leisure time usage by children. Another factor that may contribute to the birthplace effect is the more intimate and, likely, less competitive psychosocial environment of smaller cities. Smaller cities may offer increased opportunities to experience early success in sport, which, in turn, may increase self-efficacy and the motivational drive to play and practice.

The big fish, little pond effect (BFLPE; Marsh, 1987) is a theoretical framework specific to academic self-concept that may be useful in explaining how the psychosocial environment of smaller cities promotes the development of talent in sport. The BFLPE occurs when equally able students have lower academic self-concept when they are put in an environment where they compare themselves with more able students (i.e., at a top academic high school). On the other hand, the same students will have higher academic self-concept when they compare themselves with less able students (Marsh, 1987; Marsh & Tai Hau, 2003). Within the framework of the birthplace effect in sport, a young athlete who excels in sport in an average small city league could be perceived as a "big fish in a small pond" and, accordingly, have a high sport self-concept. This high sport self-concept likely drives the young athlete's commitment to stay involved in sport and facilitates the acquisition of a greater quantum of play and practice. If placed into a more selective sport program, characteristic of bigger urban center sport systems, this same athlete would be in a "larger pond with larger fish" (i.e., other excellent athletes who may be more skilled). This scenario would provide this athlete with a different frame of reference that, according to the BFLPE, would lower his or her sport self-concept and likely reduce his or her commitment to sport. The BFLPE is an appealing hypothesis that is supportive of the birthplace effect data in sport.

Given the contextual similarities between the relative age and birthplace effects, it is plausible that these factors may interact in promoting athlete development. This relationship was examined by Côté et al. (in press), and no evidence of moderation/mediation was found. Furthermore, Côté et al. showed that birthplace has a considerably stronger influence on talent development than relative age in major U.S. and Canadian sports. However, the birthplace effect requires examination in other countries and other sports to determine the generalizability of this effect.

The relative age and birthplace effects highlight the importance of the early years of a child's involvement in sport as a foundation for the development of motivation, skill, and talent. Also, it demonstrates the remarkably enduring effect that early sport experience may have on the likelihood of expertise being ultimately achieved. The relative age and birthplace effects support an environment that provides ample opportunities for youth to experience high-quality play and practice activities in their early involvement in sport. Accordingly, various researchers (Bloom, 1985; Côté, et al., 2003; Wylleman, De Knop, Ewing, & Cumming, 2000) have integrated studies on the development of talent in sport and have proposed models that demarcate the stages in athletes' paths to expertise (Durand-Bush & Salmela, 2001). In the next section, we offer directions for future research and present a working model that has recently been proposed to explain the longitudinal changes that occur in play and practice activities in the development of talent in sport.

TOWARD AN INTEGRATED FRAMEWORK FOR UNDERSTANDING THE ROLE OF PRACTICE AND PLAY IN SKILL DEVELOPMENT

It is clear from this review that studying the development of expertise in sport is a much more complex task than studying learning in controlled laboratory environments. In a recent review of the motor learning literature, Wulf and Shea (2002) distinguished between learning *effectiveness* and learning *efficiency,* both being important issues in the study of complex motor skills and the development of expert performance in sport. Learning effectiveness focuses on factors that influence the acquisition of motor skill; learning efficiency focuses on the factors that influence the acquisition of motor skills at less cost (Wulf & Shea, 2002). Unlike consideration of learning effectiveness, a focus on learning efficiency also considers the psychosocial (i.e., drop out, burn out) and physical (i.e., injury, health) costs associated with training and the development of expertise in sport. An *efficient* model of sport expertise development would limit the costs associated with long-term investment in sport; an *effective* model would focus on learning independent of the costs that may be involved.

The framework of deliberate practice developed by Ericsson et al. (1993) is an example of a model that is based on learning effectiveness. Ericsson et al. suggested that it would be next to impossible for a late starter to overcome the early advantage provided to those who begin deliberate practice at a young age and maintain high amounts of deliberate practice hours over time. The deliberate practice framework largely downplays the psychosocial and physical costs associated with this type of practice, especially in the early years of an athlete's involvement in sport.

Although the positive relationship between training and elite performance is consistent in sport research, several other dimensions of the theory of deliberate practice have not been supported (Abernethy et al., 2003). In particular, research (for reviews, see Baker & Côté, 2006; Côté et al., 2003) has shown that considering only deliberate practice training in athlete development does not adequately characterize the complexity of the relationships among developmental, motivational, and psychosocial aspects of human abilities. One model that does highlight the importance of developmentally appropriate training patterns and social influences is Côté and colleagues' developmental model of sport participation (DMSP; Côté, 1999; Côté et al., 2003; Côté & Hay, 2002).

Côté and Fraser-Thomas (2007) recently proposed a modified version of the DMSP illustrating more clearly the possible sport participation trajectories of the model. These trajectories are outlined in Figure 8.2 as (a) recreational participation through sampling and deliberate play, (b) elite performance through sampling and deliberate play, and (c) elite performance through early specialization and deliberate practice. The different stages within a trajectory are based on changes in the type and amount of involvement in sport, deliberate play, and deliberate practice. Two of these trajectories, recreational participation and elite performance through sampling, have the same foundation from ages 6 to 12. After the sampling years, sport participants can choose to either stay involved in sport at a recreational level (*recreational years,* age 13+) or embark on a path that focuses primarily on performance (*specializing years,* ages 13 to 15; *investment years,* age 16+). These two trajectories have different outcomes in terms of performance but are likely to lead to similar psychosocial and physical health benefits. A third possible trajectory consists of elite performance through early specialization (right side of Figure 8.2). Although this trajectory leads to elite performance, it has also been shown to result in a reduction in both physical health (i.e., overuse injuries) and enjoyment (e.g., Law et al., in press).

Recreational Participation through Sampling

The recreational outcome of the DMSP was examined in a retrospective study of active and inactive adult females (Robertson-Wilson, Baker, Derbyshire, & Côté, 2003). Results indicated that active females participated in significantly more physical activities than inactive females from age 6 to age 18, but no significant differences were found between the two groups in terms of their involvement in other nonphysical structured leisure activities, such as music and art. From ages 6 to 12 (i.e., sampling years) the active females participated in a variety of sports that focused primarily on deliberate play activities. These years were considered essential building blocks for their continued recreational sport participation. The recreational years (age 13+) are usually seen as an extension of the sampling years, with the primary goals being enjoyment and health. Activities during the recreational years can involve deliberate play and deliberate practice, with sport programs being flexible enough to adapt to individual interests and ages. In terms of outcomes, the physical and psychological benefits of recreational participation in sport, such as enhanced health and increased enjoyment, have been consistently supported through various studies (see Berger & Motl, 2001, for a review).

Elite Performance through Sampling

For youth interested in a more performance-oriented path, a second trajectory of the DMSP suggests that specialization begins around age 13, after the sampling years. The specializing years (ages 13 to 15) are seen as a transitional stage to the investment years (age 16+). During the specializing years, youth engage in fewer activities (which include both deliberate play and deliberate practice), whereas during the investment years, youth commit to only one activity and engage primarily in deliberate practice. This trajectory toward elite performance in sport has been supported by various qualitative and quantitative studies (e.g., Baker et al., 2003b, 2005; Bloom, 1985; Carlson, 1988; Côté, 1999; Soberlak & Côté, 2003). Athletes who follow this trajectory tend to experience positive physical and psychosocial outcomes (e.g., physical health, sport enjoyment; Korell & Côté, 2005); however, more studies are needed that directly measure the physical and psychosocial outcomes of elite performers who sampled in their early years in sport.

Elite Performance through Early Specialization

In sports where peak performance is achieved before puberty (e.g., women's gymnastics, figure skating), early specialization is often necessary to reach elite performance. Several studies support early specialization as a suitable path toward elite performance (e.g., Law et al., in press; Ward et al., 2004). Elite performers who specialize at an early age usually skip the sampling years and, consequently, do not always experience the enjoyment associated with sampling and playing (Law et al., in press). In fact, there is reasonable empirical support for the notion that early specialization is associated with higher levels of attrition at all levels of ability (Gould, 1987; Gould, Udry, Tuffey, & Loehr, 1996; Korell & Côté, 2005; Wall & Côté, in press). Furthermore, an early focus on structured training can have negative effects on developing athletes' physical health

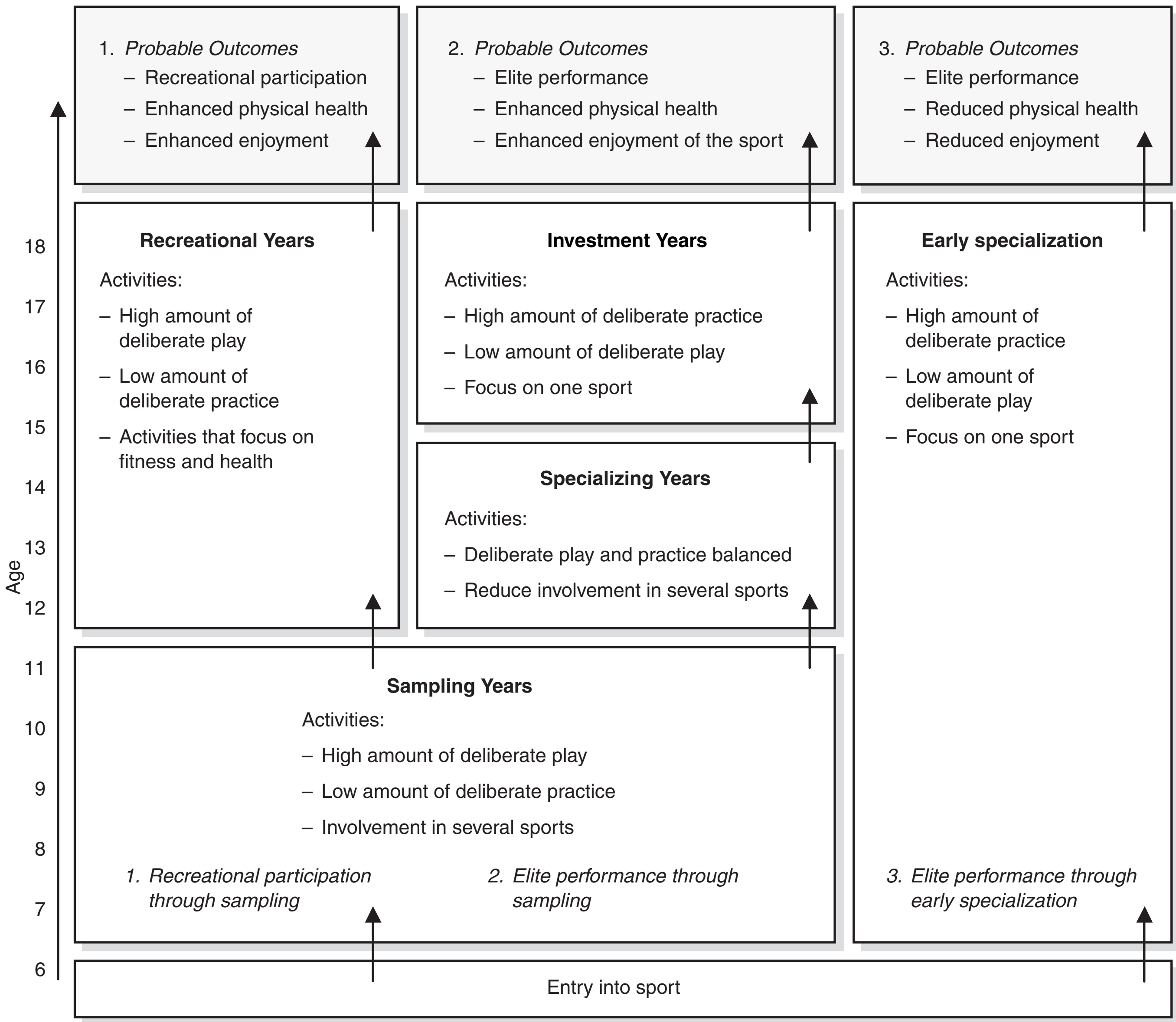


Figure 8.2 Developmental model of sport participation.

(Caine, Cochrane, Caine, & Zemper, 1989; Law et al., in press). For example, excessive forms of training during crucial periods of biological development can significantly increase the risk of overtraining injuries (Caine et al., 1989; Dalton, 1992). More developmental studies that focus on the benefits and costs associated with early specialization are necessary to fully appreciate the value of this trajectory.

Other Trajectories

Opportunities for horizontal movement across stages (e.g., going from investment to recreational) should be provided for participants so that they can change their level of participation at any age if they so desire. Unfortunately, in many sports, it is difficult for a 16-year-old to invest in a sport if he or she has not been specializing in that sport since approximately age 13. However, in some sports, such as ultra-endurance triathlon, investment in adulthood is possible (Baker et al., 2005). Sports with later ages of peak performance, such as ultra-endurance triathlon (peak at approximately age 30), have more flexibility with regard to the type of activities performed during the teenage years. In sum, the differing ages of peak performance in various sports may be a critical constraint on the type of training performed during an athlete's development (Baker & Côté, 2006).

Summary

Overall, the DMSP provides a useful framework to assess the learning environments that lead to various performance and developmental outcomes in children. Although not all the outcomes of each of the different trajectories of the DMSP have been directly tested, enough support exists to suggest developmental patterns that can be further tested through retrospective research. By considering factors other than accumulated amount of practice, the DMSP allows researchers to address questions of learning efficiency and learning effectiveness. A youth sport framework that focuses on learning efficiency should consider the various pathways that children follow in sport and consider the dropout rate of each trajectory. Concerted effort is required from physical education teachers, coaches, and parents to ensure that children learn skills and stay motivated to continue their participation in sport at either an elite or a recreational level.

CONCLUSION

This chapter focused on how expert athletes spend their time in sport throughout their development. We reviewed literature on practice and play, the two fundamental learning activities that have been shown to contribute to children's skill development in sport. Ericsson et al.'s (1993) study of musicians and subsequent studies with athletes (Helsen et al., 1998; Hodge & Deakin, 1998; Hodges & Starkes, 1996; Starkes et al., 1996) strongly support the contention that deliberate practice is a major determinant of expertise. On the other hand, child development research (e.g., Pellegrini & Smith, 1998; Russ, 2004) has consistently highlighted that play activity teaches important adaptive abilities necessary for the acquisition of new skills. The playful environment that expert athletes experience during their early involvement in sport may largely explain their early learning and exceptional motivation, which leads to subsequent learning and involvement in deliberate practice (Côté et al., 2003).

We examined retrospective studies that have been conducted to trace the training profile of athletes' development in sport. Studies using qualitative interviews, questionnaires, and quantitative interviews were reviewed. One consistent finding of these studies was that without a long-term commitment to high-quality training, athletes are unable to attain elite levels of performance. However, results are not consistent when describing the activities that should be favored in the early years of athletes' involvement. Several studies have supported a developmental approach that does not focus solely, in the early years, on sport-specific deliberate practice but emphasizes playing activities and the sampling of various sporting activities. These different trajectories toward elite performance raise questions regarding the optimal environment that should be provided for the early development of elite performance in sport. Accordingly, we presented some implications of early sampling and specializing. Furthermore, we outlined possible mechanisms that could potentially explain how sampling different sports and playing in the early years can lead to elite performance. We provided evidence from two environmental factors, relative age and birthplace, that support a type of early developmental experience in sport that increases children's opportunities for success.

Finally, we presented a model of development in sport that highlights the changing environments of athletes and has implications for the design of sport programs. Different trajectories of sport participation are suggested, with unique outcomes in terms of performance and physical and psychosocial consequences. The trajectories are differentiated by different types of involvement in sport at different ages. In our search to develop elite-level athletes, we need to be conscious not only of the acquisition of sport skills but also of optimizing the health of young athletes through continued participation in sport.

REFERENCES

Abernethy, B. (1990). Anticipation in squash: Differences in advance cue utilization between expert and novice players. *Journal of Sports Sciences, 8,* 17–34.

Abernethy, B., Baker, J., & Côté, J. (2005). Transfer of pattern recall skills as a contributor to the development of sport expertise. *Applied Cognitive Psychology, 19,* 705–718.

Abernethy, B., Farrow, D., & Berry, J. (2003). Constraints and issues in the development of a general theory of expert perceptual-motor performance. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 349–369). Champaign, IL: Human Kinetics.

Baker, J. (2003). Early specialization in youth sport: A requirement for adult expertise? *High Ability Studies, 14,* 85–94.

Baker, J., & Côté J. (2006). Shifting training requirements during athlete development: The relationship among deliberate practice, deliberate play and other sport involvement in the acquisition of sport expertise. In D. Hackfort & G. Tenenbaum (Eds.), *Essential processes for attaining peak performance* (pp. 93–110). Oxford: Meyer & Meyer.

Baker, J., Côté, J., & Abernethy, B. (2003a). Learning from the experts: Practice activities of expert decision-makers in sport. *Research Quarterly for Exercise and Sport, 74,* 342–347.

Baker, J., Côté, J., & Abernethy, B. (2003b). Sport specific training, deliberate practice and the development of expertise in team ball sports. *Journal of Applied Sport Psychology, 15,* 12–25.

Baker, J., Côté, J., & Deakin, J. (2005). Expertise in ultra-endurance triathletes: Early sport involvement, training structure and the theory of deliberate practice. *Journal of Applied Sport Psychology, 17,* 64–78.

Baker, J., & Horton, S. (2004). A review of primary and secondary influences on sport expertise. *High Ability Studies, 15,* 211–228.

Barnsley, R. H., & Thompson, A. H. (1988). Birthdate and success in minor hockey: The key to the NHL. *Canadian Journal of Behavioral Science, 20,* 167–176.

Barnsley, R. H., Thompson, A. H., & Legault, P. (1992). Family planning, football style: The relative age effect in football. *International Review for the Sociology of Sport, 27,* 77–88.

Baxter-Jones, A. (1995). Growth and development of young athletes: Should competition levels be age related? *Sports Medicine, 20,* 59–64.

Baxter-Jones, A., & Helms, P. (1994). Born too late to win. *Nature, 370,* 186.

Berger, B. G., & Motl, R. (2001). Physical activity and quality of life. In R. N. Singer, H. A. Hausenblas, & C. M. Janelle (Eds.), *Handbook of sport psychology* (2nd ed., pp. 636–671). New York: Wiley.

Berry, J., & Abernethy, B. (2003, June). *Expert game-based decision-making in Australian football: How is it developed and how can it be trained?* Brisbane, Australia: University of Queensland, School of Human Movement Studies.

Bloom, B. S. (Ed.). (1985). *Developing talent in young people.* New York: Ballantine Books.

Bouchard, C., & Malina, R. M. (1997). *Genetics of fitness and physical performance.* Champaign, IL: Human Kinetics.

Boucher, J. L., & Mutimer, B. T. P. (1994). The relative age phenomenon in sport: A replication and extension with ice-hockey players. *Research Quarterly for Exercise and Sport, 65*(4), 377–381.

Boudreau, P., & Tousignant, M. (1991). L'efficacité de l'intervention d'entraîneurs bénévoles en formation. *Canadian Journal of Sport Sciences, 16,* 134–141.

Brunelle, J., Spallanzani, C., Tousignant, M., Martel, D., & Gagnon, J. (1989). Effets d'une stratégie d'auto-supervision sur les composantes du temps d'apprentissage dans l'enseignement de deux sports. *Revue Canadienne de l'Education, 14,* 189–201.

Caine, D., Cochrane, B., Caine, C., & Zemper, E. (1989). An epidemiologic investigation of injuries affecting young competitive female gymnasts. *American Journal of Sports Medicine, 17,* 811–820.

Carlson, R. C. (1988). The socialization of elite tennis players in Sweden: An analysis of the players' backgrounds and development. *Sociology of Sport Journal, 5,* 241–256.

Charness, N., Tuffiash, M., Krampe, R., Reingold, E., & Vasyukova, E. (2005). The role of deliberate practice in chess expertise. *Applied Cognitive Psychology, 19,* 151–165.

Chase, W. G., & Simon, H. A. (1973). The mind's eye in chess. In W. G. Chase (Ed.), *Visual information processing* (pp. 215–282). New York: Academic Press.

Côté, J. (1999). The influence of the family in the development of talent in sports. *Sports Psychologist, 13,* 395–417.

Côté, J., Baker, J., & Abernethy, B. (2003). From play to practice: A developmental framework for the acquisition of expertise in team sports. In J. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 89–110). Champaign, IL: Human Kinetics.

Côté, J., Ericsson, K. A., & Law, M. P. (2005). Tracing the development of elite athletes using retrospective interview methods: A proposed interview and validation procedure for reported information. *Journal of Applied Sport Psychology, 17,* 1–19.

Côté, J., & Fraser-Thomas, J. (2007). The health and developmental benefits of youth sport participation. In P. Crocker (Ed.), *Sport psychology: A Canadian perspective* (pp. 266–294). Toronto, Ontario, Canada: Pearson.

Côté, J., & Hay, J. (2002). Children's involvement in sport: A developmental perspective. In J. M. Silva & D. Stevens

(Eds.), *Psychological foundations of sport* (2nd ed., pp. 484–502). Boston: Merrill.

Côté, J., MacDonald, D., Baker, J., & Abernethy, B. (in press). When "where" is more important than "when": Birthplace and birthdate effects on the achievement of sporting expertise. *Journal of Sport Sciences.*

Crossman, E. R. F. W. (1959). A theory of acquisition of speed-skill. *Ergonomics, 2,* 153–166.

Curtis, J. E., & Birch, J. S. (1987). Size of community of origin and recruitment to professional and Olympic hockey in North America. *Sociology of Sport Journal, 4,* 229–244.

Dalton, S. E. (1992). Overuse injuries in adolescent athletes. *Sports Medicine, 13,* 58–70.

Daniel, T. E., & Janssen, C. T. L. (1987). More on the relative age effect. *CAHPER Journal, 53,* 21–24.

Deakin, J. M., & Cobley, S. (2003). An examination of the practice environments in figure skating and volleyball: A search for deliberate practice. In J. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 90–113). Champaign, IL: Human Kinetics.

De Knop, P., Engström, L.-M., & Skirstad, B. (1996). Worldwide trends in youth sport. In P. De Knop, L.-M. Engström, B. Skirstad, & M. Weiss (Eds.), *Worldwide trends in youth sport* (pp. 276–281). Champaign, IL: Human Kinetics.

Denzin, M. K. (1975). Play, games and interaction: The contexts of childhood interaction. *Sociological Quarterly, 16,* 458–476.

Duffy, L. J., Baluch, B., & Ericsson, K. A. (2004). Dart performance as a function of facets of practice amongst professional and amateur men and women players. *International Journal of Sport Psychology, 35,* 232–245.

Dundink, A. (1994). Birthdate and sporting success. *Nature, 368,* 592.

Durand-Bush, N., & Salmela, J. H. (2001). The development of talent in sport. In R. N. Singer, H. A. Hausenblas, & C. M. Janelle (Eds.), *Handbook of sport psychology* (2nd ed., pp. 269–289). New York: Wiley.

Durand-Bush, N., & Salmela, J. H. (2002). The development and maintenance of expert athletic performance: Perceptions of world and Olympic champions. *Journal of Applied Sport Psychology, 14,* 154–171.

Edwards, S. (1994). Born too late to win? [Letter to the editor]. *Nature, 370,* 186.

Ericsson, K. A. (1996). The acquisition of expert performance: An introduction to some of the issues. In K. A. Ericsson (Ed.), *The road to excellence: The acquisition of expert performance in the arts and sciences, sports and games* (pp. 1–50). Mahwah, NJ: Erlbaum.

Ericsson, K. A. (2001). The path to expert golf performance: Insights from the masters on how to improve performance by deliberate practice. In P. R. Thomas (Ed.), *Optimizing performance in golf* (pp. 1–57). Brisbane, Australia: Australian Academic Press.

Ericsson, K. A. (2003). Development of elite performance and deliberate practice: An update from the perspective of the expert performance approach. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sports expertise* (pp. 49–81). Champaign, IL: Human Kinetics.

Ericsson, K. A., Chase, W. G., & Faloon, S. (1980). Acquisition of a memory skill. *Science, 208,* 1181–1182.

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review, 100,* 363–406.

Gilbert, J. N., Côté, J., Harada, C., Marchbanks, G., & Gilbert, W. D. (2002, October/November). *Comparison of developmental activities of NCAA Division 1 and recreational baseball players.* Paper presented at the meeting of the Association for the Advancement of Applied Sport Psychology, Tucson, AZ.

Glamser, F. D., & Vincent, J. (2004). The relative age effect among elite American youth soccer players. *Journal of Sport Behavior, 27,* 31–38.

Gould, D. (1987). Understanding attrition in children's sport. In D. Gould & M. R. Weiss (Eds.), *Advances in pediatric sports sciences* (pp. 61–85). Champaign, IL: Human Kinetics.

Gould, D., Udry, E., Tuffey, S., & Loehr, J. (1996). Burnout in competitive junior tennis players: Pt. 1. A quantitative psychological assessment. *Sport Psychologist, 10,* 322–340.

Griffin, L. L., & Butler, J. I. (Eds.). (2005). *Teaching games for understanding: Theory, research and practice.* Champaign, IL: Human Kinetics.

Helsen, W. F., Hodges, N. J., Van Winckel, J., & Starkes, J. L. (2000). The roles of talent, physical precocity and practice in the development of soccer expertise. *Journal of Sport Sciences, 18,* 727–736.

Helsen, W. F., Starkes, J. L., & Hodges, N. J. (1998). Team sports and the theory of deliberate practice. *Journal of Sport and Exercise Psychology, 20,* 12–34.

Helsen, W. F., Van Winckel, J. V., & Williams, M. (2005). The relative age effect in youth soccer across Europe. *Journal of Sport Sciences, 23,* 629–636.

Hill, G. M. (1993). Youth participation of professional baseball players. *Sociology of Sport Journal, 10,* 107–114.

Hodge, T., & Deakin, J. (1998). Deliberate practice and expertise in the martial arts: The role of context in motor recall. *Journal of Sport and Exercise Psychology, 20,* 260–279.

Hodges, N. J., Kerr, T., Starkes, J. L., Weir, P. L., & Nananidou, A. (2004). Predicting performance from deliberate practice hours for the multi-sport athlete: Issues of transfer, circumventing constraints and defining practice. *Journal of Experimental Psychology: Applied, 10,* 219–237.

Hodges, N. J., & Starkes, J. L. (1996). Wrestling with the nature of expertise: A sport specific test of Ericsson, Krampe, and Tesch-Römer's (1993) theory of deliberate practice. *International Journal of Sport Psychology, 27,* 400–424.

Korell, D., & Côté, J. (2005, November). *Training factors and psychosocial resources throughout development that affect competition investment for female distance runners.* Paper presented at the meeting of the Canadian Society for Psychomotor Learning and Sport Psychology, Niagara Falls, Ontario, Canada.

Kytta, M. (2002). Affordances of children's environments in the context of cities, small towns, suburb, and rural villages in Finland and Belarus. *Journal of Environmental Psychology, 22,* 109–123.

Launder, A. G. (2001). *Play practice: The games approach to teaching and coaching sports.* Champaign, IL: Human Kinetics.

Law, M., Côté, J., & Ericsson, K. A. (in press). The development of expertise in rhythmic gymnastics. *International Journal of Sport and Exercise Psychology.*

Lee, T. D. (1988). Transfer-appropriate processing: A framework for conceptualizing practice effects in motor learning. In O. G. Meijer & K. Roth (Eds.), *Complex motor behavior: The motor-action controversy* (pp. 210–215). Amsterdam: Elsevier.

Lee, T. D., Chamberlin, C. J., & Hodges, N. J. (2001). Practice. In R. N. Singer, H. A. Hausenblas, & C. M. Janelle (Eds.), *Handbook of sport psychology* (2nd ed., pp. 115–143). New York: Wiley.

Lee, T. D., & Magill, R. A. (1983). The locus of contextual interference in motor-skill acquisition. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 9,* 730–746.

Loy, S. F., Hoffmann, J. J., & Holland, G. J. (1995). Benefits and practical use of cross-training in sports. *Sports Medicine, 19,* 1–8.

Marsh, H. W. (1987). The big fish, little pond effect on academic self-concept. *Journal of Educational Psychology, 79,* 280–295.

Marsh, H. W., & Tai Hau, K. (2003). Big fish, little pond effect on academic self-concept: A cross-cultural (26 country) test of the negative effects of academically selective schools. *American Psychologist, 58,* 364–376.

McCaffrey, N., & Orlick, T. (1989). Mental factors related to excellence among top professional golfers. *International Journal of Sport Psychology, 20,* 256–278.

McKenzie, T. L. (1986). Analysis of the practice behavior of elite athletes. In M. Peiron & G. Graham (Eds.), *Sport pedagogy* (pp. 117–121). Champaign, IL: Human Kinetics.

Musch, J., & Grondin, S. (2001). Unequal competition as an impediment to personal development: A review of the relative age effect in sport. *Developmental Review, 21,* 147–167.

Newell, A., & Rosenbloom, P. S. (1981). Mechanisms of skill acquisition and the law of practice. In J. R. Anderson (Ed.), *Cognitive skills and their acquisition* (pp. 1–55). Hillsdale, NJ: Erlbaum.

Orlick, T., & Partington, J. (1988). Mental links to excellence. *Sport Psychologist, 2,* 105–130.

Pellegrini, A. D., & Smith, P. K. (1998). Physical activity play: The nature and function of neglected aspect of play. *Child Development, 69,* 577–598.

Piaget, J. (1962). *Play, dreams, and imitation in childhood.* New York: Norton.

Robertson-Wilson, J., Baker, J., Derbyshire, E., & Côté, J. (2003). Childhood physical activity involvement in active and inactive female adults. *Avante, 9,* 1–8.

Rubin, K. H., Fein, G. G., & Vandenberg, B. (1983). Play. In P. H. Mussen & E. M. Hetherington (Eds.), *Handbook of child psychology* (Vol. 4, pp. 693–774). New York: Wiley.

Russ, S. W. (2004). *Play in child development and psychotherapy: Toward empirically supported practice.* Mahwah, NJ: Erlbaum.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55,* 68–78.

Schmidt, R. A., & Wrisberg, C. A. (2000). *Motor learning and performance: A problem-based learning approach.* Champaign, IL: Human Kinetics.

Shea, C. H., & Kohl, R. M. (1991). Composition of practice: Influence on the retention of motor skills. *Research Quarterly for Exercise and Sport, 62,* 187–195.

Shea, J. B., & Morgan, R. L. (1979). Contextual interference effects on the acquisition, retention, and transfer of a motor skill. *Journal of Experimental Psychology: Human Learning and Memory, 5,* 179–187.

Simon, H. A., & Chase, W. G. (1973). Skill in chess. *American Scientist, 61,* 394–403.

Singer, R. N., & Janelle, C. M. (1999). Determining sport expertise: From genes to supremes. *International Journal of Sport Psychology, 30,* 117–150.

Singley, M. K., & Anderson, J. R. (1989). *The transfer of cognitive skill.* Cambridge, MA: Harvard University Press.

Smith, P. K., Takhvar, M., Gore, N., & Vollstedt, R. (1986). Play in young children: Problems of definition, categorization, and measurement. In P. K. Smith (Ed.), *Children's play: Research, developments, and practical applications* (pp. 37–54). New York: Gordon and Breach.

Soberlak, P., & Côté, J. (2003). The developmental activities of elite ice hockey players. *Journal of Applied Sport Psychology, 15,* 41–49.

Starkes, J. L., Deakin, J. M., Allard, F., Hodges, N. J., & Hayes, A. (1996). Deliberate practice in sports: What is it anyway? In K. A. Ericsson (Ed.), *The road to excellence: The acquisition* *of expert performance in the arts, and sciences, sports, and games* (pp. 81–106). Mahwah, NJ: Erlbaum.

Stelmach, G. E. (1969). Efficiency of motor learning as a function of intertrial rest. *Research Quarterly, 40,* 198–202.

Sternberg, R. J. (1996). Costs of expertise. In K. A. Ericsson (Ed.), *The road to excellence: The acquisition of expert performance in the arts and sciences, sports, and games* (pp. 347–354). Mahwah, NJ: Erlbaum.

Stevenson, C. L. (1990). The athletic career: Some contingencies of sport specialization. *Journal of Sport Behavior, 13,* 103–113.

Thompson, A. H., Barnsley, R. H., & Stebelsky, G. (1991). "Born to play ball": The relative age effect and Major League Baseball. *Sociology of Sport Journal, 8,* 146–151.

Thorndike, E. L. (1914). *Educational psychology: Briefer course.* New York: Columbia University Press.

Trudel, P., & Brunelle, J. (1985). Les situations d'apprentissage offertes aux joueurs inscrits dans des ligues de hockey mineur. *L'Association Canadienne pour la Santé, l'Education Physique et le Loisir, 51,* 18–25.

Vallerand, R. J. (2001). A hierarchical model of intrinsic and extrinsic motivation in sport and exercise. In G. C. Roberts (Ed.), *Advances in motivation in sport and exercise* (pp. 263–319). Champaign, IL: Human Kinetics.

Van Rossum, J. H. (2000). Deliberate practice and Dutch field hockey: An addendum to Starkes. *International Journal of Sport Psychology, 31,* 452–460.

Wall, M., & Côté, J. (in press). Developmental activities that lead to drop out and investment in sport. *Physical Education and Sport Pedagogy.*

Ward, P., Hodges, N. J., Williams, A. M., & Starkes, J. L. (2004). Deliberate practice and expert performance: Defining the path to excellence. In A. M. Williams & N. J. Hodges (Eds.), *Skill acquisition in sport: Research theory and practice* (pp. 231–258). New York: Routledge.

Wiersma, L. D. (2000). Risks and benefits of youth sport specialization: Perspectives and recommendations. *Pediatric Exercise Science, 12,* 13–22.

Wightman, D. C., & Lintern, G. (1985). Part-task training strategies for tracking and manual control. *Human Factors, 27,* 267–283.

Wulf, G., & Shea, C. H. (2002). Principles derived from the study of simple skills do not generalize to complex skill learning. *Psychonomic Bulletin and Review, 9,* 185–211.

Wylleman, P., De Knop, P., Ewing, M. E., & Cumming, S. P. (2000). Transitions in youth sport: A developmental perspective on parental involvement. In D. Lavallee & P. Wylleman (Eds.), *Career transitions in sport: International perspectives* (pp. 143–160). Morgantown, WV: Fitness Information Technology.

Young, B., & Salmela, J. (2002). Perceptions of training and deliberate practice of middle distance runners. *International Journal of Sports Psychology, 33,* 167–181.

CHAPTER 9

Anticipation and Decision Making

Exploring New Horizons

A. MARK WILLIAMS and PAUL WARD

There is growing awareness that perceptual-cognitive skills such as anticipation and decision making are crucial to high-level performance across a range of domains. This increased awareness has resulted in a recent spate of academic texts (e.g., see Ericsson, Hoffman, Charness, & Feltovich, in press; Starkes & Ericsson, 2003; Williams & Hodges, 2004) and special issues of journals (e.g., see Williams, 2002; Williams & Reilly, 2000a) that focus on these or closely related topics. There is empirical evidence to suggest that these skills account for a significant proportion of the variance in performance between elite and subelite athletes (e.g., see Reilly, Williams, Nevill, & Franks, 2000). As performers progress through the ranks, these perceptual-cognitive, as well as technical skills are more likely to discriminate performers than anthropometric and physiological profiles (Williams & Reilly, 2000b).

As there have been several fairly recent and comprehensive reviews of the literature on perceptual-cognitive expertise (e.g., see Starkes, Helsen, & Jack, 2001; Williams, Davids, & Williams, 1999), the aim in this chapter is not to resynthesize this material, but to highlight existing shortcomings in our understanding. We hope to highlight those questions that remain unanswered and propose a research agenda that others in the field may wish to follow in coming years. We do not claim to have superior knowledge, or indeed any more insights than others into how future research in this area should be directed. Our intention is simply to share with the reader some of the ideas that we have openly shared with each other in recent years, typically providing much food for heated discussion and debate in various corners of the globe. The discussion is largely focused on the topic of anticipation rather than decision making per se. This focus on more perceptual aspects of performance is not intended to reflect any bias on our part or, for that matter, any strong conceptual distinction between these two skills, but is merely indicative of the more abundant literature on this topic. Our hope is to share our enthusiasm for the area and encourage others to add to the literature base by challenging them to explore these issues through empirical means.

The chapter is structured into four related sections focusing on the key empirical findings to date, the typical methods and measures that have been employed, the underlying theories and models, and practical issues and interventions. The proposal is to briefly highlight what we know in each of these areas, directing readers to other key references for more detailed reviews of the literature, and then to suggest what we need to find out in coming years. It is typically the case in research that the rearview mirror is always clearer than the windshield, so we make no claims as to the longevity of our suggestions or the extent to which the ideas proposed will see the light of day in future years. We refer to recent empirical findings to help present our arguments whenever possible, whereas at other times, some of the ideas presented are merely flickers of light in some distant corner of our minds. We begin by highlighting how far we have traveled over the past few decades in our understanding of anticipation and decision-making skill in sport.

SUMMARY OF KEY FINDINGS AND ISSUES THAT REQUIRE CLARIFICATION

Although some interesting work was undertaken on either side of the Second World War (e.g., Abel, 1924; Fullerton, 1925; Hubbard & Seng, 1958), a larger body of research on the topic of visual and perceptual-cognitive skill in sport began to emerge in the last few decades of the twentieth century. This line of research was inspired by research that attempted to examine whether skilled individuals could be differentiated on domain-general, basic capacities, and abilities (e.g., Terman & Oden, 1947). In the 1970s and early 1980s, a particular trend was to examine whether skilled performers could be differentiated from their less skilled counterparts based on visual characteristics, such as acuity and depth perception (e.g., see Blundell, 1985; Sanderson, 1981).

Vision and Performance

The notion that skilled performers are endowed with enhanced visual systems has intuitive appeal. For years, anecdotes of the best players possessing great vision have pervaded the locker room, terraces, and popular press. The empirical evidence, however, is at best inconclusive. Some researchers have reported skill-based differences in certain aspects of visual function, such as dynamic visual acuity and size of peripheral visual field (e.g., Blundell, 1985; Sanderson, 1981), yet others have shown no differences or even an advantage in favor of less skilled athletes on the same measures (e.g., Helsen & Starkes, 1999; P. Ward & Williams, 2003). Loran and MacEwen (1995) and Williams and colleagues (1999) provide an extended review of this literature.

What Don't We Know?

Although it is tempting to draw a line under this body of work, there are nonetheless some unresolved issues. A particular concern is that much of the work in this area is poorly designed and piecemeal, with limited attempts to control or manipulate key variables. The measures employed generally lack sensitivity and are rarely reflective of the types of constraints that normally exist during sports performance. Attempts to make these tasks representative of the visual demands of actual competition and to impose realistic performance constraints such as temporal, physiological, and emotional stress would likely increase the sensitivity and validity of existing measures.

Another limitation of this literature is that researchers have often examined the importance of certain components of visual function (e.g., dynamic visual acuity) by using samples of participants from a sport where such components are unlikely to be important (see Gardner & Sherman, 1995). Clearly, each sport has its own unique visual requirements and the demands are likely to change from position to position (see Cockerill, 1981). Sport-specific test batteries may need to be designed to reflect such issues (Williams et al., 1999). It is also important to note that the visual system does not function in isolation from the perceptual-cognitive system; these two components work together in an integrated manner to facilitate effective perception (see Henderson, 2003). It would therefore be interesting to examine how defects in various aspects of visual function (e.g., contrast sensitivity, stereodepth perception, and acuity) and, potentially, changes in environmental conditions (e.g., ambient lighting) may be compensated for by perceptual-cognitive mechanisms, perhaps as reflected by changes in visual search behavior (for an extended discussion, see Williams, Janelle, & Davids, 2004).

Sanderson (1981) provided an excellent illustration of this notion by suggesting that an individual's dynamic visual acuity may impact the manner in which information is extracted from the environment when, for example, attempting to track a ball during flight. A suggestion is that athletes who have good dynamic visual acuity (i.e., their acuity is seen as being velocity-resistant; see Miller & Ludvigh, 1962) are more likely to track a fast-moving ball using a combination of eye and head movements, whereas those with poor dynamic visual acuity (i.e., they are velocity-susceptible) rely on the so-called image-retina system (see Haywood, 1984). It is presently not clear whether use of the eye-head system offers any advantages over the image-retina system during interceptive actions such as in tennis and cricket (see Williams, Singer, & Weigelt, 1998), but this would be an interesting area for further research, with potential implications for training and instruction (e.g., see Long & Riggs, 1991).

Finally, few researchers have examined how visual function develops with age and how maturation may vary as a function of involvement in sport (for an interesting exception, see Blundell, 1985). There is considerable evidence to suggest that expertise emerges as a result of adaptation to the unique demands of the specific sport (see Williams & Ericsson, 2005), but it is as yet unclear whether this notion extends to the visual system or merely to perceptual-cognitive, anthropometric, and physiological subsystems. The maturation of the visual system may act as an important rate limiter in the development of other subsystems and impact significantly on performance (Haywood & Getchell, 2001). This issue could be addressed by monitoring changes in visual function over time (along with other measures, such as perceptual-cognitive skill) using both longitudinal and cross-sectional designs, more sensitive sport-specific measures, higher levels of experimental control, and appropriate statistical procedures (e.g., see P. Ward & Williams, 2003).

Perception, Cognition, and Performance

Since the mid- to late 1980s researchers have focused more extensively on perceptual-cognitive aspects of performance. An extensive research base illustrates skilled performers' superiority over less skilled athletes on tests designed to examine perceptual-cognitive skills that are assumed to be essential for effective anticipation and decision making. These skills include advance cue utilization, pattern recognition, visual search behavior, and the use of situational probabilities. Although such skills are likely to be seamlessly integrated during high-level performance and their relative importance may well change as a situation dynamically unfolds, the majority of researchers have largely examined these perceptual-cognitive skills independently. Consequently, we consider each of these skills in turn.

Advance Cue Utilization

Skilled performers are able to pick up information from an opponent's postural orientation in the moments before a key event, such as football or racketball contact, to anticipate future response requirements. The skilled performer's ability to utilize advance, preevent cues is one of the earliest and most robust findings in the sport expertise literature. This ability has typically been assessed using a temporal occlusion paradigm. The action is filmed from the same viewing perspective as in the competitive situation and then edited to remove all subsequent action and outcome information after a critical point (e.g., 40 ms before football or racketball contact). The participant's task is to determine what happened next and respond accordingly. Skilled performers' superiority over less skilled athletes is most apparent at the earliest, precontact occlusion conditions, implying that the ability to anticipate future events based on advance information is crucial to high-level performance. Haskins (1965) originally introduced this paradigm as a method of training perceptual skill, whereas subsequent researchers have used this approach to examine skill-based differences in sports such as tennis (Jones & Miles, 1978), badminton (Abernethy & Russell, 1987), soccer (Williams & Burwitz, 1993), and field hockey (Salmela & Fiorito, 1979). A more detailed review of this literature is available elsewhere (see Starkes et al., 2001; Williams et al., 1999).

What Don't We Know?

Although this finding is very robust across different fast-ball sports, there have been only limited attempts to identify the underlying mechanisms or even the specific perceptual information that underpins the identification process. A few researchers have combined the temporal occlusion approach with spatial occlusion, eye movement registration, and verbal report techniques in an effort to identify the specific perceptual cues that guide performance in such contexts (e.g., see Abernethy & Russell, 1987; Williams & Davids, 1998). However, such systematic programs of research and efforts to cross-validate findings, and to extend knowledge by combining different measures, are rare in the literature.

In an attempt to identify the specific sources of information that performers use to anticipate opponents' intentions, researchers have converted film images of players in action into point-light displays. Point-light displays were originally introduced by Johansson (1973) as a means of studying the perception of human movement. These displays capture the motion of the major joint centers of the body, which are then displayed as points of light against a black background. The intention is to remove background and contextual information and to present movement in its simplest terms (Cutting & Proffitt, 1982). Several researchers have proposed that the effective pick-up of relative motion (captured by sequences of point-light displays) is an essential component of anticipation skill in fast-ball sports (e.g., see Abernethy, Gill, Parks, & Packer, 2001; P. Ward, Williams, & Bennett, 2002). The argument is that performers determine an opponent's intentions based on their perception of the relative motion between specific bodily features, rather than via the extraction of information from more superficial features or an isolated area or cue. Although this proposal would appear to have merit, there have been only limited efforts to verify initial findings or to identify the specific information that performers extract from such displays. In contrast, such issues have been more routinely explored in the image perception and observational learning literature (e.g., Breslin, Hodges, Williams, Kremer, & Curran, 2005; Dittrich & Lea, 1994; Horn, Williams, & Scott, 2002).

The use of point-light displays could be combined with temporal and spatial occlusion techniques to determine which sources of information experts become attuned to. Images may be temporally occluded at predetermined time points and/or individual or collective markers removed for all or part of a trial (e.g., see Hodges, Hayes, Breslin, & Williams, 2005). Contemporary methods of creating point-light (or stick figure) images using optoelectronic motion capture systems rather than video provide significant advantages in this regard, as it is relatively easy to remove, or even distort, the coordinates for certain markers from the entire sequence as opposed to having to edit out this part of the image on every frame of video (see also Cañal-Bruland, Huys, Hagemann, & Williams, 2006).

Another advantage of using point-light displays to assess the source of information used to anticipate opponents' intentions is that a detailed biomechanical profile of each action can be created from the two- or three-dimensional data and their first- and second-order derivatives. The data may be analyzed descriptively, or statistical and dynamical tools, such as principal component analyses, can be used to identify the key components that differentiate two movements (Williams & Ericsson, 2005). For example, biomechanical differences between the forehand cross-court and down-the-line shots in tennis are illustrated in the point-light images presented in Figure 9.1. The circles highlight the important biomechanical differences between these two shots and the unique perceptual information presented in each instance.

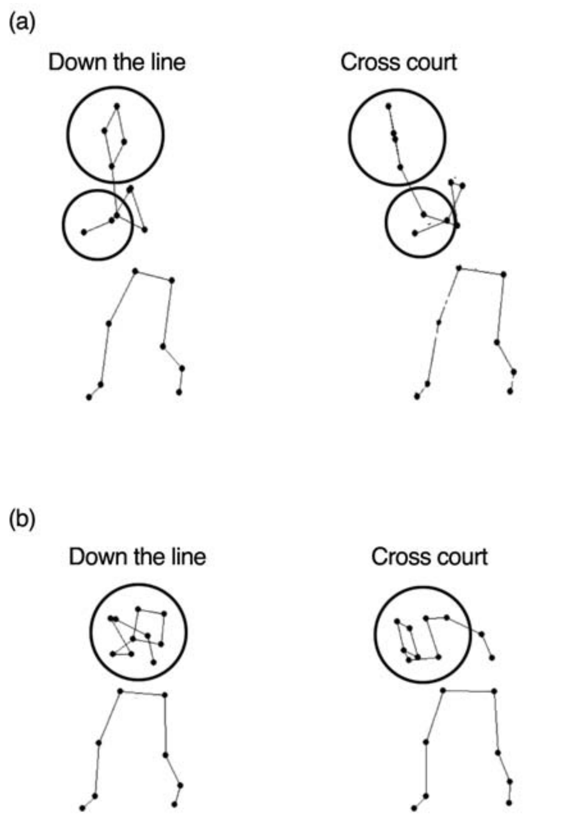


Figure 9.1 Point-light displays of the forehand cross-court and down-the-line shots in tennis. The circles highlight potentially important biomechanical differences between these shots at a point in time either (a) 400 ms or (b) 200 ms prior to ball-racket contact. Data from *Using Principal Component Analysis to Identify Potential Anticipation Cues in Tennis,* by N. J. Smeeton, R. Huys, A. M. Williams, and N. J. Hodges, August 2005, paper presented at the ISSP 11th World Congress of Sport Psychology, Sydney, Australia.

An interesting issue is the extent to which performers are able to determine discernable differences in opponents' intentions based on subtle changes in relative motion. One would suspect that the sensitivity of the observer for picking up such perceptual information changes with increasing skill level. The use of signal-detection type paradigms may allow researchers to determine whether skilled anticipators become more attuned to this information or are simply biased by their expectations to select one option over another (see Horn, Williams, Hodges, & Hayes, 2006). A related issue currently being examined in our laboratories is the extent to which the relative motion pattern provides information related to the direction of movement (e.g., the location of the goal to which the penalty shooter will kick the ball), whereas the absolute velocity of the end point (effector) within that relative motion pattern (e.g., foot/toe) is more important for predicting the weight or depth of shot. In a similar vein, how important is relative motion of the end effector compared to whole-body relative motion when perceiving an opponent's intentions? There is already evidence to suggest that performers can learn and accurately imitate a particular movement pattern based solely on information from the end point of the action (see Breslin et al., 2005; Hodges, Hayes, Breslin, & Williams, 2005). There is certainly scope to extend this work to the domain of perceptual-cognitive skill in sport.

We offer a note of caution, however: Researchers should be cautious when assuming that the way individuals respond to point-light displays is representative of how they would respond in the real world. Although skill-based differences in anticipation have typically been maintained when individuals are presented with information under the point-light compared with the video format, a decrement in performance is nonetheless reported under the former compared with the latter condition. Unless researchers attempt to take some corresponding measure of cognition (e.g., verbal reports, eye movements) during performance in both conditions, it will be impossible to determine whether the skilled processes used by high-level players in actual game play are also used under point-light conditions. An initial study of visual search during anticipation of normal and point-light displays suggests that both novice and skilled tennis players are prone to change the information they use when moving from normal to point-light conditions, although the skilled players are much less affected than are their novice counterparts (P. Ward, Williams, & Bennett, 2002). In our laboratories, we are currently examining if and how players change their think-aloud report when moving to point-light displays to explain the subtle differences in strategy observed.

A potential difficultly when attempting to identify key postural cues is the notion of perceptual redundancy or flexibility. The rationale underpinning the use of spatial occlusion techniques, whether using film or point-light displays, is that a cue is considered a crucial source of perceptual information only if there is a decrement in performance when the cue is occluded. The difficulty with this interpretation is the possibility that skilled performers may base their decisions on several concurrent and overlapping perceptual cues. If there is no decrement in performance when a particular cue is occluded, this may not imply that performers do not normally extract information from this area of the display when available. An equally plausible explanation is that the same or alternative information was extracted from some other source(s) on this occasion. This perceptual flexibility or redundancy may be an important characteristic of high-level performance in sport and, consequently, merits further clarification via, for instance, multiple measures of cue usage. An interesting corollary exists in the perceptual-motor domain, where there is evidence to suggest that when executing a technical skill, such as controlling a ball in soccer, skilled athletes are able to use several potential sources of sensory information (e.g., vision, proprioception) in an interchangeable manner to facilitate effective performance (see Williams, Harris, Weigelt, & Scott, 2002).

A question not often answered directly in the literature is whether players during performance actually rely on the perceptual cues identified by the advance cue literature. Although researchers have consistently shown that players are able to make use of such sources of information, it is possible that in certain situations skilled performers may decide not to use these cues during actual matches (e.g., see James, Caudrelier, & Murray, 2005). Occasionally the cost associated with anticipation may result in performers adopting a wait-and-see approach rather than embracing the risks that may be involved from incorrectly anticipating an opponent's intentions. This interplay between the costs and benefits associated with the anticipation process merits further consideration and investigative effort.

Pattern Recall and Recognition

The seminal work in this area was carried out in chess (e.g., see de Groot, 1946/1978; Simon & Chase, 1973) and was subsequently extended to the domain of sport by Allard, Graham, and Paarsalu (1980). Compared with less skilled players, when skilled performers are presented with structured sequences of play for brief periods of time, using either slides or filmed stimuli, they are able to more accurately recall players' positions at the end of the viewing period. In contrast, this superiority of recall diminishes when the sequences presented contain unstructured patterns involving, for example, players randomly positioned on the field of play. Allard and colleagues initially showed this effect in basketball; subsequently, researchers have reported comparable observations in volleyball (cf. Allard & Starkes, 1980; Bourgeaud & Abernethy, 1987) and soccer (Williams & Davids, 1995). An alternative approach has been to identify players' ability to recognize whether participants have previously viewed the action sequences in an earlier viewing phase (see Smeeton, Ward, & Williams, 2004; Starkes, 1987; Williams & Davids, 1995). As in the recall paradigm, skilled performers demonstrate superior recognition skill when compared with less skilled athletes.

What Don't We Know?

As in the literature focusing on advance cue usage, there have been few attempts to identify the specific sources of perceptual information that players use to identify patterns of play. Do players recognize patterns based on superficial cues (e.g., color of uniforms, pitch conditions), or is recognition based on the contextual (e.g., postural cues), structural, or higher-order relational information that may exist between players? If the latter, is it the players' relative position on the pitch, field, or court, the relative motion between these players, or the tactical or strategic information conveyed by each player's positioning or movement that is important? Are some players more important than others when attempting to identify patterns? Do players rely more on information from teammates or opponents when making such decisions? Is structure apparent early on in a sequence of play or only during a critical window of time surrounding key events, such as football contact? These questions all warrant investigative effort to help identify the underlying mechanisms that differentiate skilled from less skilled participants. Such information is essential for theoretical development and for creating suitable training protocols.

In our laboratories, we have already made some progress in this regard, with initial findings suggesting that it is the relational information between potentially only a few players that provides each pattern of play with its own unique "perceptual signature" in soccer (see Williams, Hodges, North, & Barton, 2006). A variety of experimental techniques are being employed to address this issue, such as eye movement recording, verbal reports, film occlusion, and point-light displays. For example, using point-light displays, we have shown that skilled soccer players maintain their superiority over less skilled players in pattern recognition performance even when players are presented as moving dots of light against a black background. This finding suggests that skilled soccer players are more attuned than less skilled players to the relative motions between players and/or the higher-order relational information conveyed by such motions. A typical soccer action sequence presented in point-light format is shown in Figure 9.2. Moreover, using a film-based spatial occlusion approach, we have shown that this information may be extracted from only a few key players, such as the main central attackers and strikers (see Williams et al., 2006). The extent to which such findings extend to other team games is an interesting notion that may potentially have implications for the transfer of perceptual-cognitive skills across sports (Smeeton et al., 2004).

It would also be interesting to determine the extent to which pattern recognition skill is related to, or predictive of, anticipation skill in sport. It has been suggested that this pattern recognition ability is one of the strongest predictors of anticipation skill in sport (see Williams & Davids, 1995); in contrast, others have suggested that such measures may not adequately capture the true nature of expert performance (see P. Ward, Farrow, et al., in press). In our laboratories, unpublished data suggest that performance on measures of anticipation and recognition skill are somewhat correlated, although it appears that the underlying processing strategies, as determined by eye movement recording and verbal reports, may differ markedly depending on whether participants are provided with the instruction to anticipate what will happen next or recognize whether the sequence of play was presented during an earlier viewing phase.

In addition to identifying the perceptual-cognitive information underlying pattern recognition, it would be interesting to determine the relative importance of this skill across sports, particularly in relation to other poten-

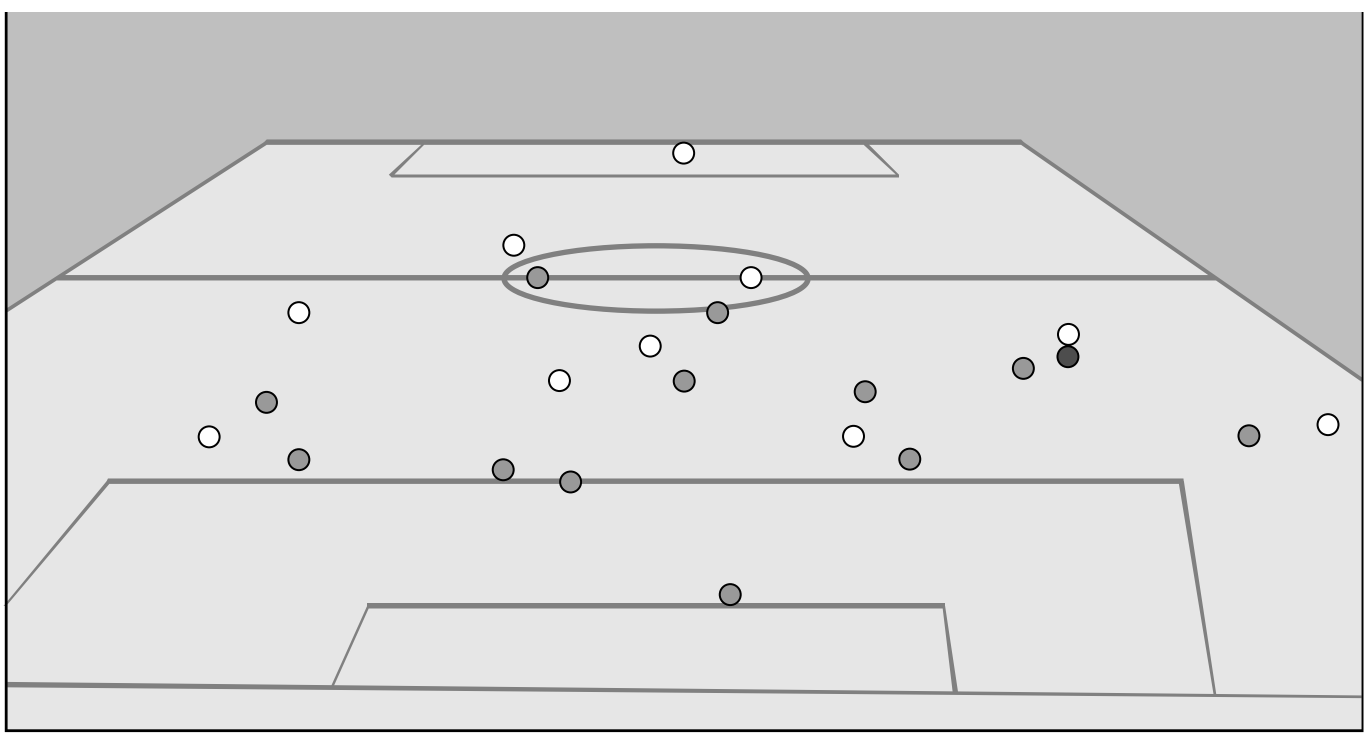


Figure 9.2 A single frame illustrating a point-light representation of an offensive sequence of play in soccer. Adapted from "Identifying Patterns of Play in Dynamic Sport Tasks: The Essential Information Underlying Skilled Performance," by A. M. Williams, N. J. Hodges, J. North, and G. Barton, 2006, *Perception, 35,* 317–332. Adapted with permission.

tially related skills, such as advance cue usage and knowledge of situational probabilities. The relative importance of these different perceptual-cognitive skills may vary across sports, and even across various positional roles within that sport (e.g., see J. D. Ward, Williams, Ward, & Smeeton, 2004).

Visual Search Behavior

The ability of performers to pick up advance visual cues or to identify patterns of play is determined, at least in part, by the manner in which they search the display in an attempt to extract the most pertinent information. A corneal reflection technique is typically used to assess visual search behavior by recording performers' eye movements and interspersed fixations (see Williams et al., 1999). Although researchers have indicated that the observed behavior is constrained by several factors, such as the nature of the task and performers' stress levels, generally skilled performers scan the display in a more effective and efficient manner than less skilled performers (Williams, Janelle, et al., 2004). The assumption is that these skill-based differences are indicative of more refined selective attention processes and enhanced task-specific knowledge structures (Henderson, 2003). The seminal work was carried out by Bard and colleagues (e.g., Bard & Fleury, 1976) in basketball and field hockey, and in recent years several researchers have extended this body of work to other sports (e.g., see Williams, 2002).

What Don't We Know?

The complex interplay between information extraction via the fovea, parafovea, and visual periphery remains an interesting line of research and a valuable area for future work. How do skilled and less skilled performers differ in the extent to which they rely on these different systems, and how does this factor vary with the constraints of the task, environmental conditions, and individual characteristics such as stress and emotion? For example, in soccer, there is evidence to suggest that visual behavior may vary as a function of the task constraints. Skilled defenders employ different search strategies when compared with skilled attackers, and different behaviors emerge when confronted with situations involving more or fewer players (e.g., a one-on-one duel versus three-on-three versus eleven-on-eleven defensive simulations), regardless of players' positional orientation within the team (see Helsen & Starkes, 1999; Williams & Davids, 1998; Williams, Davids, Burwitz, & Williams, 1994). Clearly, team sports are dynamic in nature, with continual transitions from macro- to microstates of play involving varying numbers of players, each of whom have to maintain a balance between defensive and offensive responsibilities. Further research is needed to determine how visual search behaviors alter as a function of these and other constraints and to illuminate the key factors that govern the manner in which performers extract information to guide subsequent action (Williams, Janelle, et al., 2004).

In a similar vein, there is evidence to suggest that maintaining gaze for an extended period of time (the so-called quiet eye period; Vickers, 1996) may be the key issue in self-paced tasks where the accuracy of aiming is important, as personified by the basketball free throw (Vickers, 1996), putting in golf (Vickers, 1992), and when attempting to pot a ball in billiards (Williams, Singer, & Frehlich, 2002). Although the relationship between quiet-eye period and subsequent performance has been established, knowledge as to the underlying mechanisms has not been well articulated. This measure may be reflective of the degree of preprogramming necessary prior to response initiation, or it may equally be indicative of the time needed to develop the appropriate mental set, or feeling of readiness needed to perform the task confidently (Singer, 2000). The difficulty is that in dynamic situations, such as during open play situations in basketball, the requirement to maintain an extended quiet-eye period prior to response initiation is likely to interact with the need to monitor the positions and movements of teammates and opponents and to execute the required action prior to being challenged by an opponent (e.g., see Martell & Vickers, 2004). Such factors illustrate the difficult challenge facing performers who must marry the unique constraints of the task with the need to effectively extract relevant information using the fovea, parafovea, and visual periphery. A combination of measures and approaches may be needed to effectively examine this issue (for an extended discussion, see Williams & Ericsson, 2005).

Similar challenges are presented in interceptive tasks such as in cricket, tennis, and table tennis. The requirement to extract relevant perceptual cues from opponents' actions is coupled with the need to pick up information relating to the ball's flight characteristics. The extent to which the performer relies on information extraction via the fovea, parafovea, and visual periphery remains of interest, along with the potential role of associated eye (and head) movements, such as anticipatory saccades and pursuit tracking (Williams & Starkes, 2002). Although researchers have began to explore this complex interplay and its relationship to skilled performance (e.g., see Land & McLeod, 2000;

Rodrigues, Vickers, & Williams, 2002; Singer et al., 1998), there remains great potential for empirical work.

The perceptual-cognitive skills highlighted in preceding sections are reflective of skilled performers' superior ability to process contextual information present in the display when compared to less skilled players. In sum, skilled players search the display in an efficient manner, are able to recognize patterns of play as they evolve, and are attuned to informative perceptual cues that emerge as a result of opponents' postural orientation. It also appears that skilled performers have more detailed, contextually driven expectations of the likely event outcomes, which have been termed "situational probabilities." These perceptual-cognitive skills interact with each other in a dynamic and evolving manner to facilitate appropriate anticipation and decision making in the competitive setting.

Knowledge of Situational Probabilities

Compared to other areas, there have been few empirical papers on this topic. The majority of early work was undertaken in the laboratory using choice-reaction paradigms and manipulations of stimulus probabilities and dependencies (e.g., see Hick, 1952; Hyman, 1953). Alain and colleagues (e.g., Alain & Girardin, 1978; Alain & Proteau, 1980) attempted to examine the importance of situational probabilities and its relationship with decision making in racket sports, with reasonable success (for a review, see Williams et al., 1999). P. Ward and Williams (2003) extended these notions using the sport of soccer. Participants were required to view soccer action sequences and to predict the likely passing options available to the player in possession of the ball and to rank according to their likelihood of occurring. The final frame of action from a typical film sequence is presented in Figure 9.3. Skilled soccer players were more accurate, as determined by a panel of expert coaches, than less skilled counterparts in highlighting and ranking players most likely to receive a pass from a teammate. The skilled players were better at hedging their bets than less skilled performers, judiciously determining the importance of each potential option presented, effectively priming the search for new information, and ensuring that the most pertinent contextual information was extracted from each area of the display (Anderson, 1990).

What Don't We Know?

There have been very few attempts to design more representative paradigms to examine the role of situational probabilities in sport (e.g., see Crognier & Féry, 2005; Paull & Glencross, 1997; P. Ward & Williams, 2003; P. Ward, Williams, & Ericsson, 2003). This issue needs to be addressed if understanding is to be enhanced. It would be interesting to elaborate on the potentially complex integration of performers' knowledge of situational probabilities with the processing of contextual information. A number of important questions remain to be answered in this regard: Is the integration of contextual information and prior knowledge procedurally determined (e.g., Kintsch, 1988), or do performers depend more on one source of information over the other in particular circumstances? Does this interplay vary as a function of sport, task, and skill level? Are retrieval structures necessarily soft-assembled in real-time, or are these structures preprogrammed and modified to suit? What is the nature of the representation that facilitates building a retrieval structure on the fly? How does prior learning aid the construction of subsequent retrieval structures? How do such structures develop over time? Do they develop at different rates? How are these structures influenced by practice and instruction?

Williams (2000) distinguished general from specific event probabilities. The former refers to the likelihood that opponents will typically act in a certain way given the context in question (e.g., What is the most likely pitch that most players would throw in this situation?), whereas specific probabilities relate to a particular opponent (e.g., What is pitcher X likely to do in this situation?). Clearly, both types of information are likely to be important because players have to regularly play against both familiar and unfamiliar opponents. However, to date, there have been few attempts to identify the relative importance of each type of event probability or to establish how their relative importance may vary as a function of sport, task, and participant skill level.

Several interesting questions remain, therefore, for those interested in defining the nature of perceptual-cognitive skill in sport. It is likely that complementary measures are needed to adequately address these issues. If individuals make situational assessments in a conscious and explicit manner, then the collection of verbal reports may provide the most informative approach given the performers' need to integrate knowledge and processes to effectively plan, act, monitor, evaluate, adapt, predict, and anticipate (e.g., see P. Ward et al., 2003).

METHODS AND MEASURES

In light of the need to use appropriate methods and measures to effectively capture and identify the mechanisms

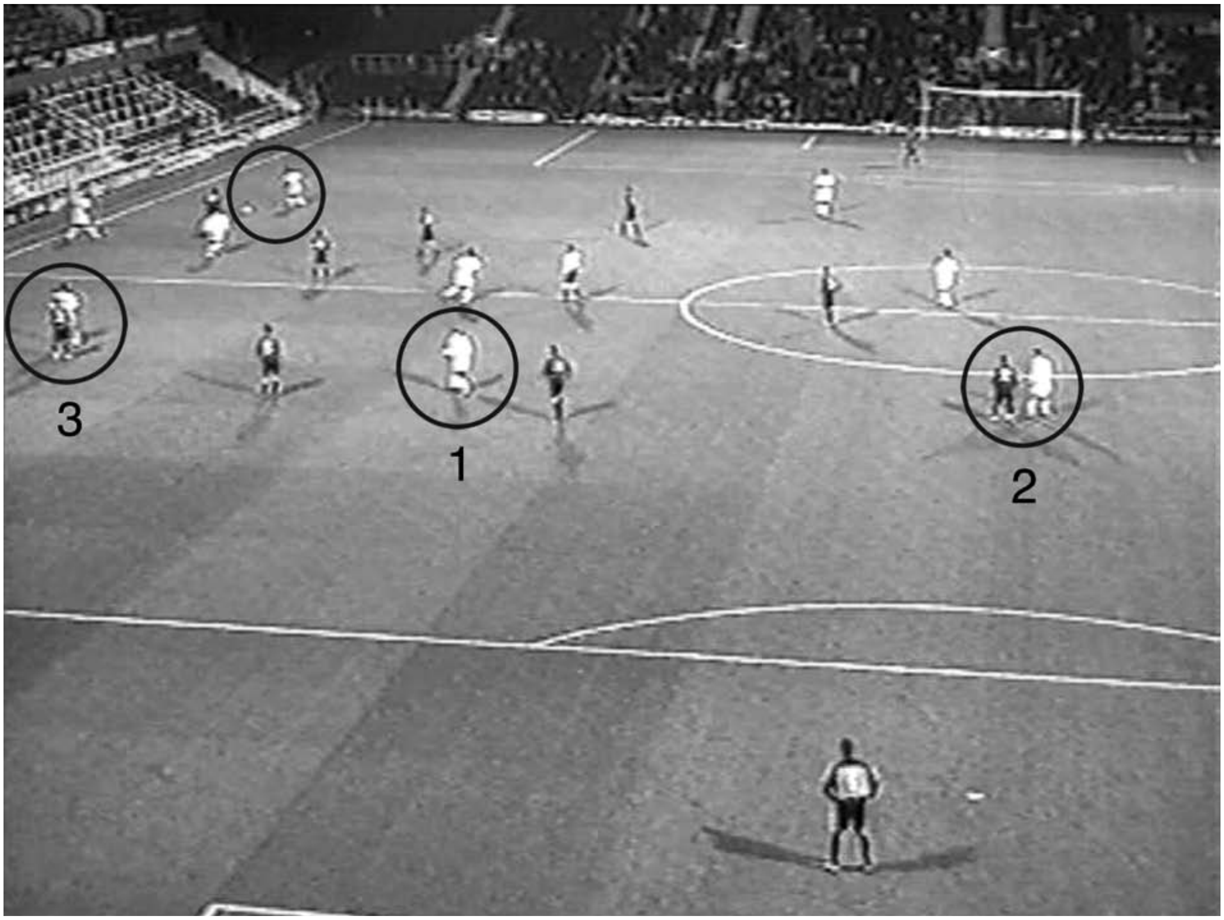


Figure 9.3 The final frame from a typical sequence of play presented in the situational probabilities paradigm. The circles highlight the potential pass options indicated by a participant, with the corresponding numbers illustrating their respective rankings. Adapted from "Underlying Mechanisms of Perceptual-Cognitive Expertise in Soccer," by P. Ward, A. M. Williams, and K. A. Ericsson, 2003, *Journal of Sport and Exercise Psychology, 25,* p. S136. Adapted with permission.

underpinning skilled performance, in this section we focus on these factors in greater detail.

Capturing Performance

The issue of how best to capture skilled performance has been discussed for some time (see Abernethy, Thomas, & Thomas, 1993; Ericsson & Smith, 1991) and remains an important topic (e.g., see Williams & Ericsson, 2005). One could argue that researchers have been too preoccupied with methodological issues at the expense of theoretical development (Williams et al., 1999), when, in reality, the greatest progress is likely to be made when the methods used to study the phenomena under investigation are specified by one's theoretical assumptions.

There are two ways of considering how best to capture performance. On the one hand, one can take a skills- or construct-oriented approach, in which a specific construct, skill, or skill set is measured, such as pattern recognition or cue usage. Researchers adopting this approach have created scenarios and paradigms that allow such skills or constructs to be directly measured (i.e., recognition paradigm, temporal occlusion paradigm), with the underlying assumption that these are integral to skilled performance (e.g., Abernethy & Russell, 1987; Allard & Starkes, 1980). Alternatively, one can take a performance or representative task-oriented viewpoint, recreating real-world scenarios in the laboratory that actually permit performers to do whatever it is they would actually do if presented with that situation during an actual game. A good example of this latter approach is the soccer free-kick task devised by Helsen and Starkes (1999), in which participants responded by performing as they would in the real world (i.e., by dribbling or passing the ball, or shooting at goal).

Most researchers have blurred the distinction between the skills- and performance-oriented views, or have adopted the viewpoint that performance is characterized by a series of skills. The assumption has been that by explicitly testing a battery of skills, one indirectly captures the essential characteristics of performance (e.g., P. Ward & Williams, 2003). From a practical perspective of conducting an experiment, the difference between approaches is often extremely subtle, but it is theoretically important. For instance, in a classical anticipation test (e.g., Williams, Ward, Knowles, & Smeeton, 2002) from the skills view, researchers have typically focused on anticipation skill (e.g., predicting the direction of the pass or shot) and have looked for scenarios in which experts would agree that anticipation was one of the primary components of task performance. From the performance view, however, when presented with multiple representative situations that truly capture performance in that domain, only a subset may require effective anticipation skill. Moreover, the importance of this variable is likely to be determined by the situation; hence, the relative contribution of this skill to performance on the representative task is likely to change from trial to trial and from moment to moment. The performance-oriented view is, therefore, not just a multidimensional approach to assessing skill (e.g., measuring multiple skills instead of one skill). Rather, this approach determines what individuals are specifically required to do in each situation to perform successfully, and focuses specifically on those situations where superior performance can reliably be identified and measured (cf. expert performance approach).

The skills view adopts a deductive approach to science, testing, for instance, the hypothesis that skilled players will be better anticipators than less skilled players. Although this approach is quite straightforward, one has to first assume that the construct or skill of interest adequately characterizes performance, or at least accounts for a significant proportion of the variance in real-world performance. Moreover, this approach often necessitates that researchers adopt certain theoretical assumptions about the nature of cognition (cf. recall paradigm; Simon & Chase, 1973). The performance view, on the other hand, adopts an inductive-deductive approach, first identifying representative situations in which superior performance can be captured, as well as the specific and context-dependent behaviors and actions required to perform successfully in those situations, then testing the hypotheses that skilled players will exhibit superior performance (reflected by more appropriate behaviors given the context). From this perspective, few a priori assumptions are required. This approach potentially offers new insights into the underlying characteristics of performance and the context-specificity of behavior and provides an objective basis for theory development.

One could argue that the skills approach is essentially equivalent to the latter half of the performance approach, having identified a priori through multivariate analyses that anticipation (or some other variable) is one of the most predictive variables of skill. However, one is likely to run into difficulty in falsifying this hypothesis when inclusion into the prior multivariate analyses is not based on some objective metric but on previous research that has adopted a skills viewpoint and/or on subjective, albeit, expert opinion. Few, if any, researchers have adopted a situation-specific performance view. This appears to be a ripe area for future research and a central issue to consider when deciding on an appropriate approach to capturing performance.

Typically, most researchers have attempted to capture performance by creating video or film simulations of the scenario in question (e.g., Abernethy, 1988; Jones & Miles, 1978; Williams et al., 1994). The advantages of film are that it enables sequences of action to be reproduced in a consistent manner from trial to trial, providing an objective method of evaluating performance. This is particularly important in sport, where sequences of events are rarely if ever repeated in an exact form (Ericsson, 2003). High-quality visual images may be easily captured and edited using digital video technology at a relatively low financial cost, and these images may be coupled with large-screen presentation formats and different methods of evaluating the appropriateness of participants' responses.

There have been a few attempts to develop potentially more representative field-based methods or to create virtual reality simulations of the performance context (see Howarth, Walsh, Abernethy, & Snyder, 1984; Starkes, Edwards, Dissanayake, & Dunn, 1995; Walls, Bertrand, Gale, & Saunders, 1998). Although it appears that film is likely to be more representative than slides (see Bourgeaud & Abernethy, 1987), it is not clear whether field-based methods or virtual reality simulations offer any advantages over film-based simulations. Although Abernethy and colleagues (1993) have argued that more representative methods increase sensitivity and therefore are more likely to discriminate performers who may be closer together on the skill continuum, this issue has rarely been examined empirically (for exceptions, see Farrow, Abernethy, & Jackson, 2005; Williams et al., 1999, pp. 112–113).

What Don't We Know?

The jury is still out as to whether there are additional benefits to be gained from developing field-based methods or immersive and interactive simulations of the performance context rather than relying on film. The development of field-based methods requires considerable creativity, and there are potential limitations both in relation to measurement accuracy and the reproducibility of stimuli. Virtual reality may offer advantages over film both in relation to access to three-dimensional images and the opportunity to interact with the environment and move in response to the action. However, in addition to the increased financial cost, virtual reality may have other disadvantages when compared to video with regard to image quality and the ability to effectively recreate the temporal characteristics of the action (see Dessing, Peper, & Beek, 2004). It would certainly be interesting to gather some empirical data to compare the veracity of each of these approaches across different sports using counterbalanced, repeated-measures designs. For example, what differences, both in relation to outcome and process, are observed when using film, virtual reality, or field-based methods to evaluate perceptual-cognitive skill in sport (for a recent review of the literature, see P. Ward, Williams, & Hancock, in press)?

It is likely that the medium of presenting stimuli to participants will interact with the expected mode of response to determine the validity of the method employed. Does it matter whether participants are required to respond verbally, using pen and paper, or via some gross, whole-body movement? It is almost certain to depend on the nature of the task. However, preliminary evidence suggests that requiring participants to move in response to the action, where an action-based response is typically required, is likely to elicit larger skill-based differences than paradigms that merely necessitate a verbal response (Williams et al., 1999). Although several researchers have lauded the virtues of employing a paradigm where participants are required to move around and interact with the environment, there have been few *well-controlled* empirical comparisons between different response modes.

It may well be that other factors are more important than the capability to move in response to presented stimuli. For instance, there is evidence to suggest that crucial factors such as emotional and physiological stress impact performance effectiveness and efficiency (Vickers, Williams, Rodrigues, Hillis, & Coyne, 1999; Williams & Elliot, 1999; Williams, Vickers, & Rodrigues, 2002). The ability to cope with stress is an important element of performance; consequently, a better understanding is needed of how perceptual and cognitive processes may be affected by such emotions in skilled and less skilled performers. Similarly, the typical approach to presenting simulations to test anticipation and decision making, whether using video, field-based methods, or virtual reality simulations, is to present experimental scenarios lasting a few seconds without additional contextual information that might drive or change prior expectations (e.g., names of players, positions of specific players, ability of players) or to specify the conditions or state of the game (e.g., winning/losing, extent of the current advantage/disadvantage, home/away, first/second half, normal/extra time). Sometimes, contextual factors are controlled so as to eliminate potential confounds. Such information is present in the competitive setting, and consequently, the addition of this information may significantly impact the underlying strategy employed to solve the task, particularly in experts.

Other methodological concerns, such as the absence of qualitative, idiographic, and longitudinal designs, the lack of consistency in defining participant groups, and the absence of appropriate control groups, are discussed elsewhere and not reiterated in detail in this chapter (see Abernethy et al., 1993; Williams et al., 1999). However, it is worth noting that there has been minimal progress in addressing many of these limitations in recent years, and the issues are as pertinent today as when first highlighted in the literature. The slow rate of progress may perhaps be indicative of the fact that although this area has grown markedly in recent years, the number of active researchers remains comparatively small—which is surprising, given the level of public interest in skilled sports performance and the potential implications for performance enhancement across domains.

Identifying the Underlying Mechanisms

The majority of researchers have relied on outcome measures of response accuracy and/or decision time to determine performance effectiveness. A smaller group of researchers have attempted to identify the important mechanisms underlying performance, even though this is a central component of the expert performance approach (Ericsson & Smith, 1991). Several process measures and task manipulations may be employed to help identify the mediating mechanisms, such as eye movement recording, verbal reports, and film-based occlusion techniques (for a detailed review, see Williams & Ericsson, 2005; Williams et al., 1999).

What Don't We Know?

Some of these process measures have been more frequently used than others. A reasonable number of researchers now routinely use eye movement registration techniques. Fewer rely on verbal reports, even fewer employ display manipulations such as film occlusion and point-light displays, and hardly any have used electrophysiological measures or biomechanical profiling using data reduction techniques such as principal component analysis. A difficulty is that each of these process measures suffers from various limitations (see Williams & Ericsson, 2005). Several researchers have recommended the need to employ more than one measure in an attempt to identify the underlying strategy, but few researchers have embraced the need to cross-validate findings or to determine which of many potential measures may be the most appropriate to use in any given context (for an exception, see Williams & Davids, 1998).

Although some researchers have employed process-based measures of perception and cognition, few have attempted to actually *trace* the process. Researchers adopting process-tracing methods in mainstream cognitive science have often used protocol analysis (Ericsson & Simon, 1980, 1993) to identify the intermediate sequence of steps (i.e., inputs and outputs—heeded or attended information—to otherwise inaccessible processes) through which individuals progress to reach their goal. Using this approach, alternative sequences of steps that an individual could plausibly undertake during performance are hypothesized a priori using a task analysis, and the (often incomplete) protocol data are then mapped to these alternatives to infer the process(es) used during performance (for more information on this approach to analyzing process-based measures such as verbal reports and eye movement data, see Ericsson & Simon, 1993; Newell & Simon, 1972). An alternative approach has been to use content analysis (Chi, 1997). In this approach, a frequency count of the types and variety of cognitions in which individuals engage is collated for a trial or across trials, and strategies are inferred from the types of cognitions employed. Given that content knowledge is the primary source of the data extracted, the latter approach may be useful if one were interested in knowledge elicitation and assumed that performance was primarily knowledge-driven. However, recent research suggests that explanations based on additional search-based processing, such as monitoring, and evaluation are perhaps more appropriate for skilled performance than explanations based on superior knowledge alone (Ericsson & Kintsch, 1995).

An issue of concern when using a particular form of content analysis, however, is that by aggregating data from a trial or multiple trials, researchers are often forced to generalize with respect to the types of strategies used by skilled individuals. Contemporary research suggests that cognition is contextually driven (see Kintsch, 1988, 1998; Zwaan & Radvansky, 1998; see also Ericsson & Kintsch, 1995), and the strategy used in one situation would not necessarily be used across all situations, even when they are similar or related. Moreover, recent research suggests that even within a trial, one cannot generalize with respect to the strategy that performers employ. Using a pseudo process-tracing approach, Savelsbergh, van der Kamp, Williams, and Ward (2002, 2005) demonstrated that, although skilled goalkeepers had previously been shown to rely on particular cues (e.g., hip rotation, nonkicking foot) when attempting to save a penalty kick in soccer, the goalkeepers used these cues only at certain moments in the penalty taker's approach run. More time was often spent fixating other cues during certain aspects of the approach, suggesting that cue importance changes over time and is clearly context-determined. This and other data suggest that an item analysis should first be performed (a) such that performance can be compared on a trial-by-trial basis, avoiding the theoretical assumption that one can generalize across trials (see P. Ward et al., 2003), and (b) to find the trials with the largest separation between skill groups, which are arguably more informative than those trials where no separation exists. In summary, to identify and understand the actual process(es) used by skilled anticipators and decision makers, there is a need for researchers to adopt a process-tracing methodology as opposed to merely using process measures or performing content analyses that are collapsed within and across trials.

It is possible that one or more process-based or process-tracing measures may produce slightly different findings. This may not necessarily threaten the validity of either measure; each measure may identify somewhat unique strategies, thereby enhancing understanding of the important differences between performers at various skill levels. One measure may be used to provide support for another, but it is equally likely that slightly different hypotheses may be posed for each measure, ensuring that any differences that emerge may be explained through reference to the prevailing theoretical framework. We consider some of these frameworks in the next section.

Theories and Models

Scientists working in the area of perceptual-cognitive expertise in sport have been criticized for not undertaking more theoretically driven research (e.g., see Abernethy et al., 1993; Williams et al., 1999). The majority of researchers have focused their efforts on developing realistic methods to capture expert performance and on providing detailed descriptions of the key differences between skilled and less skilled performers. Although description is often a precursor to theory building, the field is now at the stage where it must move beyond description and toward understanding and prediction. There are encouraging signs that reflect growing maturity within the field. In particular, there has been a much stronger focus of late on identifying the underlying mechanisms on which skilled performers' superiority over their less skilled counterparts may be based. However, there still remains a paucity of more theoretically driven research.

What Don't We Know?

A major difficulty perhaps is the absence of a unifying theory of expertise. The prototypical approach has been to embrace the metaphors of cognitive psychology and various information-processing models of human performance. A simple information-processing model illustrating the main components involved in anticipation and decision making is presented in Figure 9.4. The process of selective attention and the need to invoke a detailed role for knowledge structures stored in memory are deemed essential to help guide the search for, and effective processing of, task-specific information. Various theories have been proposed to explain experts' more refined and organized memory or their task-specific knowledge (e.g., Anderson, 1992; Ericsson & Kintsch, 1995; Gobet & Simon, 1996). For example, the long-term working memory theory proposed by Ericsson and coworkers (e.g., Ericsson, 1998; Ericsson & Delaney, 1999; Ericsson & Kintsch, 1995) suggests that experts bypass the limitations of short-term working memory by acquiring skills that promote rapid encoding of information in long-term memory and allow selective access to this information when required. After extended practice, experts index information in such a way that they can successfully anticipate future retrieval demands. The proposal is that retrieval cues kept in short-term working memory facilitate access to information stored in long-term memory. Skilled performers develop more flexible and detailed representations than less skilled athletes, allowing them to adapt rapidly to changes in situational demands.

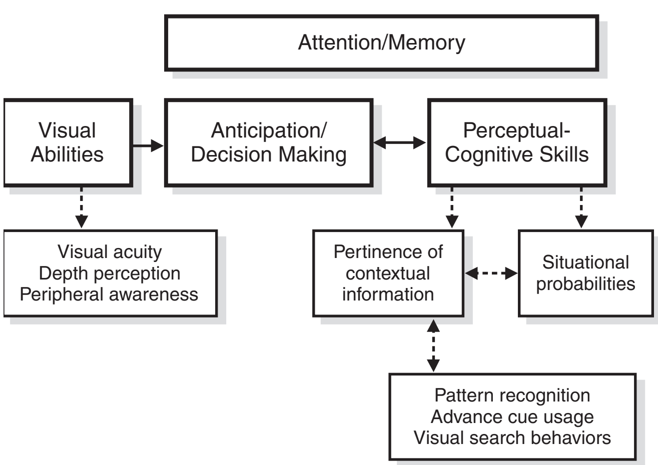


Figure 9.4 A simple information-processing based model of anticipation and decision-making skill in sport.

A particularly relevant aspect of the theory is their example of how one might go about constructing a retrieval structure on the fly that would allow such rapid adaptation to the changing nature of the situation. The construction-integration model provides a detailed explanation and computational mechanism for building a situation model and arriving at an appropriate response, albeit in text comprehension (see Kintsch, 1988). The model is supported by empirical evidence that has since been extended to explain dynamic and real-world tasks such as computer programming and piloting an airplane (e.g., Doane & Sohn, 2000). To date, there have been no efforts to take up the same mantle in sport to assess anticipation and decision making—a fact that is rather surprising given that an accurate situation model is likely to be the primary precursor to successful prediction of future consequences of action (see P. Ward, Williams, et al., in press). Although the long-term working memory theory has been used in a discursive manner to explain the nature of the knowledge structures guiding expert performance in sport, the original weak theory has not been sufficiently developed in the sporting domain such that clear hypotheses can be specified and tested. Until we extend this research beyond description, the theory will not provide a unifying framework for the study of expert performance.

An interesting notion is whether it is conceivable, or even desirable, to develop a unifying theory to account for expertise. In our laboratories, we have often debated the distinction between expertise as an entity in its own right or as the end product of a collection of skills. In sport, superior performers develop a range of skills, yet these skills do not always come together in a predetermined manner to create an expert level of performance. Nor do they have to! Not every elite performer possesses the same skills; this is often an advantage when molding a group of individuals into an effective team or unit. Although it is conceivable that every athlete requires a certain number of these skills, or at least a fundamental grasp of each skill, to be deemed an expert, it is likely that weaknesses in certain skills may be overridden by strengths in others. The eventual level of performance attained by any athlete may reflect the manner in which a range of skills is effectively integrated to achieve the goal in question. For example, in many team sports a player who lacks exceptional speed or agility may compensate by being good at reading the game or by developing exceptional technical skill when in possession of the ball. The key issue, therefore, is whether the development of each skill should be guided by its own unique theory, or whether there is sufficient similarity across skills such that a unified theory of expertise could be deemed viable.

A related question is whether coaches and others who mentor elite athletes attempt to develop skills or to enhance performance. In our experience, most coaches attempt to develop specific skills in the hope that any improvements lead to a positive change in performance. Put slightly differently, to improve performance coaches must develop the skills required to succeed. However, it is eminently probable that elite players develop strategies and skills over and above those in which they are directly instructed by engaging in deliberate practice activities and subsequently discovering new and better ways to perform. Unfortunately, this inevitability of expertise compounds the issue of measurement by necessitating that researchers answer the question "What constitutes expertise?" rather than "Do experts differ solely on certain skills?" To examine these issues, researchers should explore whether there are similarities in the causal mechanisms underlying the acquisition and performance of different skills. If one were to embrace the notion that expertise is merely a collection of skills, then there exists a range of relatively independent theories to explain the development of each unique skill. A brief glimpse at most academic texts focusing on topics such as perception, cognition, memory, attention, and learning reveals an abundance of different models and theories to explain superior performance of one skill or another. Do these theories share common principles? The challenge for a potentially unifying theory of expertise is whether it can subsume current theories of skill acquisition, provide an explanation for existing findings, and create a unifying framework that would permit adequate explanation and prediction of expert performance. This issue is likely to consume much thought and discussion over coming years.

In recent years, alternative theoretical explanations for expertise effects have been proposed from the perspectives of ecological psychology and dynamical systems theory. Beek and colleagues (e.g., Beek, Jacobs, Daffertshofer, & Huys, 2003; Huys, Daffertshofer, & Beek, 2004) have provided several excellent reviews to illustrate the potential value of these two theoretical frameworks for the study of expertise. In particular, the ecological notions of educating attention (i.e., the process of picking up specifying, higher-order invariants at the expense of nonspecifying information) and freezing and exploiting perceptual degrees of freedom (see Savelsbergh, van der Kamp, Oudejans, & Scott, 2004) may provide useful perspectives on the process of perceptual learning. Similarly, the dynamical notion of reducing dimensionality (i.e., the process of harnessing control over essential, and relinquishing nonessential, degrees of freedom for effective performance) may help answer interesting questions in relation to how skilled performers develop more effective coordination dynamics when compared with less skilled performers (Huys et al., 2004).

It should be noted that important epistemological and methodological differences exist between ecological/dynamical perspectives and the cognitive approach to perceptual-cognitive expertise. In the first instance, ecological/dynamical systems perspectives share a marked reluctance to resort to cognitive structures to explain human behavior, making reconciliation with more traditional models of perceptual-cognitive expertise difficult, to say the least. Although there have been several attempts to integrate cognition into more recent modeling in this area (for a review, see Davids, Williams, Bennett, & Court, 2001), this remains a significant philosophical barrier to overcome if a coherent and integrated framework for understanding expertise is to emerge.

A related hurdle to overcome is created by the contrasting methodological approaches employed by those working from each unique perspective. Those embracing the perspective of cognitive psychology have typically focused on the area of perceptual-cognitive expertise, with limited efforts to examine how decisions are translated into action, whereas those undertaking research from the perspectives of ecological or dynamical systems theory have examined issues related to perceptual-motor expertise, with limited efforts to identify how cognition may impact on the perceptual and motor subsystems. These underlying differences are readily apparent on reading a handful of publications in each area. In many ways, there is a clear need for multidisciplinary research to examine the complex interplay that exists among perception, cognition, and action in dynamic sport settings (Williams et al., 1999). The absence of truly cross-disciplinary research on expert performance in sport remains disappointing, particularly given the potential benefits that may be offered by exploring this issue from different theoretical and methodological perspectives. Concerted efforts are needed to map cognition, including key skills such as anticipation and decision making, onto the dynamics of perception and action via the use of a performance-oriented approach.

Practical Issues and Interventions

There have been concerted attempts of late to explore the practical value of existing research on perceptual-cognitive expertise in sport. Several researchers have attempted to develop interventions to enhance the acquisition of these skills. The typical approach has been to recreate the performance environment using film (e.g., return of serve in tennis) and then to provide instruction on the important cues underlying performance, coupled with practice and feedback (e.g., see Smeeton, Williams, Hodges, & Ward, 2005; Williams, Ward, & Chapman, 2003; Williams, Ward, et al., 2002). Although the literature base is not extensive, and several methodological shortcomings may be identified, results are encouraging and suggest that perceptual-cognitive skills can be enhanced using simulation training coupled with relevant instructional interventions. These experimentally based manipulations can provide useful information in the quest to elicit the adaptive learning mechanisms that account for effective performance on such tasks. A wealth of exciting research opportunities exists for those interested in enhancing perceptual-cognitive expertise using these types of approaches; these are discussed in detail elsewhere (e.g., see Abernethy, Parks, & Wann, 1998; P. Ward, Farrow, et al., in press; Williams & Ward, 2003; Williams, Ward, & Smeeton, 2004).

An alternative approach to identify useful practical interventions is to examine the practice history profiles of those individuals who can objectively demonstrate exceptional and superior perceptual-cognitive skills. Several researchers have employed the deliberate practice framework proposed by Ericsson, Krampe, and Tesch-Römer (1993) to determine whether skilled performers may be differentiated from their less skilled counterparts based on the nature and amount of practice hours accumulated since their initial involvement in the sport. Findings are consistent that skilled performers accumulate significantly more deliberate practice hours than less skilled performers (e.g., see Helsen, Starkes, & Hodges, 1998; Starkes, Deakin, Allard, Hodges, & Hayes, 1996; P. Ward, Hodges, Williams, & Starkes, 2004). The proposal is that deliberate practice activities demand significant effort from the learner and are designed specifically to improve some aspect of performance.

What Don't We Know?

As indicated earlier, readers are directed elsewhere for a more detailed review of those questions that have yet to be answered in relation to the practical utility of perceptual-cognitive training interventions. Although progress in answering these questions has been encouraging of late, there remain more questions than answers, but we hope this area will attract new and innovative research over coming years. A difficulty with these interventions is that they are designed to improve a very specific perceptual-cognitive skill, usually advance cue utilization, within a fairly narrow or restricted context (e.g., tennis serve, penalty kick in soccer). The extent to which these observed improvements transfer to the highly variable and unpredictable situations characteristic of high-level sports performance may be limited. An important point of concern is that although researchers have recently attempted to examine whether improvements transfer to the field setting, the transfer tests used typically involve replicating the laboratory scenario in the field setting. It may well be that there is only limited transfer to the real competitive situation where successful performance results from a complex interplay among a multitude of different perceptual-cognitive skills.

Similarly, there have been some recent reviews of the deliberate practice literature, with ample suggestions for future research (see P. Ward, Hodges, et al., 2004). The proposal in this final section, therefore, is to focus more specifically on deliberate practice theory as it relates to the development of anticipation and decision-making skill. Thus far, few researchers have attempted to identify how deliberate practice activities contribute to the development of perceptual-cognitive expertise (for some exceptions, see Baker, Côté, & Abernethy, 2003a, 2003b; P. Ward, Hodges, et al., 2004), with the majority of researchers focusing almost exclusively on the proposed relationship between deliberate practice and expert performance.

P. Ward, Hodges, and colleagues (2004) reported that compared with less elite players, elite soccer players spend a much higher proportion of their time engaged in activities that necessitate good decision-making skills, although the specific nature of these proposed activities was not outlined. A breakdown of activities for a typical practice session is shown in Figure 9.5. Baker and colleagues (2003a, 2003b) attempted to identify whether there were differences in the practice history profiles of those who were deemed to be good and not so good at decision making in various sports. Although evidence was presented to indicate that those deemed to be good decision makers had participated in a broader range of sports prior to specializing in their specific sport, no efforts were made to determine whether differences in decision-making skill across groups

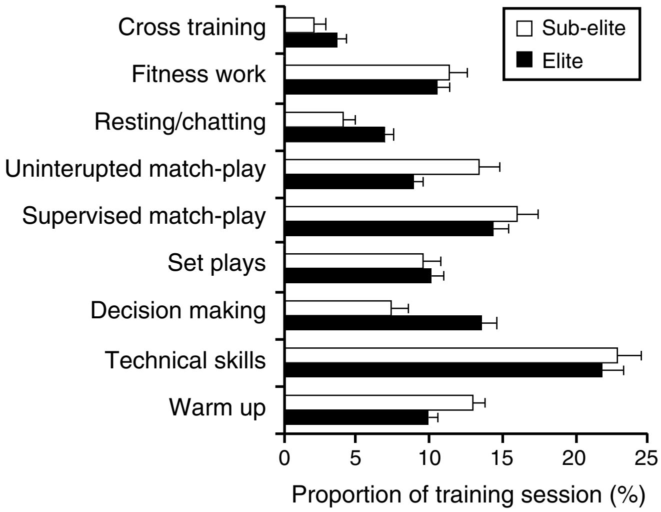


Figure 9.5 The proportion of time spent in various activities (along with standard error bars) during a typical practice session.

were directly related to specific practice activities. No attempt was made to classify participants based on their perceptual-cognitive expertise. The elite players were rated somewhat subjectively by a panel of coaches as good decision makers, rather than via any empirical means, whereas the control participants were not classified as good or not so good decision makers. Moreover, P. Ward and colleagues have recently reported contradictory evidence with respect to the issue of whether experts are characterized by greater sporting diversity during development. These contradictory findings leave open the question of whether individuals are better off spending time practicing their specialist sport or gaining different experiences from other sports during development.

A worthwhile comparison for researchers to undertake would be to examine whether a group of elite athletes who record high scores on various empirical measures of perceptual-cognitive skill can be discriminated from another group of elite athletes with poorer scores on such measures using the deliberate practice framework. One way to approach this issue is to undertake an initial analysis using large groups of elite participants and then to use a within-group criterion based on various measures of perceptual-cognitive expertise to identify those with high levels of perceptual-cognitive skill, assuming, of course, that these within-group differences actually reflect real-world performance differences. A logical progression would then be to identify a very small sample of athletes with truly exceptional levels of perceptual-cognitive skill for more detailed investigation using single case study designs and idiographic methods of enquiry. Such a multitiered approach would lead to progressively more detailed information on a few select participants, thereby providing a deeper and more meaningful analysis of the factors that impact the development of perceptual-cognitive expertise (Housner & French, 1994; Williams et al., 1999).

A criticism that has been directed at the deliberate practice approach is that there may be an overemphasis on merely adding up the accumulated practice hours, which has been termed "bean counting" (P. Ward, Hodges, et al., 2004, also see Sternberg, 1996). Clearly, the quality of practice activities, the nature of the instruction process, and the specific strategies employed by learners during practice are likely to be at least as important as the amount of accumulated practice hours in determining the rate of progress toward excellence. Greater effort is needed to identify the specific types of practice activities in which skilled performers engage and the specific relationship between these activities and the development of perceptual-cognitive expertise. At one level, a more fine-grained analysis of specific practice and instructional activities is required, using, for example, detailed behavioral coding of events within and across practice sessions (see Deakin & Colby, 2003). Practice sessions need to be dissected to determine how various activities and instructional interventions contribute to skill development. To this end, some measure of performance improvement over time is necessary. At another level, it would be helpful to identify the strategies that players classified as good perceivers or decision makers use during training and matches. A possibility is that the observed differences between groups of skilled players with good and below-average perceptual-cognitive skills may be more a product of the specific strategies employed during practice than mere exposure to the training stimuli per se. Those with exceptional perceptual-cognitive skills may approach the practice activity in a fundamentally different manner from those who are less exceptional in relation to these skills. Skilled individuals may display a much greater awareness of the underlying strategic and tactical aspects of performance, with these differences being apparent in the manner in which they process or recall information before, during, and after training and match play.

To identify those strategies that facilitate the development of perceptual-cognitive skill, researchers should endeavor, where possible, to use process-tracing measures before, during, and immediately after practice and matches. Although there has been some contention regarding the use of verbal reports, when correct procedures are adopted (see Ericsson & Simon, 1993), think-aloud and retrospective reports may provide valuable information on how those with high levels of perceptual-cognitive skill monitor, plan, act, and evaluate during performance. Perhaps more important, such reports may identify important differences between these individuals and those deemed to possess lower levels of perceptual-cognitive skill. Other process-tracing measures, such as eye movement recording and film occlusion techniques, may also be of value under more controlled laboratory conditions. Some empirical measure of performance improvement would also be helpful to attempt to determine causal relationships between specific practice activities or instructional interventions and improvements in anticipation and/or decision-making skill. The important point is that there is limited knowledge as to how perceptual-cognitive skills develop as a result of practice and instruction, and several exciting opportunities exist for those interested in this theoretical and applied issue.

CONCLUSION

The intention in this chapter was not to provide a comprehensive review of existing research findings, but to highlight some important questions and issues that have yet to be adequately addressed in relation to the area of anticipation and decision-making skill in sport. We have attempted to highlight several exciting opportunities for those interested in improving understanding in this area. In particular, we restricted discussion to projects associated with extending our knowledge of key perceptual-cognitive skills and their relationship with performance, the methods and measures that should be employed to capture these skills, the conceptual frameworks that may guide empirical research in this area, and the practical interventions that may be used to enhance performance. Our hope was to encourage new and innovative research in this area so as to extend current knowledge and understanding of those factors that contribute to anticipation and decision-making skill.

REFERENCES

Abel, O. (1924). Eyes and baseball. *Western Optometry World, 12*(1), 401–402.

Abernethy, B. (1988). The effects of age and expertise upon perceptual skill development in a racquet sport. *Research Quarterly for Exercise and Sport, 59*(3), 210–221.

Abernethy, B., Gill, D. P., Parks, S. L., & Packer, S. T. (2001). Expertise and the perception of kinematic and situational probability information. *Perception, 30,* 233–252.

Abernethy, B., Parks, S., & Wann, J. (1998). Training perceptual-motor skills in sport. In B. Elliott & J. Mester (Eds.), *Training in sport* (pp. 1–69). Chichester, West Sussex, England: Wiley.

Abernethy, B., & Russell, D. G. (1987). Expert-novice differences in an applied selective attention task. *Journal of Sport Psychology, 9,* 326–345.

Abernethy, B., Thomas, K. T., & Thomas, J. T. (1993). Strategies for improving understanding of motor expertise (or mistakes we have made and things we have learned!). In J. L. Starkes & F. Allard (Eds.), *Cognitive issues in motor expertise* (pp. 317–356). Amsterdam: Elsevier Science.

Alain, C., & Girardin, Y. (1978). The use of uncertainty in racquetball competition. *Canadian Journal of Applied Sport Sciences, 3,* 240–243.

Alain, C., & Proteau, L. (1980). Decision making in sport. In C. H. Nadeau, W. R. Halliwell, K. M. Newell, & G. C. Roberts (Eds.), *Psychology of motor behavior and sport* (pp. 465–477). Champaign, IL: Human Kinetics.

Allard, F., Graham, S., & Paarsalu, M. L. (1980). Perception in sport: Basketball. *Journal of Sport Psychology, 2,* 14–21.

Allard, F., & Starkes, J. L. (1980). Perception in sport: Volleyball. *Journal of Sport Psychology, 2,* 22–53.

Anderson, J. R. (1990). *Cognitive psychology and its implications* (3rd ed.). New York: Freeman.

Anderson, J. R. (1992). Automaticity and the ACT theory. *American Journal of Psychology, 105*(2), 165–180.

Baker, J., Côté, J., & Abernethy, B. (2003a). Learning from the experts: Practice activities of expert decision makers in sport. *Research Quarterly for Exercise and Sport, 74*(3), 342–347.

Baker, J., Côté, J., & Abernethy, B. (2003b). Sport-specific practice and the development of expert decision making in team ball sports. *Journal of Applied Sport Psychology, 15,* 12–25.

Bard, C., & Fleury, M. (1976). Analysis of visual search activity during sport problem situations. *Journal of Human Movement Studies, 3,* 214–222.

Beek, P. J., Jacobs, D., Daffertshofer, A., & Huys, R. (2003). Views on expert performance in sport from the joint perspectives of ecological psychology and dynamical systems theory. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 321–344). Champaign, IL: Human Kinetics.

Blundell, N. (1985). The contribution of vision to the learning and performance of sports skills: Pt. 1. The role of selected visual parameters. *Australian Journal of Science and Medicine in Sport, 17*(3), 3–11.

Bourgeaud, P., & Abernethy, B. (1987). Skilled perception in volleyball defense. *Journal of Sport Psychology, 9,* 400–406.

Breslin, G., Hodges, N. J., Williams, A. M., Kremer, J., & Curran, W. (2005). Modelling relative motion to facilitate intra-limb coordination. *Human Movement Science, 24,* 446–463.

Cañal-Bruland, R., Huys, R., Hagemann, N., & Williams, A. M. (2006). The effects of occlusion, neutralization, and deception of perceptual information on anticipation in tennis. *Journal of Sport and Exercise Psychology, 28,* S44.

Chi, M. T. H. (1997). Quantifying qualitative analyses of verbal data: A practical guide. *Journal of the Learning Sciences, 6,* 271–315.

Cockerill, I. M. (1981). Peripheral vision and hockey. In I. M. Cockerill & W. W. MacGillivary (Eds.), *Vision in sport* (pp. 54–63). London: Stanley Thorne.

Crognier, L., & Féry, Y. (2005). Effect of tactical initiative on predicting passing shots in tennis. *Applied Cognitive Psychology, 19,* 1–13.

Cutting, J. E., & Proffitt, D. R. (1982). The minimum principle and the perception of absolute, common, and relative motions. *Cognitive Psychology, 14,* 211–246.

Davids, K., Williams, A. M., Button, C., & Court, M. (2001). An integrative modeling approach to the study of intentional movement behavior. In R. N. Singer, H. A. Hausenblas, & C. M. Janelle (Eds.), *Handbook of sport psychology* (2nd ed., pp. 144–173). New York: Wiley.

Deakin, J. M., & Cobley, S. (2003). A search for deliberate practice: An examination of the practice environments in figure skating and volleyball. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 115–135). Champaign, IL: Human Kinetics.

de Groot, A. D. (1978). *Thought and choice in chess.* The Hague, The Netherlands: Mouton. (Original work published 1946)

Dessing, J. C., Peper, C. E., & Beek, P. J. (2004). A comparison of real catching with catching using stereoscopic visual displays. *Ecological Psychology, 16,* 1–21.

Dittrich, W. H., & Lea, S. E. (1994). Visual perception of intentional motion. *Perception, 23,* 253–268.

Doane, S. M., & Sohn, Y. W. (2000). ADAPT: A predictive cognitive model of user visual attention and action planning. *User Modeling and User-Adapted Interaction, 10*(1), 1–45.

Ericsson, K. A. (1998). The scientific study of expert levels of performance: General implications for optimal learning and creativity. *High Ability Studies, 9,* 75–100.

Ericsson, K. A. (2003). How the expert performance approach differs from traditional approaches to expertise in sport. In search of a shared theoretical framework for studying expert performance. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 371–402). Champaign, IL: Human Kinetics.

Ericsson, K. A., & Delaney, P. F. (1999). Long-term working memory as an alternative to capacity models of working memory in everyday skilled performance. In A. Miyake & P. Shah (Eds.), *Models of working memory: Mechanisms of active maintenance and executive control* (pp. 257–297). New York: Cambridge University Press.

Ericsson, K. A., Hoffman, P., Charness, N., & Feltovich, P. (in press). *Cambridge handbook of expertise and expert performance.* Cambridge, England: Cambridge University Press.

Ericsson, K. A., & Kintsch, W. (1995). Long-term working memory. *Psychological Review, 102,* 211–245.

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review, 100,* 363–406.

Ericsson, K. A., & Simon, H. A. (1980). Verbal reports as data. *Psychological Review, 87,* 215–251.

Ericsson, K. A., & Simon, H. A. (1993). *Protocol analysis: Verbal reports as data* (Rev. ed.). Cambridge, MA: MIT Press.

Ericsson, K. A., & Smith, J. (1991). Prospects and limits of the empirical study of expertise: An introduction. In K. A. Ericsson & J. Smith (Eds.), *Toward a general theory of expertise: Prospects and limits* (pp. 1–38). New York: Cambridge University Press.

Farrow, D., Abernethy, B., & Jackson, R. C. (2005). Probing expert anticipation with the temporal occlusion paradigm: Experimental investigations of some methodological issues. *Motor Control, 9*(3), 332–351.

Fullerton, C. (1925). Eye, ear, brain, and muscle tests on Babe Ruth. *Western Optometry World, 13*(4), 160–161.

Gardner, J. J., & Sherman, A. (1995). Vision requirements in sport. In D. F. C. Loran & C. J. MacEwen (Eds.), *Sports vision* (pp. 22–37). Oxford: Butterworth Heinemann.

Gobet, F., & Simon, H. A. (1996). Templates in chess memory: A mechanism for recalling several boards. *Cognitive Psychology, 31,* 1–40.

Haskins, M. J. (1965). Development of a response-recognition training film in tennis. *Perceptual and Motor Skills, 21,* 207–211.

Haywood, K. M. (1984). Use of the image-retina and eye-head movement visual systems during coincidence-anticipation performance. *Journal of Sport Sciences, 2,* 139–144.

Haywood, K. M., & Getchell, N. (2001). *Life span motor development.* Champaign, IL: Human Kinetics.

Helsen, W. F., & Starkes, J. L. (1999). A multidimensional approach to skilled perception and performance in sport. *Applied Cognitive Psychology, 13,* 1–27.

Helsen, W. F., Starkes, J. L., & Hodges, N. J. (1998). Team sports and the theory of deliberate practice. *Journal of Sport and Exercise Psychology, 20,* 12–34.

Henderson, J. M. (2003). Human gaze control during real-world scene perception. *Trends in Cognitive Sciences, 7*(11), 498–504.

Hick, W. E. (1952). On the rate of gain of information. *Quarterly Journal of Experimental Psychology, 4,* 11–26.

Hodges, N. J., Hayes, S., Breslin, G., & Williams, A. M. (2005). An evaluation of the minimal constraining information during movement observation and reproduction. *Acta Psychologica, 119*(3), 264–282.

Horn, R. N., Williams, A. M., Hodges, N. J., & Hayes, S. (2006). Kinematic specification of the perception of relative motion differences: Toward bandwidths of expectancy for the imitation of movement. *Journal of Sport and Exercise Psychology, 28,* S86.

Horn, R. N., Williams, A. M., & Scott, M. A. (2002). Learning from demonstrations: The role of visual search during observational learning from video and point-light models. *Journal of Sports Sciences, 20,* 253–269.

Housner, L. D., & French, K. E. (1994). Future directions for research on expertise in learning, performance, and instruction in sport and physical activity. *Quest, 46,* 241–246.

Howarth, C., Walsh, W. D., Abernethy, B., & Snyder, C. W., Jr. (1984). A field examination of anticipation in squash: Some preliminary data. *Australian Journal of Science and Medicine in Sport, 16,* 7–11.

Hubbard, A. W., & Seng, S. N. (1958). Visual movements of batters: Research. *Quarterly of the American Association of Health and Physical Education, 25,* 42–57.

Huys, R., Daffertshofer, A., & Beek, P. J. (2004). Multiple time scales and multiform dynamics in learning to juggle. *Motor Control, 8,* 188–212.

Hyman, R. (1953). Stimulus information as a determinant of reaction. *Journal of Experimental Psychology, 45,* 188–196.

James, N., Caudrelier, T., & Murray, S. (2005). The use of anticipation by elite squash players. *Journal of Sports Sciences, 23*(11/12), 1249–1250.

Johansson, G. (1973). Visual perception of biological motion and a model for its analysis. *Perception and Psychophysics, 14,* 201–211.

Jones, C. M., & Miles, T. R. (1978). Use of advance cues in predicting the flight of a lawn tennis ball. *Journal of Human Movement Studies, 4,* 231–235.

Kintsch, W. (1988). The use of knowledge in discourse processing: A construction-integration model. *Psychological Review, 95,* 163–182.

Land, M. F., & McLeod, P. (2000). From eye movements to actions: How batsmen hit the ball. *Nature Neuroscience, 3,* 1340–1345.

Long, G. M., & Riggs, C. A. (1991). Training effects on dynamic visual acuity with free-head viewing. *Perception, 20,* 363–371.

Loran, D. F. C., & MacEwen, C. J. (Eds.). (1995). *Sports vision.* Oxford: Butterworth Heinemann.

Martell, S. G., & Vickers, J. N. (2004). Gaze characteristics of elite and near-elite athletes in ice hockey defensive tactics. *Human Movement Science, 22,* 689–712.

Miller, J. W., & Ludvigh, E. J. (1962). The effect of relative motion on visual acuity. *Survey of Ophthalmology, 7,* 83–116.

Newell, A., & Simon, H. A. (1972). *Human problem solving.* Englewood Cliffs, NJ: Prentice-Hall.

Paull, G., & Glencross, D. (1997). Expert perception and decision making in baseball. *International Journal of Sport Psychology, 28,* 35–56.

Reilly, T., Williams, A. M., Nevill, A., & Franks, A. (2000). A multidisciplinary approach to talent identification in soccer. *Journal of Sports Sciences, 18,* 695–702.

Rodrigues, S., Vickers, J., & Williams, A. M. (2002). Eye, head, and arm co-ordination in table tennis. *Journal of Sports Sciences, 20,* 187–200.

Salmela, J. H., & Fiorito, P. (1979). Visual cues in ice hockey goaltending. *Canadian Journal of Applied Sport Sciences, 4,* 56–59.

Sanderson, F. H. (1981). Visual acuity and sports performance. In I. M. Cockerill & W. W. MacGillivary (Eds.), *Vision in sport* (pp. 64–79). Cheltenham, England: Stanley Thorne.

Savelsbergh, G. J. P., van der Kamp, J., Oudejans, R. R. D., & Scott, M. A. (2004). Perceptual learning is mastering perceptual degrees of freedom. In A. M. Williams & N. J. Hodges (Eds.), *Skill acquisition in sport: Research, theory and practice* (pp. 374–389). London: Routledge.

Savelsbergh, G. J. P., van der Kamp, J., Williams, A. M., & Ward, P. (2002). Visual search, anticipation and expertise in soccer goalkeepers. *Journal of Sports Sciences, 20,* 279–287.

Savelsbergh, G. J. P., van der Kamp, J., Williams, A. M., & Ward, P. (2005). Anticipation and visual search behavior in expert soccer goalkeepers. *Ergonomics, 48*(11/14), 1686–1697.

Simon, H. A., & Chase, W. G. (1973). Skill in chess. *American Scientist, 61,* 394–403.

Singer, R. N. (2000). Performance and human factors: Considerations about cognition and attention for self-paced and externally-paced events. *Ergonomics, 43,* 1661–1680.

Singer, R. N., Williams, A. M., Frehlich, S. G., Janelle, C. M., Radlo, S. J., Barba, D. A., et al. (1998). New frontiers in visual search: An exploratory study in live tennis situations. *Research Quarterly for Exercise and Sport, 69,* 290–296.

Smeeton, N. J., Huys, R., Williams, A. M., & Hodges, N. J. (2005, August). *Using principal component analysis to identify potential anticipation cues in tennis.* Paper presented at the ISSP 11th World Congress of Sport Psychology, Sydney, Australia.

Smeeton, N. J., Ward, P., & Williams, A. M. (2004). Transfer of perceptual skill in sport. *Journal of Sports Sciences, 19*(2), 3–9.

Smeeton, N. J., Williams, A. M., Hodges, N. J., & Ward, P. (2005). The relative effectiveness of explicit instruction, guided-discovery and discovery learning techniques in enhancing perceptual skill in sport. *Journal of Experimental Psychology: Applied, 11*(2), 98–110.

Starkes, J. L. (1987). Skill in field hockey: The nature of the cognitive advantage. *Journal of Sport Psychology, 9,* 146–160.

Starkes, J. L., Deakin, J., Allard, F., Hodges, N. J., & Hayes, A. (1996). Deliberate practice in sports: What is it anyway? In K. A. Ericsson (Ed.), *The road to excellence: The acquisition of expert performance in the arts and sciences, sports, and games* (pp. 81–106). Mahwah, NJ: Erlbaum.

Starkes, J. L., Edwards, P., Dissanayake, P., & Dunn, T. (1995). A new technology and field test of advance cue usage in volleyball. *Research Quarterly for Exercise and Sport, 66*(2), 162–167.

Starkes, J. L., & Ericsson, K. A. (Eds.). (2003). *Expert performance in sports: Advances in research on sport expertise.* Champaign, IL: Human Kinetics.

Starkes, J. L., Helsen, W. F., & Jack, R. (2001). Expert performance in sport and dance. In R. N. Singer, H. A. Hausenblas, & C. M. Janelle (Eds.), *Handbook of research in sport psychology* (pp. 174–201). New York: Wiley.

Sternberg, R. J. (1996). Costs of expertise. In K. A. Ericsson (Ed.), *The road to excellence: The acquisition of expert performance in the arts and sciences, sports, and games* (pp. 347–354). Mahwah, NJ: Erlbaum.

Terman, L. M., & Oden, M. H. (1947). *Genetic studies of genius* (Vol. 4). Stanford, CA: Stanford University Press.

Vickers, J. N. (1992). Gaze control in putting. *Perception, 21,* 117–132.

Vickers, J. N. (1996). Visual control while aiming at a far target. *Journal of Experimental Psychology: Human Perception and Performance, 22,* 342–354.

Vickers, J. N., Williams, A. M., Rodrigues, S. T., Hillis, F., & Coyne, G. (1999). Eye movements of elite biathlon shooters during rested and fatigued states. *Journal of Sport and Exercise Psychology, 21,* S116.

Walls, J., Bertrand, L., Gale, T., & Saunders, N. (1998). Assessment of upwind dinghy sailing performance using a virtual reality dinghy sailing simulator. *Journal of Science and Medicine in Sport, 1,* 61–71.

Ward, J. D., Williams, A. M., Ward, P., & Smeeton, N. J. (2004). The effects of playing position and viewing perspective on anticipation skill in soccer. *Journal of Sports Sciences, 22,* 575.

Ward, P., Farrow, D., Harris, K. R., Williams, A. M., Eccles, D. W., & Ericsson, K. A. (in press). Training perceptual-cognitive skills: Can sport psychology research inform military decision training? *Military Psychology.*

Ward, P., Hodges, N. J., Williams, A. M., & Starkes, J. L. (2004). Deliberate practice and expert performance: Defining the path to excellence. In A. M. Williams & N. J. Hodges (Eds.), *Skill acquisition in sport: Research, theory and practice* (pp. 231–258). London: Routledge.

Ward, P., & Williams, A. M. (2003). Perceptual and cognitive skill development in soccer: The multidimensional nature of expert performance. *Journal of Sport and Exercise Psychology, 25*(1), 93–111.

Ward, P., Williams, A. M., & Bennett, S. J. (2002). Visual search and biological motion perception in tennis. *Research Quarterly for Exercise and Sport, 73*(1), 107–112.

Ward, P., Williams, A. M., & Ericsson, K. A. (2003). Underlying mechanisms of perceptual-cognitive expertise in soccer. *Journal of Sport and Exercise Psychology, 25,* S136.

Ward, P., Williams, A. M., & Hancock, P. (in press). Simulation for performance and training. In K. A. Ericsson, P. Hoffman, N. Charness, & P. Feltovich (Eds.), *Handbook of expertise and expert performance.* Cambridge, England: Cambridge University Press.

Williams, A. M. (2000). Perceptual skill in soccer: Implications for talent identification and development. *Journal of Sports Sciences, 18,* 1–14.

Williams, A. M. (Ed.). (2002). Visual search behaviors in sport [Special issue]. *Journal of Sport Sciences, 20.*

Williams, A. M., & Burwitz, K. (1993). Advance cue utilization in soccer. In T. P. Reilly, J. Clarys, & A. Stibbe (Eds.), *Science and football II* (pp. 239–244). London: E. & F.N. Spon.

Williams, A. M., & Davids, K. (1995). Declarative knowledge in sport: A byproduct of experience or a characteristic of expertise? *Journal of Sport and Exercise Psychology, 7*(3), 259–275.

Williams, A. M., & Davids, K. (1998). Visual search strategy, selective attention, and expertise in soccer. *Research Quarterly for Exercise and Sport, 69*(2), 111–128.

Williams, A. M., Davids, K., Burwitz, L., & Williams, J. G. (1994). Visual search strategies of experienced and inexperienced soccer players. *Research Quarterly for Exercise and Sport, 5*(2), 127–135.

Williams, A. M., Davids, K., & Williams, J. G. (1999). *Visual perception and action in sport.* London: E. & F.N. Spon.

Williams, A. M., & Elliot, D. (1999). Anxiety and visual search strategy in karate. *Journal of Sport and Exercise Psychology, 21,* 362–375.

Williams, A. M., & Ericsson, K. A. (2005). Perceptual-cognitive expertise in sport: Some considerations when applying the expert performance approach. *Human Movement Science, 24,* 283–307.

Williams, A. M., Harris, M., Weigelt, C., & Scott, M. A. (2002). Age related differences in vision and proprioception during a lower limb interceptive task: The effects of skill and practice. *Research Quarterly for Exercise and Sport, 73*(4), 386–395.

Williams, A. M., & Hodges, N. J. (Eds.). (2004). *Skill acquisition in sport: Research, theory and practice.* London: Routledge.

Williams, A. M., Hodges, N. J., North, J., & Barton, G. (2006). Identifying patterns of play in dynamic sport tasks: The essential information underlying skilled performance. *Perception, 35,* 317–332.

Williams, A. M., Janelle, C. M., & Davids, K. (2004). Constraints on the search for visual information in sport. *International Journal of Sport and Exercise Psychology, 2,* 301–318.

Williams, A. M., & Reilly, T. P. (Eds.). (2000a). Talent identification and development in soccer [Special issue]. *Journal of Sports Sciences, 18.*

Williams, A. M., & Reilly, T. P. (2000b). Talent identification and development in soccer. *Journal of Sports Sciences, 18,* 657–667.

Williams, A. M., Singer, R. N., & Frehlich, S. (2002). Quiet eye duration, task complexity, and expertise in a near and far aiming task. *Journal of Motor Behavior, 34*(2), 197–207.

Williams, A. M., Singer, R. N., & Weigelt, C. (1998). Visual search strategy in live "court" situations in tennis: An exploratory study. In A. Lees, I. Maynard, M. Hughes, & T. P. Reilly (Eds.), *Science and racket sports II* (pp. 121–129). London: E. & F.N. Spon.

Williams, A. M., & Starkes, J. (2002). Cognitive expertise in interceptive actions. In K. Davids, G. J. P. Savelsbergh, S. J. Bennett, & J. van der Kamp (Eds.), *Vision and interceptive actions in sport* (pp. 40–63). Routledge: London.

Williams, A. M., Vickers, J., & Rodrigues, S. (2002). The effects of anxiety on visual search, movement kinematics, and performance in table tennis: A test of Eysenck and Calvo's processing efficiency theory. *Journal of Sport and Exercise Psychology, 24*(4), 438–455.

Williams, A. M., & Ward, P. (2003). Perceptual expertise: Development in sport. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 220–249). Champaign, IL: Human Kinetics.

Williams, A. M., Ward, P., & Chapman, C. (2003). Training perceptual skill in field hockey: Is there transfer from the laboratory to the field? *Research Quarterly for Exercise and Sport, 74*(1), 98–103.

Williams, A. M., Ward, P., Knowles, J. M., & Smeeton, N. J. (2002). Perceptual skill in a real-world task: Training, instruction, and transfer in tennis. *Journal of Experimental Psychology: Applied, 8*(4), 259–270.

Williams, A. M., Ward, P., & Smeeton, N. J. (2004). Perceptual and cognitive expertise in sport: Implications for skill acquisition and performance enhancement. In A. M. Williams & N. J. Hodges (Eds.), *Skill acquisition in sport: Research, theory and practice* (pp. 328–348). London: Routledge.

Zwaan, R. A., & Radvansky, G. A. (1998). Situation models in language comprehension and memory. *Psychological Bulletin, 123,* 162–185.

CHAPTER 10

Degenerate Brains, Indeterminate Behavior, and Representative Tasks

Implications for Experimental Design in Sport Psychology Research

KEITH DAVIDS, DUARTE ARAÚJO, CHRIS BUTTON, and IAN RENSHAW

Increasingly, experimental models used by many sport psychologists and movement scientists to gain theoretical insights into processes of decision making and action in human movement systems are being provided by a rich range of sports and cultural pastimes (e.g., Davids, Renshaw, & Glazier, 2005; Davids, Savelsbergh, Bennett, & van der Kamp, 2002). Traditionally, selection of movement models in motor behavior experiments has not favored dynamic, multijoint, functional actions prevalent in sports because of a reductionist idea that experimental rigor could be better maintained in laboratory studies of simple movements. The scientific philosophy of reductionism is based on a deterministic (completely predictable) view of the world, dating back to the Enlightenment period in European history (Glimcher, 2005). Scientific determinism arose in the mid-seventeenth century because of the desire to reduce uncertainty and enhance predictive capacity. Traditional experimental movement models in laboratory settings tend to involve fewer motor system degrees of freedom (e.g., muscles, joints, and limb segments) than sports movements, have a lower level of intentional constraint on behavior, and typically require a reduced amount of perceptual information to regulate action (Davids, Williams, Button, & Court, 2001; Newell, 1989). Research using movement models from sports to investigate actions has been sporadic (for rare exceptions, see Anderson & Sidaway, 1994; Beek & van Santvoord, 1992; Lee, Lishman, & Thompson, 1982; Tyldesley & Whiting, 1985; Zatsiorsky & Aktov, 1990). Of particular importance, these studies have used disparate theoretical frameworks, and there have been few attempts to theoretically rationalize why task constraints in sports and physical pastimes represent an important avenue for advancing understanding of functional movement behaviors (for exceptions, see Beek, 1989; Bootsma & van Wieringen, 1990; Newell, 1989).

In this chapter, we seek to redress this deficiency in the literature. We note that preference for more complex experimental models from sports and physical pastimes has accelerated rapidly in recent years. Consequently, detailed insights into the adaptive nature of movement behavior are now being provided by a large number of studies, ranging from apparently superficial and frivolous cultural activities such as playground swinging (Post, Peper, & Beek, 2003), hula-hooping (Balasubramaniam & Turvey, 2004), and pedalo paddle boating (Chen, Liu, Mayer-Kress, & Newell, 2005) to more traditional sporting tasks such as javelin and discus throwing (Schöllhorn, 2003), rowing (Daffertshofer, Huys, & Beek, 2004; Shuttleworth, 2004), and long jumping run-ups (Montagne, Cornus, Glize, Quaine, & Laurent, 2000).

HOW DEGENERATE BRAINS AND INDETERMINATE BEHAVIORS SUPPORT FUNCTIONAL BEHAVIORS IN DYNAMIC ENVIRONMENTS

In this chapter, we argue that the increasing popularity of movement models from sports is associated with the powerful influence of a functionalist philosophical perspective viewing decision making and the control of action as adaptive, emergent behaviors that self-organize under constraints. Recognizing the apparent indeterminate (not completely predictable) nature of solutions to many behavioral tasks has amplified the utility of relativist theoretical perspectives on brain and behavior (Glimcher, 2005). Virtually all previous decision-making studies in sport psychology have knowingly or unknowingly adopted a closed-systems analysis founded on classical utility theory and used to model economic systems. The application of such a model of rational action underpins traditional assumptions in sport psychology that decision making, perceptual judgments, and actions are dependent on knowledge structures stored in memory, from where *the* de facto appropriate program or schema can be recalled (for a review, see Starkes, Helsen, & Jack, 2001; Williams, Davids, & Williams, 1999). In such deterministic experimental paradigms, a major aim is the reduction of uncertainty for examining behavior in closed systems. From this philosophical standpoint, legitimate scientific enterprises include the empirical identification of *optimization mechanisms* of behavior (e.g., how experts make "correct decisions" and achieve reliable performances over trials; Staddon & Hinson, 1983).

However, theoretical approaches emerging in physics during the early decades of the twentieth century (e.g., quantum theory and the theory of special relativity) led to a change of thinking that was taken up later in the social, psychological, and neurosciences (Glimcher, 2005). As a result, indeterminacy has begun to emerge as a critical feature of many systems analyses of brain and behavior, leading to more open and dynamic, indeterminate models of decision making, perception, and action, incorporating the contextual constraints surrounding biological systems (e.g., Hastie, 2001; Schall, 2001, 2004). From this perspective it makes little sense to refer to optimization as a mechanism rather than as a functional outcome of indeterminate decision making and action (Staddon & Hinson, 1983). In this respect, optimization, as a functional outcome for each individual performer, emphasizes that expertise in specific domains, such as sports, is defined by attunement to relevant perceptual variables and the concomitant calibration of actions (Vicente, 2003; Vicente & Wang, 1998). Consequently, a focus has developed on models of *constrained optimization,* which emphasize functional descriptions of how individuals seek to optimally satisfy the unique interacting constraints on them in dynamic, complex environments (e.g., Araújo, Davids, Bennett, Button, & Chapman, 2004; Araújo, Davids, & Serpa, 2005; Davids, Araújo, Shuttleworth, & Button, 2003).

Models of constrained optimization are harmonious with concepts from nonlinear dynamics, such as emergence and self-organization under constraints, and capture the adaptability and compensatory variability of human actions required in dynamic contexts such as sport. Of particular importance, this modeling trend fits well with data from recent studies revealing the inherent degeneracy of biological movement systems (Edelman & Gally, 2001).

Why "Degeneracy" Is a Better Descriptor of Human Movement Systems Than "Redundancy"

In recent years, inspired by the insights of Nikolai Bernstein (1967), questions have arisen over the efficacy of descriptions of human movement systems as complex systems with many redundant degrees of freedom. For example, with tongue firmly in cheek, Latash (2000) pointed out that to make degrees of freedom truly redundant, surgical removal might be required. These criticisms may be a result of "redundancy" not being the most appropriate term to use in the context of describing biological systems. Tononi, Sporns, and Edelman (1999) argued that the term redundancy has specific usages in physics, engineering, and communications theory generally related to the duplication or repetition of components as a backup in case of system failure. Redundant systems provide similar outputs from the presence of identical components. However, Tononi et al. pointed out that biological systems are not structured in the same way as mechanical or electronic systems, as nature has a different solution for ensuring system robustness and adaptivity. In this respect, degeneracy is a more typical feature of biological systems than the ubiquitous redundancy.

Degeneracy refers to the capacity of structurally different components of complex biological movement systems to achieve different outcomes in varying contexts, and is exemplified by the networks existing at different levels of human movement systems, including molecular, genetic, and musculoskeletal. Degeneracy in complex biological systems provides the neurophysiological basis for the diversity of actions required to negotiate information-rich, dynamic environments from moment to moment as well as providing a huge evolutionary fitness advantage (Edelman & Gally, 2001). For example, several researchers using brain imaging techniques have revealed that the visual cortex in blind humans can be activated during tasks requiring attention to auditory and haptic information sources. These data have demonstrated how compensatory adjustment in degenerate nervous systems can result in the pick-up of novel information sources for planning and organizing movements (e.g., Kujala et al., 2005). Additionally it is now well established that motor equivalence, or the ability of different patterns of neuromuscular activity to achieve specific movement outcomes, can provide the degenerate human movement system with a distinct advantage through the contextual adjustment of actions to information-rich environments, typically needed in many sports. Degeneracy of human movement systems provides the capacity to trade off specificity and diversity of actions under changing task constraints, influencing the emergence of decision making and action (Edelman & Gally, 2001).

Why Movement Models from Sports Provide Representative Tasks for Studying Emergent Behaviors

What do the functionalist ideas of degeneracy and indeterminacy of brain and behavior imply for the study of decision making and action in sport? One important consequence of the influence of such relativist theorizing in science is that traditional distinctions between experimental rigor and field research are now being recognized as creating a false dichotomy. One relevant functionalist theoretical paradigm on movement behavior is dominated by the juxtaposition of ideas in ecological psychology (e.g., Brunswik, 1956; Gibson, 1979) and nonlinear dynamics (e.g., Jirsa & Kelso, 2004). It adheres to the metatheoretical commitment that knowledge of the world in biological systems is demonstrated by behavioral adaptations to functionally relevant invariant features of the environment (Heft, 2001; Reed, 1996). In sport psychology, this theoretical approach has been characterized as a "constraints-based framework" emphasizing the need to study behavior as an emergent property of the continuous interactions of a biological organism and its environment (Araújo et al., 2004; Davids et al., 2003; Handford, Davids, Bennett, & Button, 1997). Within this theoretical rationale, it is reasoned that experimental tasks need to provide adequate opportunities for emergence of adaptive behavior by ensuring that cognitive, perceptual, and movement processes function in a contextualized manner without being biased by the restriction of arbitrary and artificial tasks.

Sports and physical activities provide numerous relevant movement models because they readily lend themselves to the representative design of tasks to study adaptive behavior through the processes of perception, decision making, intentionality, and action. From this perspective it makes little sense to use the term *real-world* tasks, because all tasks—including artificial laboratory tasks—are performed in the real world (Hammond & Stewart, 2001). Indeed, it should be noted that not all dynamical systems and ecological psychology studies of coordination and control have chosen to investigate multijoint movement models from sports. In fact, some dynamical systems theorists have been criticized for implementing reductionist movement models that are somewhat isolated from everyday life, thus overemphasizing the rigor of experimental control over generalizability of findings (Schöllhorn, 2003). For example, it has been proposed that the experimental goal of seeking empirical support for abstract dynamical laws that characterize the movement system as comprising nonlinear coupled oscillators has led to the selection of "contrived laboratory tasks (finger, hand and arm wiggling), which sometimes involve rather unusual timing goals (polyrhythms)" (Walter, 1998, p. 327).

The theoretical insights of Egon Brunswik (1956) in ecological psychology provide a powerful theoretical rationale for evaluating the merits of these criticisms and the more general dichotomous trend of considering laboratory tasks as being diametrically opposed to field-based research designs for studying behavior. The issue of task constraints and their effect on performance has often been mistakenly presented as an issue of differences in ecological validity involving contrived, laboratory tasks versus natural tasks. Brunswik showed how this representation of scientific methodology was a false distinction, based on a misunderstanding of the concept of task "representativeness." For Brunswick, representativeness refers to the degree to which environmental conditions adopted in a research study reflect those present in the situations where the task is implemented (see later for a more detailed explanation). More generally, Brunswik's contribution to understanding of functional movement behavior has been highly significant. His work preempted both the emphasis on idiographic analyses of how individuals solve motor problems, relevant in indeterminate paradigms of brain and behavior, and the current shift to designing specialized experimental contexts that have a high level of representativeness of a biological organism's niche habitat. Clearly, these issues are still important today, with the generalization of findings outside of specific experimental contexts being recognized as a challenge in educational, social, developmental, and experimental psychology.

Although technological advances have undoubtedly impacted the selection of movement models for study, in this chapter we highlight how sports and physical pastimes provide relevant movement models for studying decision making and action because they provide unbounded opportunities to enhance the *representativeness* of experimental task design. They exemplify how processes of perception, decision making, and action (a) are examples of adaptive behavior, (b) are mutually enabling and "embodied" within the performer-environment system, (c) function in a task-specific manner, and (d) are dependent on nested, interacting constraints inherent to specific performance contexts. We have chosen to focus on research in the sports of basketball and cricket to exemplify the study of adaptive behavior in representative tasks involving dribbling, throwing, catching, batting, and locomotor pointing. We start by briefly discussing key concepts from the theoretical frameworks of nonlinear dynamics and ecological psychology for studying decision making and action, including the idea of task representativeness, which provides a cogent rationale for selection and adaptation of movement models from sports.

THE THEORETICAL IMPETUS OF NONLINEAR DYNAMICS AND ECOLOGICAL PSYCHOLOGY

Although there are some subtle differences, prominent ideas from nonlinear dynamics and ecological psychology demonstrate some theoretical consensus, for both theories seek to enhance our understanding of how actions are coordinated with respect to complex and dynamical environments (for detailed overviews, see Davids et al., 2001; Williams et al., 1999). Researchers in these areas have typically adopted a systems perspective. They have sought to characterize biological movement systems as complex, dynamical systems, revealing how the abundance of degrees of freedom is coordinated and controlled during goal-directed movements (see Bernstein, 1967). A functionalist perspective has revealed that patterns emerge between parts of dynamical movement systems through processes of self-organization ubiquitous to physical and biological systems in nature, as task solutions are assembled and implemented (see Davids et al., 2003). Dynamical movement systems are able to exploit surrounding constraints, particularly informational constraints, to allow functional, self-sustaining patterns of behavior to emerge in specific contexts. New behaviors emerge in a nonlinear manner as natural dynamical systems transit from one stable state of organization to another. The conditions surrounding these so-called phase transitions are of particular interest to researchers because they are relevant for understanding transitions between patterns of coordination in biological movement systems as actions are selected and implemented.

The type of order that emerges in movement systems is dependent on initial conditions (existing environmental conditions) and the ecological constraints that shape a system's behavior (Newell, 1986). Natural environments are dynamic, complex, and rich in indeterminacy, often requiring indeterminate responses from actors based on perception and anticipation of unfolding events. Ecological psychologists have addressed the problem of how perceptual information guides actions in natural environments, by emphasizing how biological movement systems are surrounded by banks of energy that can constrain decision making and action. To pick up this information, Gibson (e.g., 1979) attributed a significant role to specific *movements* of the performer and/or objects to be acted on. Movements cause changes to energy flows that provide specific information to organisms on the properties of a dynamic environment. Because flow patterns are specific to particular environmental properties, they can act as invariant information variables to be picked by individual performers to constrain their actions in specific contexts. It is clear that the specificity of ecological constraints provides the basis for the regulation of action, and it has become evident that the influence of task constraints can override the influence of other relevant constraints. For example, a number of studies of rhythmical finger movements have reported that neuroanatomical constraints of muscles involved in coordination have a strong influence on stability observed (for reviews, see Carson, 2004; Carson & Kelso, 2004). Finger flexions synchronous with an acoustic beat have been found to be more stable than extension movements syncopated with the beat. It has been proposed that evolutionary constraints on the neuroanatomical system have had a profound influence on differential stability of flexors compared to extensors (Carson, 2004). Flexor muscles originated phylogenetically as antigravity muscles and have evolved to produce relatively stronger forces than extensor musculature from similar numbers of motor units. However, when a small plastic mechanical stop was inserted into the typical experimental protocol to interrupt the oscillating finger movements, the effects of neuroanatomical constraints were overridden and neither flexion nor extension phases of the rhythmic oscillatory finger movements were found to be more stable (Kelso, Fink, Delaplain, & Carson, 2001). It was proposed that this simple modification to the protocols of rhythmical finger movement experimentation provided additional haptic information from the mechanical stop for participants; this exemplifies well how coordination patterns are soft-assembled and tuned to prevailing task conditions (Kugler & Turvey, 1987).

For sport psychologists, the major implication of these ideas is that perceptions, memories, intentions, plans, and actions may be conceived of as emergent, self-organizing, macroscopic patterns formed under a range of interacting ecological constraints (see Davids et al., 2001; Vicente & Wang, 1998). These arguments have led to proposals for an integrated constraints-based framework, effectively opening the window onto movement models from sports and exemplifying why they have gained such rapid popularity in recent years. In the following section, we explore in greater depth the implications of Brunswikian notions of representative task design for the constraints-based rationale for studying decision making and action.

TASK REPRESENTATIVENESS AND A CONSTRAINTS-BASED FRAMEWORK

Brunswikian (Brunswik, 1956; Hammond & Stewart, 2001) ecological psychology is predicated on key concepts of representative design (sometimes confused with Brunswik's concept of ecological validity; see Araújo et al., 2005, for clarifications) and intra-ecological correlation. Intra-ecological correlation refers to the close relationship between cues in the environment so that one or more may provide the same informational support to the actor (for an alternative explanation, see Savelsbergh & van der Kamp, 2000). Representativeness is a key feature that refers to the generalization of task constraints in a specific research context to constraints on behavior outside the experimental setting. Brunswik argued that psychological processes were essentially adaptive processes. Consequently, he noted that there needs to be congruence between the conditions of an experimental setting designed for the study of a particular feature of behavior and the environmental conditions within which that behavior is functionally implemented. To study how psychological processes help adapt behavior to dynamic environments, the basic principle of task representativeness is predicated on accurate sampling of environmental conditions for behavioral experiments. Brunswik's ideas suggest that, to be representative, ecological constraints of a to-be-studied behavior also need to interact, as they do in many contexts of performance. He labeled this feature of experimental design *ecological intercorrelation.* His ideas on sampling environmental conditions preempted the popularization of the current strategy of focusing on the interacting organismic, task, and environmental constraints on the participant in psychology experiments (e.g., Araújo et al., 2004, 2005). The more extensive the sampling of constraints, the more representative is experimental task design, according to Brunswikian ideas. The critical role of task constraints, as explained in our discussion of experiments showing how haptic information sources interacted with flexion/extension phases of finger movements, exemplifies the significance of the principle of ecological intercorrelation in task representativeness.

Brunswik's (1956) notions of representative task design make redundant the traditional dichotomization of empirical research as either laboratory or field-based. Understanding the interaction among key organismic, task, and environmental constraints for the emergence of movement behavior provides a comprehensive theoretical framework for designing natural, representative tasks, regardless of whether they are located in a laboratory or field setting.

So, what are the key principles of a constraints-based framework that can inform the design of representative tasks? How do these principles feature in sports tasks? Informed by the principles of a broad ecological psychology and nonlinear dynamics, a constraints-based framework demonstrates a metatheoretical commitment to understanding the organism and environment as the fundamental level of analysis, viewing it as a coherent, indeterminate ecological system (Davids et al., 2001). Such a functionalist analysis begins by understanding the ecological constraints on behavior and rejects any attempt to emphasize unilateral explanations of mind, body, and environment. The primacy of perception is complemented by a recognition that a useful functionalist theory of knowledge as adaptation to environments needs to explain the complex interactions among perception, intentions, and actions.

An important implication of these theoretical commitments for empirical work on processes of perception, decision making, and action is that representative task design to examine the function of adaptive behavior needs to consider the role of ecological constraints during active task exploration (i.e., at the level of the organism-environment relationship). Ecological psychology presupposes that an organism intends to be as empirically accurate as possible in its perception of information for action and its decisions about environmental objects and events. A broad ecological psychology begins by analyzing the ecological constraints on behavior before addressing the organism's adaptation over subsequent time scales (Vicente, 2003). The constraints-based framework provides a way of measuring the degree of adaptation between the organism's behavior and the structure of the environment. This is possible because the interaction of key task and environmental constraints provides a referent for evaluating the fitness (i.e., functionality) of behavior in individual performers. The empirical data reviewed in this chapter serve to demonstrate that very simple changes in task constraints can provide powerful insights into the adaptive coordinative structures that emerge as individuals find functional coordination solutions. They also show that sports abound with a variety of unique task constraints and that analysis of behavioral solutions after manipulating task constraints provides a particularly useful window on the role of specific intentions and perceptual information sources in constraining movements.

REPRESENTATIVENESS OF TASK CONSTRAINTS AND RESEARCH ON DECISION MAKING AND ACTION

To exemplify the theoretical arguments developed so far in this chapter, in this section we refer to two different approaches to studying dynamic interceptive actions. Sometimes quite subtle differences in methodologies can lead to significant adaptations in the behavior of participants, underlining the significance of considering sports tasks to enhance representativeness of experimental design. There are a number of key differences between traditional laboratory methodologies for studying processes of perception and movement, and the task constraints of natural interceptive movements such as catching, batting, or running toward a take-off board (Davids et al., 2002). The design of some traditional experimental contexts for studying perception has been characterized by "informational minimalism" because of a reductionist belief that holding a huge number of variables constant will allow investigators to produce laws of perception (see Harris & Jenkin, 1998).

For example, an inordinate emphasis on the use of simulated motion has led to the popularity of coincident timing tasks in which participants have to typically *predict* when a (suddenly occluded) object image will arrive at a designated target point. The task constraints of motion prediction paradigms emphasize the significance of *perceptual anticipation* processes in studying predictive visual timing during interception. In perceptual anticipation methodologies, participants are permitted to see only a part of the trajectory of the object image on the computer screen, for example, and are required to predict the arrival time of the object image at a designated target point. Those experimental constraints are assumed to "represent" part of the approach trajectory of an object image in short-term memory of participants to predict its time to arrival at a target location (e.g., see Bootsma & Oudejans, 1993; Todd, 1981). This traditional emphasis in designing studies to investigate processes of predictive visual timing fit well with theories of hierarchically organized perceptual and movement systems (see Poulton, 1957; Williams et al., 1999). From this perspective, the performer is highly dependent on accurate perception of spatiotemporal characteristics of projectile motion to program the movement of an effector toward a predicted future contact point.

However, it has been observed that the design of these tasks may not be representative of many natural interceptive actions where the emphasis is on *receptor anticipation* processes (Davids et al., 2001; Poulton, 1957). Under the natural constraints of interceptive tasks such as ball catching and cricket batting, participants are usually able to continuously regulate movements by viewing the ball until it arrives at the location of the hands or the bat, and do not need to perceptually construct the ball's flight path from earlier remembered information from ball flight. This view of task constraints in many interceptive actions fits well with the concept of information-movement coupling in ecological psychology, intrinsic to a strategy of prospective control of movement (Beek, Jacobs, Daffertshofer, & Huys, 2003). Prospection is based on a heterarchical view of the performer and an integrated relationship between movement and perceptual systems. It involves a close and continuous coupling of movement and perceptual systems based on the relationship between the instantaneous states of the performer and environment during task performance (e.g., see Montagne, 2005).

The different constraints of motion prediction and natural interceptive tasks might imply the existence of different control mechanisms for successful performance, highlighting the relevance of Brunswik's (1956) concept of task representativeness. For example, slower velocities are typically used in perceptual anticipation tasks (>1 s) and might permit the perceptual construction of the stimulus trajectory for prediction of future contact points. In most natural interceptive actions, however, movement execution times are usually much briefer (e.g., 300 ms for one-handed catching at 10 m/s; Alderson, Sully, & Sully, 1974), facilitating the use of strategies based on continuous regulation or information-movement coupling (Tresilian, 1995).

However, extant data on movement outcome variability suggest that performers find the task constraints of natural interceptive actions more functionally relevant than psychophysically based experiments. For example, in some studies involving computer simulations, participants usually underestimate time to arrival of a stimulus object at a designated location point on monitor screens. The amount of underestimation increases with increasing time to arrival (e.g., see data from Kaiser & Mowafy, 1993; McLeod & Ross, 1983; Schiff & Detwiler, 1979; Schiff & Oldak, 1990). Tresilian (1994) has calculated that the average underestimate of reported time to arrival in these tasks is around 60% of actual time to arrival at the point of execution of the button press, with the standard deviation of the estimates being 50%. These error margins and levels of outcome variability suggest that participants are not familiar with these task constraints and rarely experience them in real life. In contrast, data on timing from adults and infants suggest that such large levels of variability in estimated time to arrival are often not observed in performance of natural interceptive actions (see later section on spatiotemporal constraints of interceptive movements, documenting the results of several studies of interceptive actions in sport). Tresilian (1995, p. 237) highlighted the fact that "the variability (standard deviation of response times) of responses in CA [coincidence anticipation] tasks is some five or six times greater than that observed in IAs [interceptive actions] performed under the same stimulus conditions."

This observation can be interpreted in light of Bootsma's (1989) criticism of the "unprincipled" and arbitrary way in which processes of perception and movement have sometimes been separated in experimental designs. Bootsma examined the effects on performance of decoupling information and movement under three different types of task constraints. Participants in his study were presented with squash balls dropped through a plastic tube (length = 50 cm, diameter = 4.3 cm) from a height of 270 cm above a table surface. They attempted to intercept the ball in one of three different randomized conditions: (1) using their own arm and a bat, (2) pressing a button to release a 55 cm mechanical arm to hit the ball just before it landed on the tabletop, and (3) pressing a button when the ball was judged to be level with the tabletop surface (equivalent to motion prediction task constraints). These conditions were intended to provide a successive degradation in information-movement coupling, and percentage accuracy data on hitting performance under natural-arm task constraints (82.4%) and artificial-arm constraints (49.5%) were significantly different. Moreover, movement times were more variable for the natural-arm task constraints (14.6 ms) than the artificial-arm task constraints (5.0 ms). These findings are consistent with an ecological notion of information continuously regulating behavior under the natural task constraints of interceptive actions. With reference to Tresilian's (1995) observations discussed earlier, it is worth noting that variability in timing the initiation of striking movements was lower under natural-arm constraints ($SD = 16.3$ ms) compared to artificial arm task constraints ($SD = 34.0$ ms). When only perceptual judgments of interception points were required by participants (i.e., no physical movements were required), variability was significantly higher ($SD = 61.8$ ms) than under both arm conditions.

These findings imply that structuring experimental tasks to keep key sources of perceptual information and actions together seems to be an important principle for designing representative tasks to study natural interceptive actions. Interestingly, even after a 100-trial learning period (including 20 familiarization trials), although mean movement initiation time (MIT) in the motion prediction conditions was higher than in the natural-arm conditions, the observed differences were not statistically significant (Davids et al., 2001). In line with Bootsma's (1989) findings, statistically significant differences were obtained for the variability of MIT (operationalized as the SD around the mean) between the two conditions. Variability of MIT was greater in the motion prediction conditions compared to the natural-arm condition (see Table 10.1).

When the number of trials in the perceptual judgment (i.e., CA) task was quintupled, performance was still significantly better in the natural-arm striking condition, as evidenced by variability of movement initiation time. The task constraints of striking a ball set up the saliency of various sources of perceptual information involved in timing the movement (Davids et al., 2001). Under these specific task and informational constraints, the performer develops a coupling of movement to relevant sources of perceptual information. As evident from the data from the motion prediction task, the developed coupling cannot easily be transferred to different task constraints (Bootsma, 1989), highlighting the importance of task representativeness for studying adaptive movement behaviors.

Table 10.1 Interception and Movement

Subject Number	Motion Prediction Task (Mean MIT)	(SD)	Interceptive Action (Mean MIT)	(SD)
1	298	59	293	16
2	224	57	288	15
3	384	27	276	16
4	349	28	306	20
5	271	38	289	13
6	360	27	306	21

Note: MIT = Mean movement initiation time; SD = Variability of participants performing interceptive actions under the constraints of a motion prediction paradigm and a natural interception task. Each participant performed a total of 100 trials (including habituation trials) in each condition. Data are calculated in milliseconds.

Source: "Accuracy of Perceptual Processes Subserving Different Perception-Action Systems," by R. J. Bootsma, 1989, *Quarterly Journal of Experimental Psychology, 41A,* pp. 489–500. Reprinted with permission.

To summarize so far, these data indicate the extensive insights that might be available when studying movement models under the enriched ecological constraints of sport. Degenerate brains and indeterminate behavior support functioning in complex, dynamically changing environments. There is a need to examine processes of perception and action under dynamic task constraints to understand how people actively explore information to guide functional behaviors. Most important, individual *and* environmental constraints should be explicitly considered in studies of movement coordination and control. The constraints-based framework signals the need to carefully distinguish variability in *movement organization,* a healthy sign of adaptive behavior in indeterminate, biological movement systems, from variability in *movement output,* which is less functional (Davids et al., 2006). The latter is often caused by the use of task constraints that are unrepresentative, as data reported from studies of hitting actions have shown.

Sports and many apparently frivolous pastimes provide a plethora of tasks that lend themselves to representative design for studying ubiquitous actions such as interceptions. They exemplify how a process-oriented, time-continuous approach motivated by the study of adaptive behavior can be achieved in the analysis of complex movement models (Cordo & Gurfinkel, 2004; Schöllhorn, 2003). Sports and physical activities are replete with an extensive range of task constraints to experimentally manipulate, including clothing, equipment, rules, targets, boundaries, surfaces, and the presence of other individuals (Davids, Button, & Bennett, in press). Compelling arguments exist for empirical work to adequately reflect "enriched action environments" based on a broad range of task constraints (Cordo & Gurfinkel, 2004; Newell, 1991).

MOVEMENT MODELS IN BASKETBALL AND CRICKET: WINDOWS ON EMERGENT ACTIONS

In this section, we discuss how the sports of basketball and cricket provide a rich backdrop for the study of emergent functional solutions during performance.

The 1 × 1 Subphase of Basketball: A Dyadic System

Spontaneous movement variability can play an important role in allowing sport performers to create different movement solutions to fit various performance situations. In the dynamic context of basketball, one can get a good impression of how skilled players utilize a range of movement patterns to achieve individual and team goals. Araújo et al. (2004) recently examined the dynamics of motion interaction in a dyadic system formed by competing individuals in basketball dribbling. A start point for this analysis was consideration of two individuals in a dribbling dyad as a single system with dyadic synergy (Schmidt, Carello, & Turvey, 1990). In physical terms, these processes are expressed in the emergence of organized structures in phase-space describing the interpersonal interactions of the dribbling attacker and marking defender. Interpersonal coordination can be studied in the emergence and regulation of coordinated states through inherent perceptual processes, based on the dynamics between individuals in a dyadic system (Kugler & Turvey, 1987).

With the tools and concepts of nonlinear dynamics, the behavior of interacting players can be interpreted as an emergent process resulting from the spatiotemporal relations established during game situations. A dyadic synergy can show nonlinear properties, namely, entrainment and sustained periodic behavior, as specific modes of interpersonal coordination emerge from contextual, personal, and task constraints. In basketball, the interaction of a dribbler and a defender in a one-on-one situation can result in a relatively stable interactive dynamic structure, because the defender may counteract any movement toward the basket by an attacker. According to coaching knowledge, this stable balance between attackers and defenders characterizes the 1 × 1 situation in basketball (e.g., Bain, Hayes, & Quance, 1978). In this classic subphase of team sports, the attacker needs to destabilize or perturb the stable state of this momentary dyad. If this system is successfully destabilized, the attacker can dribble past the defender toward the basket. This destabilization corresponds to a symmetry-breaking process where the previous stable interpersonal state transits to a new dynamic state (Kugler & Turvey, 1987).

A dynamical systems analysis of this phase transition from one attractor pattern to another needs to begin with a measure of order in the stable interpersonal pattern formed by the position of the attacker and defender with respect to the ball and the basket. Analysis of coaching literature reveals that a candidate collective variable to describe order in an attacker-defender system is the distance between the basket and the median point of the distance between the attacker and defender during the 1 × 1 confrontation. The pedagogical literature also reveals that a specific control parameter can be the interpersonal distance between attacker and defender. We examined whether the distance from the attacker-defender dyad to the basket would become less stable until some critical value was reached, as interpersonal distance decreased. This investigation considered whether changes in interpersonal distance were associated with dribbling success by attackers. A specific issue of interest was whether the attacker-defender dyad became more frequently destabilized at critical values of interpersonal distance. Ten male players (regional level, 15 to 16 years old) participated in the experiment after recommendation by their coaches and providing informed consent. They were paired to form 5 dyads. Each dyad started at the free throw line, with the other members of both teams placed on the court based on the "attack system 1:2:2" (see Figure 10.1).

The horizontal plane trajectory (two-dimensional) of the center of mass of each player in the dyad was recorded by one digital camera. Body mass center was calculated with the 6 markers (2 ankles, 2 hips, and 2 shoulders). Task instructions were for the attacker to score and the defender to prevent a score, within the rules of basketball. The eight other players started to participate in the play 5 seconds after the beginning of the task (temporal task constraints), after having being placed in valid positions based on typical basketball match strategy (spatial task constraints). The action sequence started when the defender passed the ball to the attacker, after a signal from experimenters. In Figure 10.2a, it can be observed that, during the initial part of the dyadic entrainment, there is a stable state of the collective variable, followed by an abrupt change in the state of the system due to the attacker's success in destabilizing the dyad.

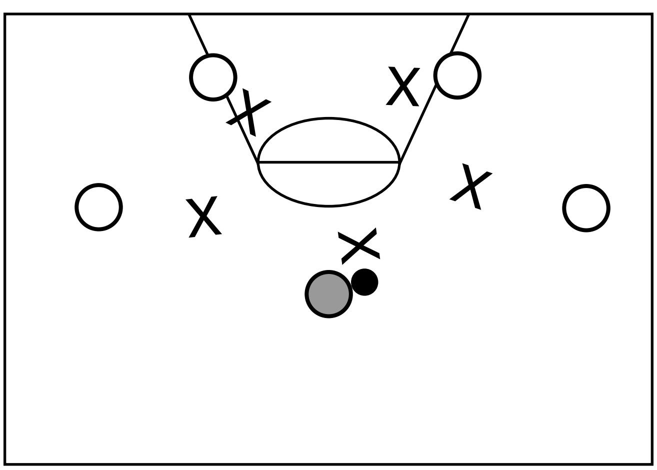


Figure 10.1 A schematic diagram illustrating the starting position of a typical basketball dyad (in gray), based on the "attack system 1:2:2." *Note:* X = Defenders; O = Attackers.

Interpersonal equilibrium, one stable state of the dyadic system, is kept during the whole situation (Figure 10.2c), where the defender has managed to constantly counterbalance the symmetry-breaking actions of the attacker. On the other hand, when the attacker is successful, there is almost no equilibrium. Figure 10.2b shows that the transition from a new state started immediately after the beginning of the interaction between the players in the dyad. Interestingly, the symmetry was broken exactly during the shortest values of the control parameter (i.e., interpersonal distance; right side of the figure). This is the transition phase from dyad equilibrium to a new system order (attacker's supremacy). In general, the attacker-defender system exhibited initial symmetry (clearly shown in Figures 10.2a and 10.2c), which was broken during transition to a new state at a certain value of the control parameter (which is clear in Figures 10.2a and 10.2b). These points can be further emphasized if we decompose our collective variable (distance between the medium point of the dyad to the basket), showing each player's distance to the basket. In Figure 10.3 we show the same situations as in Figure 10.2. There we can see more clearly how symmetry breaking occurs (Figures 10.3a and 10.3b) and how symmetry was maintained (Figure 10.3c). To create a diagnostic tool for coaches we can illustrate the behavior of both players in a phase space (right side of Figure 10.3).

The attacker-defender system exhibited initial symmetry, which was broken during transition to a new state at a certain value of the control parameter. In other words, the attacker was trying to dribble past the defender, but the defender was attempting to maintain the initial steady state. The attacker increased the variability of dribbling actions to create information on the emergence of a system transition (the decision when to drive with the ball). Suddenly (when the symmetry was broken), the decision emerged in the intending-perceiving-acting cycle. Considering the characteristics of the phase-space, the positions above its diagonal represent attacker supremacy and the positions of the system below the diagonal represent defender supremacy. In summary, the data suggest that it is possible to interpret the dynamics of player interactions in dribbling as emergent properties under constraints. As an aside, an interesting question concerns the relationship between the ability of the defender to maintain the symmetry of the system and his or her perceptual skills. An interesting question for future research concerns whether initial system stability is more easily maintained when the defender is able to perceive the specifying information provided in the attacker's dribbling actions. Alternatively, a

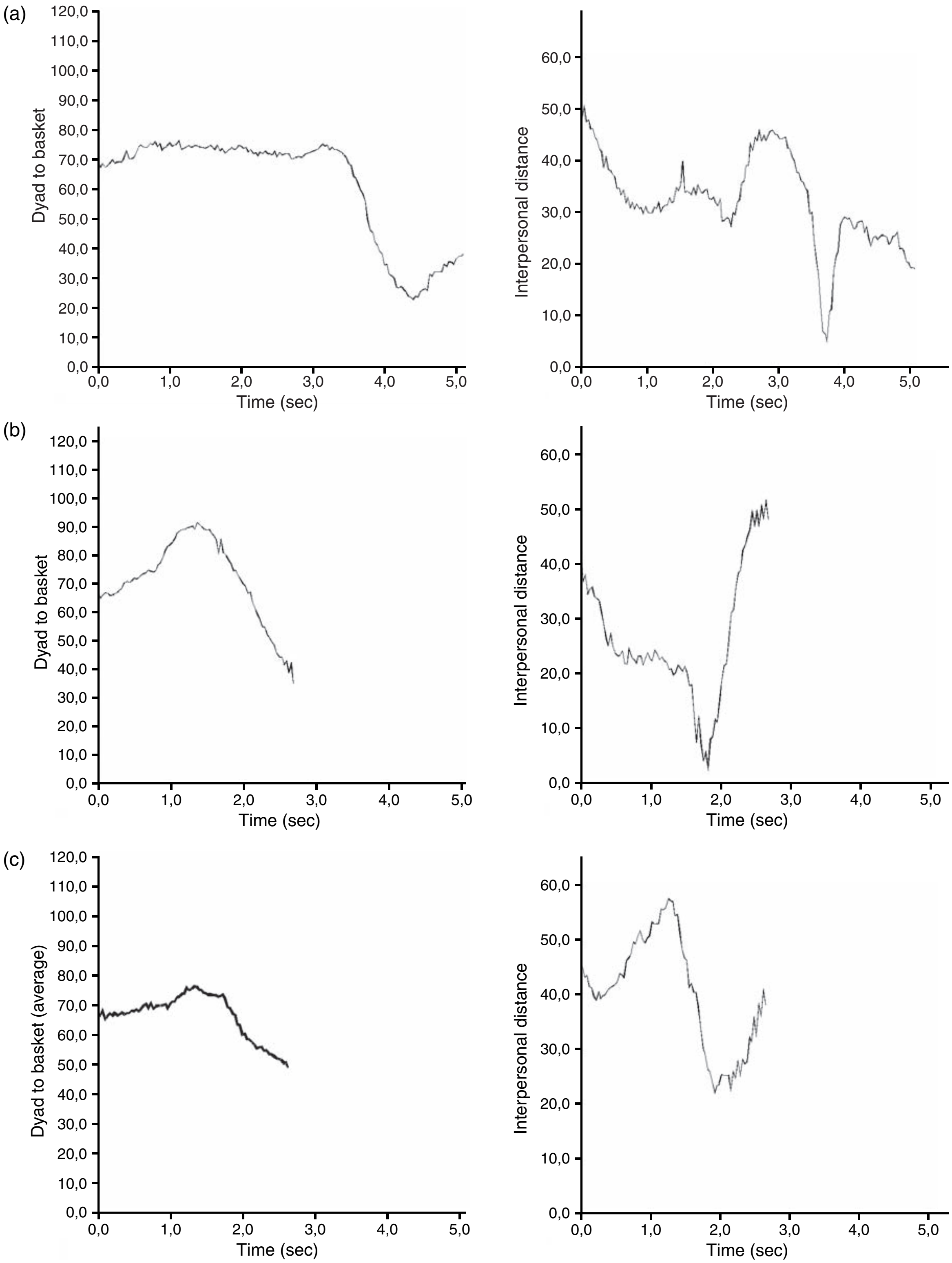


Figure 10.2 Three examples of collective variables (distance of dyad to basket) on the left column and control parameters (interpersonal distance) on the right column: 1st row = equilibrium situation with a slight attacker advantage; 2nd row = attacker's advantage; 3rd row = defender's advantage. Some of these data were initially presented in "Emergent Decision Making in Sport: A Constraints-Led Approach" (p. 77), by D. Araújo, K. Davids, J. Sainhas, and O. Fernandes, in *International Congress on "Movement, Attention and Perception,"* L. Toussaint & P. Boulinguez (Eds.), 2002, Poitiers, France: Université de Poitiers.

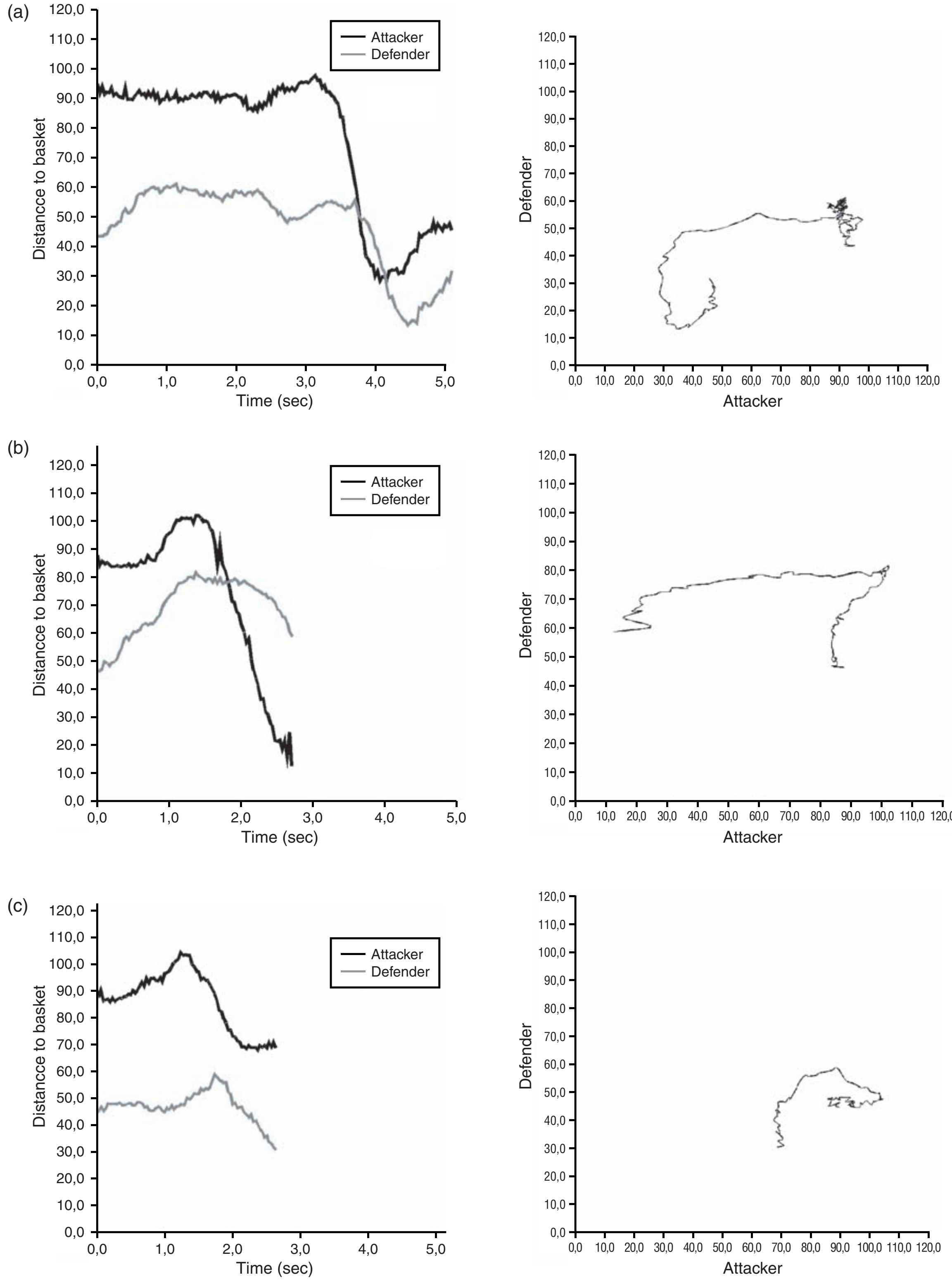


Figure 10.3 Same examples as previous figure. Decomposed collective variables (distance of dyad to basket) on the left column and phase space (interpersonal distance) on the right column: 1st row = equilibrium situation with a slight attacker advantage; 2nd row = attacker's advantage; 3rd row = defender's advantage. Some of these data were initially presented in "Emergent Decision Making in Sport: A Constraints-Led Approach" (p. 77), by D. Araújo, K. Davids, J. Sainhas, and O. Fernandes, in *International Congress on "Movement, Attention and Perception,"* L. Toussaint & P. Boulinguez (Eds.), 2002, Poitiers, France: Université de Poitiers.

phase transition may be more likely to result when unspecifying information is accessed.

Inter-Trial Variability in the Free-Throw Action

Using the sport of basketball, we have also revealed how the amount and structure of movement variability changes as an individual becomes increasingly skilled at a discrete task. The free-throw shot in basketball is a precision throwing task that is seemingly associated with a high degree of movement consistency among experienced performers. To test this observation, Button, McLeod, Sanders, and Coleman (2003) conducted a detailed individual analysis of the throwing kinematics of 6 female players performing 30 free-throw shots. The players comprised a range of expertise levels, from novice (Participant 1) to international (Participant 6). The data revealed an increasing amount of inter-trial consistency from the elbow and wrist joints as skill level improved (see Figure 10.4). One might associate such characteristics of the data with a stable attractor shell that enhances the reproducibility of the movement system under high levels of pressure and fatigue, which are important demands in competitive basketball. However, particularly at ball release, there was evidence of angular joint covariation to adapt to subtle changes in key release parameters of the ball. Regardless of expertise level, all players showed an increase in movement variability, indicating that this behavioral feature was a function of the task constraints rather than skill level. It could be that to satisfy the unique task constraints of the basketball free-throw, a bandwidth of trajectory variability is necessary that all the players tended to exploit. For example, the elbow position tended to be most variable during the middle phase of the throwing action, with a decrease toward ball release. It has previously been shown that increased variability is associated with rapid, accelerative phases of a movement, and projecting the ball in an arc toward the basket demands a forceful extension of the shooting arm.

Interestingly, Button et al. (2003) found that the coordination between the elbow and wrist joints became more variable toward the end of the action. Even Participant 6 showed a distinct peak in variability at approximately 90% of the movement duration. One explanation may be that as a result of changes in key release parameters, players need to maintain a functional level of joint-space adaptation toward the end of the action. For example, it has been observed that skilled throwers compensate the values of release speed and release angle against each other to achieve a consistent outcome. An implication of this work is that although sports performers may appear to use increasingly stereotypical movements with expertise, functional variability in trajectory space exemplifies adaptive behavior, which can be exploited on a trial-to-trial basis.

Cricket

Cricketers require skill in a variety of complex, multijoint, interceptive actions, including batting, bowling, and fielding. Interceptive actions involve controlled collisions during which perceptual information from the environment is picked up to guide the appropriate limb(s), or a striking implement, into the right place at the right time, while imparting an appropriate amount of force into a projectile. The task constraints of cricket are demanding; for example, batting requires the interception of a ball with a bat under severe time constraint (typically, the time from ball delivery to contact ranges from around 1 s to 0.6 s). Regan (1997) estimated that skilled cricketers, facing fast bowling speeds of 160 kph, need to be able to perceptually discriminate the spatial trajectories in depth of balls to a precision of 0.5 degrees. Response timing precision in cricket batting has estimated margins of failure of around ±2.5 ms at the point of movement execution. Fielding requires players to perform one- and two-handed catches of the ball, sometimes after running to an appropriate location in the field. Alderson et al. (1974) showed that errors could occur if skilled catchers varied the timing of hand closure around a ball during the grasp phase by around 16 ms.

Prospective Control of Interceptive Actions in Cricket

How does the central nervous system meet such severe spatiotemporal task constraints? Empirical support has recently increased for prospective control modeling in which various information sources are coupled to movements and used to continuously regulate even the most rapid interceptive actions (for overviews, see Beek, Dessing, Peper, & Bullock, 2003; Montagne, 2005). Modeling has revealed how properties of ball flight trajectories can be instantaneously perceived to continuously constrain the spatiotemporal movement patterning.

Beek, Dessing, et al. (2003) described how time to contact and place of contact have been identified as two relevant perceptual variables for prospective control of action in studies of catching and batting (see Figure 10.5). They showed how, according to prospective control models (e.g., Bootsma & Peper, 1992; Peper, Bootsma, Metre, & Bakker, 1994), catching a ball requires a performer to control the hand's acceleration based on an optically specified velocity differential (see equation 10.1). Information can

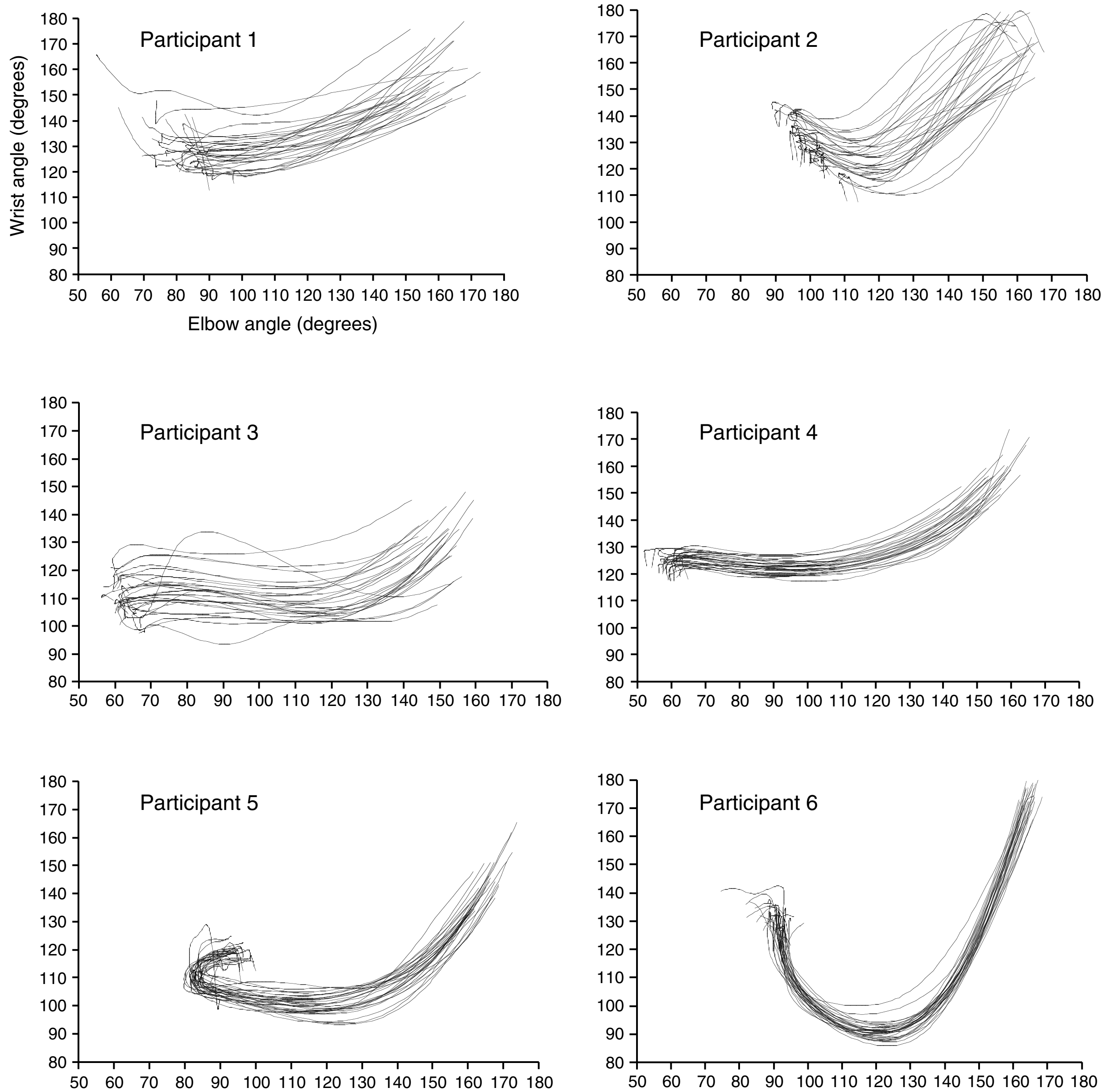
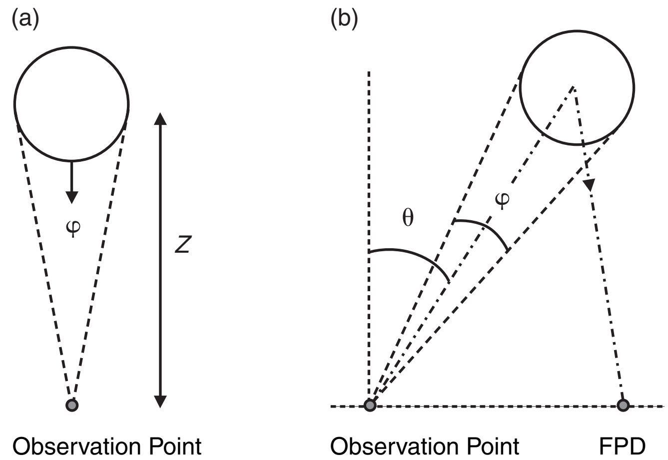


Figure 10.4 Elbow-wrist angle-angle plots for basketball players across a range of skill levels performing 30 free-throw shots. Participants 1 and 2 are novices, 3 and 4 are club, 5 and 6 are internationals. Data from "Examining Movement Variability in the Basketball Free-Throw Action at Different Skill Levels," by C. Button, M. McLeod, R. Sanders, and S. Coleman, 2003, *Research Quarterly for Exercise and Sport, 74,* pp. 257–269.

be continuously used to control the hand's acceleration so that the current hand velocity at a given instant (t) is increased or decreased for the hand to move at the required velocity needed to catch the ball. As shown in equation 10.2, the required velocity can be expressed as the ratio of the current lateral distance (i.e., distance between the hand and the ball's projection plane onto the hand-movement axis) to the first-order TC between the ball and the hand-movement axis. Factors on the right-hand side of equation 10.1 (i.e., the velocity differential) can be optically specified by monocular and binocular (lower order) variables.

$$\ddot{X}_h = \alpha \dot{X}_{h\,\mathrm{req}} - \beta \dot{X}_h \qquad (10.1)$$

with



$$\tau = -\frac{\varphi}{\dot{\varphi}} \approx -\frac{Z}{\dot{Z}} \approx \text{TC} \qquad \frac{\dot{\theta}}{\dot{\varphi}} \approx \text{FPD}$$

Figure 10.5 Schematic representations of (a) time to contact for an object approaching a stationary observer (local tau 1) and (b) final place of contact for a stationary observer.

$$\dot{X}_{h\,req} = \frac{X_h - X_b}{TC_1} \qquad (10.2)$$

where X_h, $X_{h\,req}$ and X_h are the hand's current acceleration, current required velocity, and current velocity, respectively, and α and ß are constants, and where X_h, X_b and TC_1 are the hand's current position, the projection of the ball's current position on the hand-movement axis, and the first-order TC between the ball and the hand-movement axis, respectively.

In prospective control models, successful catching is dependent on achieving and maintaining required velocity by modulating the intercepting limb's acceleration on the basis of optical information from ball flight. Recent data support the use of this law of control. In one experiment, Montagne, Laurent, Durey, and Bootsma (1999) manipulated current lateral distances between the ball and hand to observe influence on hand acceleration. Individuals were required to catch a ball approaching the same point of interception from different initial starting points. Use of a prospective strategy would predict that when the hand was positioned at the point of interception, individuals would start by moving their hand to "fill in" the lateral distance (to the left for an outward angle, to the right for an inward angle) and then change direction to catch the ball (causing a movement reversal). Individuals demonstrated a significant number of movement reversals for the balls that approached on an inward or outward trajectory rather than a straight pathway (approximately 60% of all trials). Furthermore, they started moving their hand at the required velocity approximately 300 ms before catching the ball. Movement reversals are not superfluous and can be construed as evidence of performers creating constraining perceptual information (e.g., place of contact) to couple hand movements continuously with ball flight information. It remains a challenging task to identify the perceptual variables used to regulate action because humans are so adept at picking up and using many different types of information to prospectively control action (Savelsbergh & van der Kamp, 2000). Interestingly, many of the tasks used to investigate prospective control of interceptive actions have relied on experimental tasks in laboratory settings. An important feature of these studies is that they were designed to ensure that participants were able to use perceptual information to constrain action in an ongoing manner. It is clear from the research discussed in this section that experimental tasks for the study of processes of perception for action need to be carefully designed to allow human perceptual systems to function in an evolutionary-designed manner. The constraints of many sports tasks are suitable for this purpose.

Bimanual Coordination in Cricket

Batting is a two-handed task and cricket is replete with movement models to deepen understanding of bimanual coordination. Obhi (2004) noted that task constraints requiring two hands to perform continuous, rhythmical, cyclical, or oscillatory movements are overrepresented in the bimanual coordination literature, to the detriment of the study of discrete, object-oriented, goal-directed actions, as exemplified in slip fielding in cricket. Task constraints used to study two-handed actions can be broadly broken down into two main categories: (1) hands moving symmetrically and simultaneously and (2) hands moving asymmetrically and simultaneously (Swinnen, 2002). Slip fielding in cricket exemplifies the latter, in which both hands are brought together to move isodirectionally and intercept a ball moving rapidly off the edge of the bat at speeds in excess of 160 kph. It is an ideal movement model for studying bimanual coordination, although it has rarely been investigated. An exception to this trend was a study of two-handed catching behavior under similar task constraints to slip fielding in cricket reported by Tayler (2002). He found that during successful catching, skilled performers formed a coordinative structure in which the two hands adhered to a common timing structure that ensured synchronization of time of arrival at the perceived interception point, even from

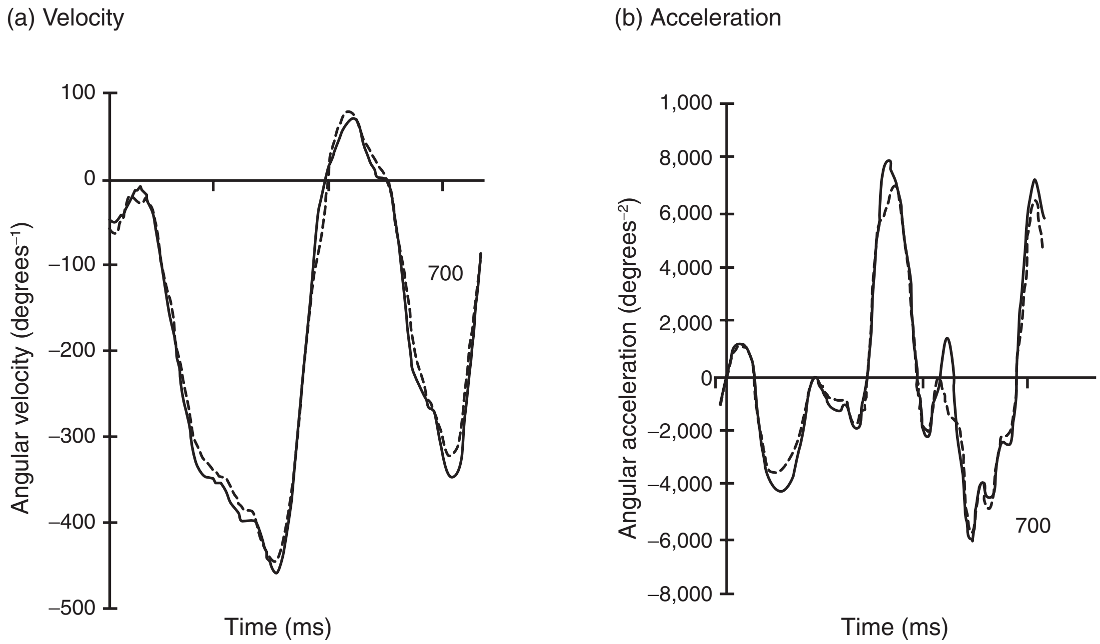


Figure 10.6 The (a) velocity and (b) acceleration trace for a single subject (subject 3) for one catch projected to the center of the chest area of the catcher. The dashed line represents the right arm and the solid line the left arm. Data from "Catching with Both Hands: An Evaluation of Neural Cross-Talk and Coordinative Structure Models of Bimanual Coordination," by M. A. Tayler and K. Davids, 1997, *Journal of Motor Behavior, 29,* pp. 254–262.

spatially variable initiation points. When one hand needed to travel farther than the other hand to the perceived interception point, it traveled faster to synchronize time of arrival. Movement initiation time data revealed that the limbs began to move at identical moments in time under three task constraints varying the distances that hands needed to travel. Despite the left and right limbs having to move farther under the three constraints, both limbs set off at the same time when performing the catch: MIT 208 (±18) ms, 204 (±22) ms, and 196 (±30) ms. Velocity and acceleration data also supported the idea that the two hands formed a coordinative structure to achieve the interception goal. The largest interlimb difference for time to peak velocity was 5 ms, with velocity traces of the two limbs showing a synchronous pattern throughout the entire movement; the largest interlimb difference in time to peak acceleration was 6 ms (see Figure 10.6). The slip-catching problem is solved by integrating the motor system degrees of freedom into a single unit of coordination that can be regulated by the central nervous system.

Bimanual Coordination Modes Emerge under Differing Practice Task Constraints

Two-handed tasks such as slip fielding and batting are often practiced with the use of ball projection machines, and research from cricket batting is beginning to raise important questions on their role in fine-tuning processes of perception and action. Because perception is specific to environmental properties uniquely constraining each performance situation, changing the ecological constraints of practice can deeply influence the movement behaviors that emerge (Beek, Jacobs, et al., 2003). An important role of practice is to educate learners to pick up constraining perceptual variables rather than nonconstraining (less relevant) variables in specific and relevant practice contexts (Jacobs & Michaels, 2002). However, practice environments have traditionally been adapted to manage the information load on learners by decomposition of the movement model into microtask components. This type of management strategy is prevalent in educational, training, and practice contexts and can be achieved in many different ways, for example, by use of ball projection machines to enable acquisition of specific batting skills in isolation from stressful performance contexts.

The problem with this approach in managing information loads during practice is that experienced performers use preball flight information to constrain coordination modes, as revealed by studies of cricket batting (Renshaw & Fairweather, 2000). Specificity of coordination was uncovered by analyses of the forward defensive stroke when batting against a real bowler and a bowling machine. The forward defensive stroke has been broken down into two phases: (1) the back lift and stance, and (2) the downswing to impact. To understand if the different task constraints of batting against a bowling machine or a bowler changes the timing and coordination of the forward defensive stroke, the temporal organization of the shot played by English premier league batsmen of high intermediate standard was examined from the moment of ball release (from the machine projection mouth or the bowler's hand) up to the point of ball-bat contact (velocity 26.76 ms^{-1} under both conditions). Data generally showed significant differences in coordination and timing under these different ecological constraints.

Against the bowling machine, batters coupled the backswing to the moment of ball release (0.02 ± 0.10 s), whereas against the bowler, the backswing started later (0.12 ± 0.04 s). Initiation of the front foot movement occurred after ball release by the bowling machine (0.16 ± 0.04 s) and earlier after ball release by the bowler. Initiation of the downswing commenced earlier against the machine than the bowler (0.32 ± 0.04 s compared with 0.41 ± 0.03 s). There was also a different ratio of backswing : downswing when batting against the machine (46% : 54%) compared to the bowler (56% : 44%). Peak bat height differed under the two constraints (bowling machine 1.56 ± 19.89 m; bowler 1.72 ± 10.36 m; see Figure 10.7). Mean length of front foot stride was shorter against the machine (0.55 ± 0.07 m) compared to the bowler (0.59 ± 0.06 m). Correlation between initiation of backswing and front foot movement was much higher against the bowler ($r = .88$) than the machine ($r = .65$).

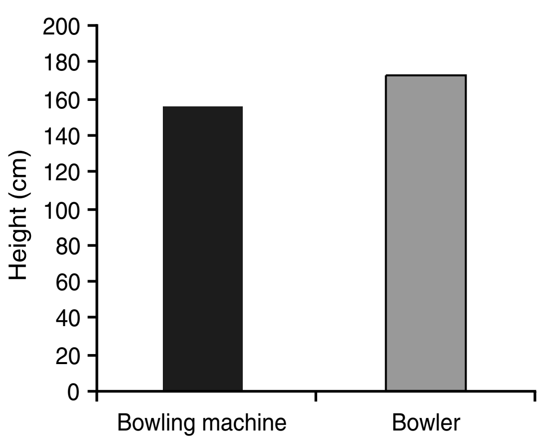


Figure 10.7 Peak height of the batsman's backswing in the bowler and bowling machine conditions.

In summary, results suggested that practice constraints involving projectile machines should be restricted to learners at the coordination stage, or when coordination needs to be restabilized after absence due to illness or injury. Although Bartlett (2003) has proposed that batting against a bowling machine is different, at least up until the release of the ball, from batting against a bowler, the data in this chapter show that batting against the task constraints of a bowling machine is also different *after* ball release.

Locomotor Pointing in the Cricket Bowling Run-Up

Cricket bowling requires the player to run toward a target area (the popping crease) to bowl a ball, placing the back foot before or across the front line of the popping crease to avoid bowling a no-ball. The bowling run-up is an example of locomotor pointing or running to place the foot on a target in space, a movement model that has been used quite extensively to study processes of perception and action in goal-directed gait. How are such actions controlled, and what information sources are used to regulate gait in the run-up phase? De Rugy, Taga, Montagne, Beukers, and Laurent (2002) proposed a prospective control model to explain visually driven adaptations of basic locomotion and locomotor pointing performance. It was argued that, if information on current and required behavior were optically available, then regulation of gait might be continuously based on the perception of the difference between them.

Some behavioral support for the prospective control model of locomotor pointing has been obtained with representative tasks in sports. For example, a study of the long jump run-up by Montagne et al. (2000) found that locomotor pointing was a direct function of the optical flow generated by the performer and that the onset of stride length adjustment was a function of the amount of adjustment required. Evidence has also shown that an important source of constraint in natural locomotor pointing tasks is provided by the nested actions at the end of an approach run. Certain locomotor pointing tasks in sports, such as horizontal jumps and gymnastics vaulting, require the generation of maximum velocity during the run-up to hit the take-off board, whereas others require a more controlled collision with a target area because of the need to complete additional complex actions nested on the end of the approach phase.

Two examples of complex, nested task constraints in locomotor pointing are the javelin throw and cricket bowling, both of which involve a run-up to a target area followed by reorientation of the body into a new projectile delivery position. Under these task constraints, a strategy of initiating visual regulation earlier is an advantage because adjustments can be spread evenly over more strides, causing less disruption to nested actions. Cricket bowling actions are composed of four phases; run-up, bound, delivery stride, and follow through. The run-up enables the bowler to transit into the bound phase while maintaining the velocity generated and positioning the body effectively for a successful "link" to the delivery stride. During the bound phase, the bowler aims to jump forward and high enough to enable him or her to land in the correct position for the delivery stride to release the ball with the desired velocity (i.e., angle and speed). The ideal final front foot placement in the delivery stride is one that cuts the front line, known as the popping crease, enabling the ball to be delivered as close as possible to the batter, reducing his or her potential response time.

An analysis of the run-ups of professional cricketers has revealed support for the continuous perception-action coupling locomotor control model proposed by de Rugy et al. (2002). A combination of interstep and intrastep analyses on the run-ups of cricket bowlers showed that, due to the specific constraints of cricket bowling, the majority of the bowlers made adjustments early in the run-up, before making late adjustments just prior to the bound stride (Renshaw & Davids, 2004; see Figure 10.8). This aspect of the modeling was emphasized by the high number of visually regulated run-ups reported in the study of bowlers compared to the analysis of long jumpers by Montagne et al. (2000). Almost all of the run-ups of the cricket bowlers were regulated at some stage (91 out of 92), and these regulations were spread over the whole length of the run-ups.

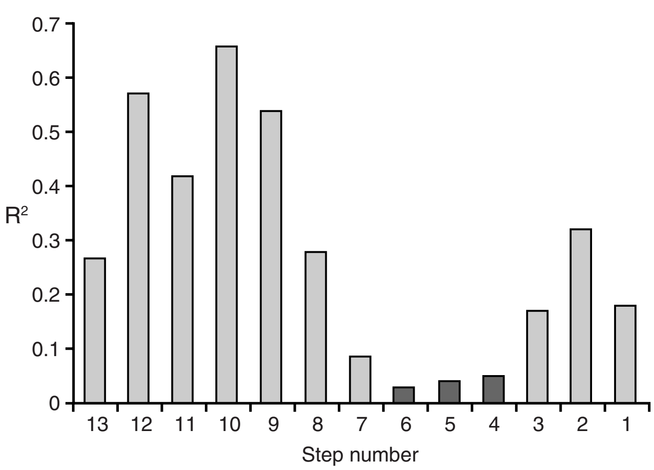


Figure 10.8 Relationships (R^2) between amount of step length adjustment and amount needed for each run-up step among professional cricketers.

An intertrial analysis was used by Montagne et al. (2000) to show that the amount of adjustment produced was a function of the point at which regulation was initiated. A linear relationship between stride number and amount of adjustment putatively showed that perception and action were closely coupled. In the study of cricket bowlers, few correlations were found between stride number and amount of adjustment. However, the inconsistent starting points of the bowlers, and initial high levels of variability, did not prevent them from achieving remarkably low levels of variability at the bound stride, consistent with findings in previous studies of long jumpers. To achieve such functional levels of footfall variability at the critical bound stride, the cricket bowlers were making adjustments based on need at a very early stage of the run-up, a finding in line with a key premise of de Rugy et al.'s model (2002): that regulation is continuous and based on perception of current and required behavior. Data showed that the task constraints of cricket bowling benefited from a greater amount of adaptive visual control during the run-up, compared to the velocity-generation constraint that dominates the athletic jumps. When the intertrial plots were followed with an intratrial analysis, significant relationships were observed between amount of adjustment produced and the amount of adjustment needed at steps throughout the run-up.

The data also demonstrated how nested task constraints shape the nature of control strategies implemented during locomotor pointing tasks. Bowlers were making significant adjustments at steps over 20 m from the popping crease. Speed-accuracy trade-offs required that, to successfully arrive at the bound stride with the feet correctly oriented and with functional run-up velocity, it was essential that bowlers made online adjustments at early stages of their run-ups, at all stages throughout the run-up, as and when they were needed. These findings support the model notion that locomotor pointing control is based on a stable attractor being open to instantaneous intentional or perceptual adaptations through the association of two model parameter values for threshold and gain.

CONCLUSION

The emergence of new theoretical approaches in the field of sport psychology and movement science is resulting in sports and physical pastimes being increasingly used to provide useful movement models for studying how indeterminacy and degeneracy is manifested in brain and behavior. A functionalist philosophy, based on a systemic perspective, emphasizes the constrained optimization that best characterizes how actions emerge from nonlinear movement systems. Such a philosophical perspective clarifies that behaviors or capacities can be studied only under conditions or constraints that facilitate their emergence. Based on Brunswik's (1956) insights, the clear implication for sport psychologists is that studying processes of decision making and action require tasks that are high in representativeness.

In this chapter, we outlined how representative task design is a key feature exemplified in many different movement models from sports and physical pastimes. We highlighted how research studies that use representative designs are better able to reflect the adaptive behaviors seen outside the laboratory context. We also demonstrated that the false distinction related to the issues of ecological validity in laboratory and field-based experiments is redundant due to the greater understanding of task representativeness informed by Brunswik's (1956) insights. We provided a detailed explanation of the metatheoretical concepts that underpin ecological psychology and nonlinear dynamics and the impetus that these approaches have had on research design in sport psychology and the movement sciences. For example, we highlighted the importance of the organism-environment interaction as a relevant scale of analysis for decision making and action. At this level of analysis, the examination of human behavior should occur with tasks that enable the interaction of the individual with appropriate task and environmental constraints.

The theoretical need for representative tasks is related to the increasing predilection for studying movement models from sports and physical activities. As exemplified in this chapter by a range of movement models from the sports of basketball and cricket, we have shown that many phenomena of interest to sport psychologists need to be understood in relation to the interacting constraints of structural and functional neuroanatomical design, specific task goals, and environmental contexts.

Specifically, we provided research examples that show how advances in theorizing from ecological psychology and dynamical systems theory combined in a constraints-led perspective has led to the utilization of complex multijoint task vehicles to provide greater understanding of movement behavior. A constraints-based framework for studying decision making and action provides the theoretical impetus for considering task representative design because it emphasizes:

- The need to adopt a systems perspective in viewing the human being as a degenerative system composed of many interacting subsystems
- The need to understand that a system viewed at another level of analysis is a subsystem of a larger system (e.g., the appropriate scale of analysis for the movement system is at the level of the performer-environment interaction)
- The need to understand the close link between a biological movement system and its environment (particularly the perceptual, movement, and cognitive subsystems and the surrounding energy sources)
- The role of energy arrays acting as perceptual information for constraining, that is, supporting, guiding, and regulating, movement coordination and control
- The study of functional, goal-directed movement activity, such as those performed in the context of sports

This emphasis on how individual constraints interact with task constraints is signaling a fresh perspective on the role of variability in facilitating adaptation to dynamic task environments. Analysis of behavior at the level of the performer-environment system is revealing action modes as examples of natural, emergent phenomena that can be functionally varied to suit the challenge of performing in dynamic contexts. A challenge for psychologists is to consider the benefits of a functionalist philosophy and the implications it has for the representativeness of experimental designs for studying decision making and action in sport.

REFERENCES

Alderson, G. J. K., Sully, D. J., & Sully, H. G. (1974). An operational analysis of one-handed catching task using high speed photography. *Journal of Motor Behavior, 6,* 217–226.

Anderson, D. I., & Sidaway, B. (1994). Coordination changes associated with practice of a soccer kick. *Research Quarterly for Exercise and Sport, 65,* 93–99.

Araújo, D., Davids, K., Bennett, S., Button, C., & Chapman, G. (2004). Emergence of sport skills under constraints. In A. M. Williams & N. J. Hodges (Eds.), *Skill acquisition in sport: Research, theory, and practice* (pp. 409–434). London: Routledge, Taylor & Francis.

Araújo, D., Davids, K., Sainhas, J., & Fernandes, O. (2002). Emergent decision-making in sport: A constraints-led approach. In L. Toussaint & P. Boulinguez (Eds.), *International Congress on "Movement, Attention and Perception"* (p. 77). Poitiers, France: Université de Poitiers.

Araújo, D., Davids, K., & Serpa, S. (2005). An ecological approach to expertise effects in decision-making in sailing. *Psychology of Sport and Exercise, 6,* 671–692.

Bain, B., Hayes, D., & Quance, A. (1978). *Coaching certification manual: Level two.* Quebec, Canada: J. Seaman, Basketball Canada.

Balasubramaniam, R., & Turvey, M. T. (2004). Coordination modes in the multisegmental dynamics of hula hooping. *Biological Cybernetics, 90,* 176–190.

Bartlett, R. M. (2003). The science and medicine of cricket: An overview and update. *Journal of Sports Sciences, 21,* 733–752.

Beek, P. J. (1989). *Juggling dynamics.* Amsterdam: Free University Press.

Beek, P. J., Dessing, J. C., Peper, C. E., & Bullock, D. (2003). Modelling the control of interceptive actions. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 358,* 1511–1523.

Beek, P. J., Jacobs, D. M., Daffertshofer, A., & Huys, R. (2003). Expert performance in sport: Views from the joint perspectives of ecological psychology and dynamical systems theory. In J. L. Starkes & K. A. Ericcson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 321–344). Champaign, IL: Human Kinetics.

Beek, P. J., & van Santvoord, A. A. M. (1992). Learning the cascade juggle: A dynamical systems analysis. *Journal of Motor Behavior, 24,* 85–94.

Bernstein, N. (1967). *The co-ordination and regulations of movements.* Oxford: Pergamon Press.

Bootsma, R. J. (1989). Accuracy of perceptual processes subserving different perception-action systems. *Quarterly Journal of Experimental Psychology, 41A,* 489–500.

Bootsma, R. J., & Oudejans, R. R. D. (1993). Visual information about time-to-collision between two projectiles. *Journal of Experimental Psychology: Human Perception and Performance, 19,* 1041–1052.

Bootsma, R. J., & Peper, L. (1992). Predictive visual information sources for the regulation of action with special emphasis on catching and hitting. In D. Elliott & L. Proteau (Eds.), *Vision and motor control* (pp. 285–314). Amsterdam: North Holland.

Bootsma, R. J., & van Wieringen, P. C. (1990). Timing and attacking forehand drive in table tennis. *Journal of Experimental Psychology: Human Perception, 16,* 21–29.

Brunswik, E. (1956). *Perception and the representative design of psychological experiments* (2nd ed.). Berkeley: University of California Press.

Button, C., McLeod, M., Sanders, R., & Coleman, S. (2003). Examining movement variability in the basketball free-throw action at different skill levels. *Research Quarterly for Exercise and Sport, 74,* 257–269.

Carson, R. G. (2004). Governing coordination: Why do muscles matter? In V. K. Jirsa & J. A. S. Kelso (Eds.), *Coordination dynamics: Issues and trends* (pp. 141–154). New York: Springer-Verlag.

Carson, R. G., & Kelso, J. A. S. (2004). Governing coordination: Behavioral principles and neural correlates. *Experimental Brain Research, 154,* 267–274.

Chen, H. H., Liu, Y.-T., Mayer-Kress, G., & Newell, K. M. (2005). Learning the pedalo locomotion task. *Journal of Motor Behavior, 37,* 247–256.

Cordo, P. J., & Gurfinkel, V. S. (2004). Motor coordination can be fully understood only by studying complex movements. *Progress in Brain Research, 143,* 29–38.

Daffertshofer, A., Huys, R., & Beek, P. J. (2004). Dynamical coupling between locomotion and respiration. *Biological Cybernetics, 90,* 157–164.

Davids, K., Araújo, D., Shuttleworth, R., & Button, C. (2003). Acquiring skill in sport: A constraints-led perspective. *International Journal of Computer Sciences in Sport, 2,* 31–39.

Davids, K., Button, C., Araújo, D., Renshaw, I., & Hristovski, R. (2006). Movement models from sports provide representative task constraints for studying adaptive behavior in human motor systems. *Adaptive Behavior, 14,* 73–95.

Davids, K., Button, C., & Bennett, S. J. (in press). *Acquiring movement skill: A constraints-led approach.* Champaign, IL: Human Kinetics.

Davids, K., Renshaw, I., & Glazier, P. (2005). Movement models from sports reveal fundamental insights into coordination processes. *Exercise and Sport Science Reviews, 33,* 36–42.

Davids, K., Savelsbergh, G., Bennett, S. J., & van der Kamp, J. (Eds.). (2002). *Interceptive actions in sport.* London: Routledge, Taylor & Francis.

Davids, K., Williams, A. M., Button, C., & Court, M. (2001). An integrative modeling approach to the study of intentional movement behavior. In R. N. Singer, H. A. Hausenblas, & C. M. Janelle (Eds.), *Handbook of sport psychology* (2nd ed., pp. 144–173). New York: Wiley.

de Rugy, A., Taga, G., Montagne, G., Beukers, M. J., & Laurent, G. (2002). Perception-action coupling model for human locomotor pointing. *Biological Cybernetics, 87,* 141–150.

Edelman, G. M., & Gally, J. A. (2001). Degeneracy and complexity in biological systems. *Proceedings of the National Academy of Science, 98,* 13763–13768.

Gibson, J. J. (1979). *The ecological approach to visual perception.* Boston: Houghton Mifflin.

Glimcher, P. W. (2005). Indeterminacy of brain and behavior. *Annual Review of Psychology, 56,* 25–56.

Hammond, K., & Stewart, T. (2001). *The essential Brunswik: Beginnings, explications, applications.* New York: Oxford University Press.

Handford, C., Davids, K., Bennett, S. J., & Button, C. (1997). Skill acquisition in sport: Some applications of an evolving practice ecology. *Journal of Sports Sciences, 15,* 621–640.

Harris, L. R., & Jenkin, M. (1998). *Vision and action.* Cambridge, England: Cambridge University Press.

Hastie, R. (2001). Problems for judgment and decision making. *Annual Review of Psychology, 52,* 653–683.

Heft, H. (2001). *Ecological psychology in context: James Gibson, Roger Barker, and the legacy of William James' radical empiricism.* Mahwah, NJ: Erlbaum.

Jacobs, D. M., & Michaels, C. F. (2002). On the paradox of learning and realism. *Ecological Psychology, 14,* 127–140.

Jirsa, V. K., & Kelso, J. A. S. (Eds.). (2004). *Coordination dynamics: Issues and trends.* New York: Springer-Verlag.

Kaiser, M. K., & Mowafy, L. (1993). Optical specification of time-to-passage: Observer's sensitivity to global tau. *Journal of Experimental Psychology: Human Perception and Performance, 19,* 1028–1040.

Kelso, J. A. S., Fink, P. W., Delaplain, C. R., & Carson, R. G. (2001). Haptic information stabilizes and destabilizes coordination dynamics. *Proceedings of the Royal Society of London. Series B, Biological Sciences, 268,* 1207–1213.

Kugler, P. N., & Turvey, M. T. (1987). *Information, natural law and the self-assembly of rhythmical movement.* Hillsdale, NJ: Erlbaum.

Kujala, T., Palva, M., Salonen, O., Alku, P., Huotilainen, M., Järvinen, A., et al. (2005). The role of blind humans' visual cortex in auditory change detection. *Neuroscience Letters, 379,* 127–131.

Latash, M. L. (2000). There is no motor redundancy in human movements: There is motor abundance. *Motor Control, 4,* 259–261.

Lee, D. N., Lishman, J. R., & Thompson, J. A. (1982). Regulation of gait in long jumping. *Journal of Experimental Psychology: Human Perception and Performance, 8,* 448–459.

McLeod, P., & Ross, H. E. (1983). Optic-flow and cognitive factors in time to collision estimates. *Perception, 12,* 417–423.

Montagne, G. (2005). Prospective control in sport. *International Journal of Sport Psychology, 36,* 127–150.

Montagne, G., Cornus, S., Glize, D., Quaine, F., & Laurent, M. (2000). A perception-action coupling type of control in long jumping. *Journal of Motor Behavior, 32,* 37–43.

Montagne, G., Laurent, M., Durey, A., & Bootsma, R. J. (1999). Movement reversals in ball catching. *Experimental Brain Research, 129,* 87–92.

Newell, K. M. (1986). Constraints on the development of coordination. In M. G. Wade & H. T. A. Whiting (Eds.), *Motor development in children: Aspects of coordination and control* (pp. 341–360). Dordrecht, The Netherlands: Martinus Nijhoff.

Newell, K. M. (1989). On task and theory specificity. *Journal of Motor Behavior, 21,* 92–96.

Newell, K. M. (1991). Motor skill acquisition. *Annual Review of Psychology, 42,* 213–237.

Obhi, S. S. (2004). Bimanual coordination: An unbalanced field of research. *Motor Control, 8,* 111–120.

Peper, C. E., Bootsma, R. J., Metre, D. R., & Bakker, F. C. (1994). Catching balls: How to get the hand to the right place at the right time. *Journal of Experimental Psychology: Human Perception and Performance, 20,* 591–612.

Post, A. A., Peper, C. E., & Beek, P. J. (2003). Effects of visual information and task constraints on intersegmental coordination in playground swinging. *Journal of Motor Behavior, 35,* 64–78.

Poulton, E. C. (1957). On prediction in skilled movements. *Psychological Bulletin, 54,* 467–478.

Reed, E. S. (1996). *Encountering the world: Toward an ecological psychology.* Oxford: Oxford University Press.

Regan, D. (1997). Visual factors in hitting and catching. *Journal of Sports Sciences, 15,* 533–558.

Renshaw, I., & Davids, K. (2004). Nested task constraints shape continuous perception-action coupling control during human locomotor pointing. *Neuroscience Letters, 369,* 93–98.

Renshaw, I., & Fairweather, M. M. (2000). Cricket bowling deliveries and the discrimination ability of professional and amateur batters. *Journal of Sports Sciences, 18,* 951–957.

Savelsbergh, G. J. P., & van der Kamp, J. (2000). Information in learning to co-ordinate and control movements: Is there a need for specificity of practice? *International Journal of Sport Psychology, 31,* 467–484.

Schall, J. D. (2001). Neural basis of deciding, choosing and acting. *Nature Neuroscience, 2,* 33–42.

Schall, J. D. (2004). On building a bridge between brain and behavior. *Annual Review of Psychology, 55,* 23–50.

Schiff, W., & Detwiler, M. L. (1979). Information used in judging impending collision. *Perception, 8,* 647–658.

Schiff, W., & Oldak, R. (1990). Accuracy of judging time-to-arrival: Effects of modality, trajectory, and gender. *Journal of Experimental Psychology: Human Perception and Performance, 16,* 303–316.

Schmidt, R. C., Carello, C., & Turvey, M. T. (1990). Phase transitions and critical fluctuations in the visual coordination of rhythmic movements between people. *Journal of Experimental Psychology: Human Perception and Performance, 16,* 227–247.

Schöllhorn, W. (2003). Coordination dynamics and its consequences on sports. *International Journal of Computer Science in Sport, 2,* 40–46.

Shuttleworth, R. (2004, April). *Differential effects of varying attentional-focus through instruction in acquisition of movement* *coordination in rowing.* Paper presented at the 31st Australasian Experimental Psychology Conference, Dunedin, New Zealand.

Staddon, J. E. R., & Hinson, J. M. (1983). Optimization: A result or mechanism? *Science, 221,* 976–977.

Starkes, J., Helsen, W., & Jack, R. (2001). Expert performance in sport and dance. In R. N. Singer, H. A. Hausenblas, & C. M. Janelle (Eds.), *Handbook of sport psychology* (2nd ed., pp. 174–201). New York: Wiley.

Swinnen, S. (2002). Intermanual coordination: From behavioral principles to neural network interactions. *Nature Reviews Neuroscience, 3,* 348–359.

Tayler, M. T. (2002). Bimanual coordination in catching behavior. In K. Davids, G. J. P. Savelsbergh, S. J. Bennett, & J. van der Kamp (Eds.), *Interceptive actions in sport* (pp. 242–258). London: Routledge, Taylor & Francis.

Tayler, M. A., & Davids, K. (1997). Catching with both hands: An evaluation of neural cross-talk and coordinative structure models of bimanual coordination. *Journal of Motor Behavior, 29,* 254–262.

Todd, J. T. (1981). Visual information about moving objects. *Journal of Experimental Psychology: Human Perception, 7,* 795–810.

Tononi, G., Sporns, O., & Edelman, G. M. (1999). Measures of degeneracy and redundancy in biological networks. *Proceedings of the National Academy of Science, 96,* 3257–3262.

Tresilian, J. R. (1994). Approximate information sources and perceptual variables in interceptive timing. *Journal of Experimental Psychology: Human Perception and Performance, 20,* 154–173.

Tresilian, J. R. (1995). Perceptual and cognitive processes in time-to-contact estimation: Analysis of prediction-motion and relative judgment tasks. *Perception and Psychophysics, 57,* 231–245.

Tyldesley, D., & Whiting, H. T. A. (1975). Operational timing. *Journal of Human Movement Studies, 1,* 172–177.

Vicente, K. (2003). Beyond the lens model and direct perception: Toward a broader ecological psychology. *Ecological Psychology, 15,* 241–267.

Vicente, K., & Wang, J. (1998). An ecological theory of expertise effects in memory recall. *Psychological Review, 105,* 33–57.

Walter, C. (1998). An alternative view of dynamical systems concepts in motor control and learning. *Research Quarterly for Exercise and Sport, 69,* 326–333.

Williams, M., Davids, K., & Williams, J. (1999). *Visual perception and action in sport.* London: E. & F.N. Spon.

Zatsiorsky, V. M., & Aktov, A. V. (1990). Biomechanics of highly precise movements: The aiming process in air rifle shooting. *Journal of Biomechanics, 23,* 35–41.

CHAPTER 11

Attentional Processes in Skill Learning and Expert Performance

BRUCE ABERNETHY, JONATHON P. MAXWELL, RICHARD S. W. MASTERS,
JOHN VAN DER KAMP, and ROBIN C. JACKSON

Attention and attentional processes pervade virtually all aspects of perception, cognition, and action—indeed, it is difficult to conceive of any aspect of human skill that is not, in some way, either dependent on or influenced by attention. Equally, it is difficult to conceive of any aspect of psychology that may be more central to the enhancement of skill learning and expert performance than attention (Rogers, Rousseau, & Fisk, 1999). However, despite its ubiquitous nature and its long history of philosophical and experimental scrutiny, attention remains a poorly defined and (mis)understood concept. In large part, this is because attention as a term is used to refer to a variety of different processes, many of which are only quite loosely related (Nougier, Stein, & Bonnel, 1991). Attention is not a unitary construct but a construct composed of a range of different, diverse, and contextually sensitive processes (Parasuraman & Davies, 1984).

In spite of its diversity, it is nevertheless possible to identify some common roles that attention plays in skill learning and expert performance (Posner & Boies, 1971). One critical role of attention is to preferentially select only particular information for detailed processing. This process of *selective attention* is one that permits relevant or essential information to gain access to the nervous system's limited processing resources while at the same time providing a means to effectively gate out irrelevant or potentially distracting or misleading sources of information, the processing of which may impede performance. Effective and efficient operation of selective attentional processes is essential for skilled performance in sports tasks where critical cues may be available only momentarily and sources of distraction abound. Selective attention is frequently examined experimentally using tasks in which focusing of attention ("concentration") to information from a specified modality, spatial location, or context is required in the face of competition from other items and sources of distraction. In natural tasks, the selective attention of experts is frequently examined using approaches such as cue occlusion and eye movement recording (e.g., see Abernethy, Wann, & Parks, 1998, for a review) and interpretation is heavily influenced by Gibsonian notions of the education of attention and attunement (e.g., see Beek, Jacobs, Daffertshofer, & Huys, 2003; Gibson, 1991).

A second role of attention relates to *alertness* and individual differences in the capacity to develop and maintain optimal sensitivity and readiness to respond to particular stimuli when they appear. Sustained attention, which refers to the capability of an individual to efficiently and effectively process incoming information over an extended period of time, is frequently measured using vigilance tasks and has been found to be influenced strongly by factors such as fatigue, anxiety, and motivation. In sports tasks optimal attention may need to be sustained for only a matter of seconds (in the case of a sprinter awaiting the starter's gun) or for a matter of hours (in the case of road cyclists or cricket fieldsmen awaiting their opportunity to make a definitive move or play). Regardless of the time frame, the quality of the attentional processes involved can have a direct impact on performance levels and outcomes.

A third major role attention plays in human performance relates to the management and allocation of *limited information-processing resources*. Understanding this role involves consideration of the attentional requirements of different tasks, individual- and expertise-related differences in the capacity to divide and switch attention between concurrent tasks, and, of particular importance, the capability, with practice, to "automatize" at least some task components such that they come to require little or no conscious attention to control. The progressive automatization of skills as they become better learned is an issue of potentially great importance to people involved with skill development in sport and other performance domains and, in itself, warrants more detailed examination.

Attention, in all its different roles, is crucial to human performance, and some of the evidence related to each role and some of the consequential implications for sports performance have been reviewed in detail in previous editions of the *Handbook* (Abernethy, 1993, 2001). A further comprehensive review of the evidence relating attention to sports performance is beyond the scope of the current chapter. Rather, in this chapter, we focus exclusively on attention as a limited processing resource and address in detail issues related to controlled and automatic aspects of skill learning and expert performance. Our treatment of this topic involves, inter alia, consideration of the implicit learning of movement skills, the neural pathways through which such learning might be achieved, and some directions for new approaches to the practice and learning of perceptual-motor skills grounded in the emerging evidence.

The chapter is organized into three major sections. In the first section we briefly review some of the key historical developments in attentional research to provide a background in which to position both established and newer theoretical perspectives on the construct of attention. The second, and largest, section of the chapter focuses on the role of automaticity in skill learning and expert performance. In this section, we introduce key distinctions between controlled and automatic modes of processing, implicit and explicit learning, and ventral and dorsal pathways that process visual information used in the perception and control of action, plus overview the major approaches that have been used for the measurement of attentional requirements. Evidence emerging from (cross-sectional) expert-novice comparisons of attentional requirements and from (longitudinal) learning studies of attention is reviewed and used to propose, and speculate on, some alternatives to existing forms of practice and instruction that may help accelerate the rate of skill learning and the acquisition of expertise beyond existing levels. The final section of the chapter provides a synthesis and some comments on future research directions and priorities.

A BRIEF HISTORY OF ATTENTIONAL RESEARCH

The study of attention has a distinguished history in psychology, with an interest in the concept being at least as old as the field of experimental psychology itself (see Boring, 1970, for a review). Some, now classical experimental examinations of divided attention (Binet, 1890; Bliss, 1892–1893; Welch, 1898) and of practice and skill learning (e.g., Bryan & Harter, 1899; Solomons & Stein, 1896) were undertaken in the late nineteenth century and early twentieth century. These complemented writings on attention from an introspective perspective undertaken around the same time by phenomenologists and psychophysicists such as Hamilton (1859), James (1890), and Titchener (1908). By 1928, there was sufficient literature on attention to support a review paper on the topic in the *Psychological Bulletin* (Dallenbach, 1928). Interest in attention waned, however, throughout the first half of the twentieth century, when behaviorism dominated thinking and theorizing in psychology but became reinvigorated post-WWII with the advent of information-processing theory (e.g., Wiener, 1948) and the rise of cognitive psychology.

A major stimulus for theory development in selective attention in particular came from the dichotic listening paradigm studies of Cherry (1953). In this paradigm, people were presented with separate messages to the left and right ears and were required to verbally repeat (or *shadow*) the message presented to one of the ears. The shadowing task was assumed to cause attention to be allocated preferentially to the message that was to be repeated, and the interest was in determining to what extent selective attention to only the shadowed message was complete. Measurement was made of how much and what features of the message presented to the other ear could be reported. The dichotic listening studies consistently indicated that people processed very little of the information from the unshadowed message, apparently being able to selectively process only that information that was relevant to the task at hand. Nevertheless, some particular physical characteristics of the unshadowed message (such as a change from a male to a female voice) were regularly detected, suggesting preferential (arguably automatic) processing of this kind of information.

Attempts to explain the selective listening data gave rise to a series of models of attention that all proposed bottlenecks at one or more stages of information processing (see Figure 11.1). Broadbent (1958) proposed a filter model of attention, with the processing bottleneck located early in the processing sequence and based on the physical properties of the different stimuli. Deutsch and Deutsch (1963) argued for much later selection, with all stimuli first given extensive feature processing. Treisman (1969) argued for an attenuation model of attention that proposed a series of tests (the first based on physical properties of the stimuli,

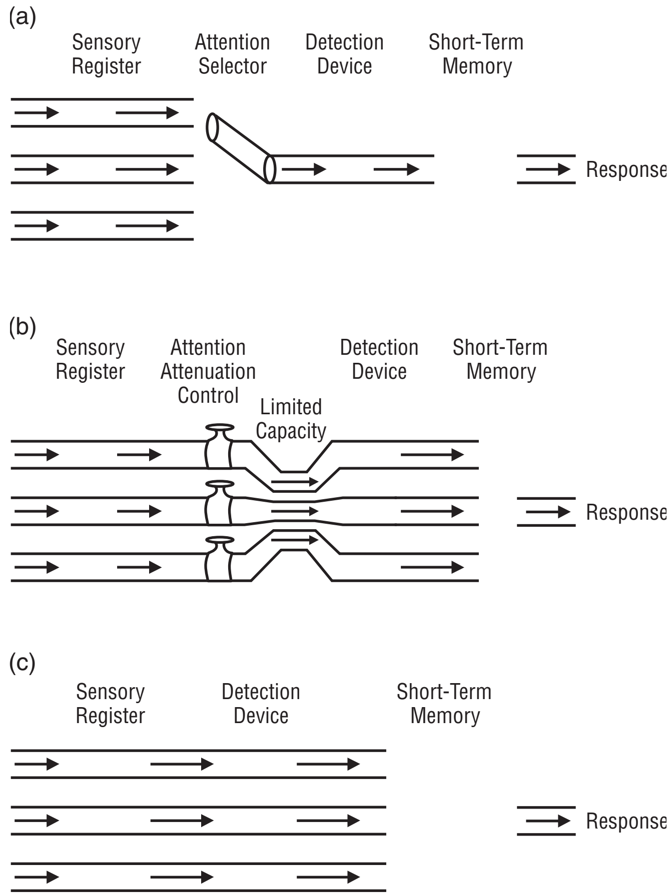


Figure 11.1 Comparative structure of (a) early filter models, (b) attenuation models, and (c) late selection models of selective attention. *Source:* "On the Degree of Attention and Capacity Limitations in Tactile Processing," by R. M. Shiffrin, J. C. Craig, and E. Cohen, 1973, *Perception and Psychophysics, 13,* p. 329. Copyright 1973 by the Psychonomics Society, Inc. Reprinted with permission.

the second based on collective stimulus patterns, and the third based on semantics), with irrelevant information being progressively attenuated at each of these levels of analysis. The attenuation model differed fundamentally from the filter models in that it proposed that (a) selection is based on elements additional to the simple physical properties of the incoming stimuli, and (b) the analyses guiding selection of stimuli for further processing occur in an essentially continuous rather than discrete fashion.

Inconsistent experimental data on the putative location of the information-processing bottleneck led Moray (1967) and Kahneman (1973) to suggest that cognitive (and attentional) processes were far more flexible than acknowledged by models that proposed structural bottlenecks and processing channels of limited capacity (e.g., see Welford's 1967 single-channel theory). Kahneman proposed that attention should be more appropriately viewed as a commodity that, while having finite overall limitations, can be flexibly allocated between concurrent tasks in a manner that the individual chooses and that best matches the situational requirements. Flexible allocation of a limited resource provides a reasonable explanation of why different bottlenecks emerge for different individuals and for different task combinations but was ultimately unable to explain the observations of inconsistent interference that appear when different secondary tasks are coupled with the same primary task. If attention really exists in the form of a large, undifferentiated general capacity, then different secondary tasks performed in conjunction with a common primary task should reveal consistent conclusions regarding the attention demand of the primary task; however, such does not appear to be the case (e.g., Wakelin, 1967).

The difficulties associated with viewing attention as a general-purpose, limited-capacity, central processor were clearly articulated by Navon and Gopher (1979) and Allport (1980a), and a major theoretical reformulation was set in place in the early 1980s. Attention is now most frequently conceived as a series of resource pools (Gopher & Sanders, 1984; Wickens, 1992) or multiprocessors (Allport, 1980b), each with their own unique capacities and resource-performance relationships. Within such a conceptualization, attentional capacity is seen not to be centralized but *distributed* throughout the nervous system. The major challenge presented by such a view of attention is therefore not to measure the limits of central processing capacity but to isolate the specific, special-purpose modular subsystems that collectively compose the attentional resource pool.

Over the past 2 decades development of theories of attention have also been progressively influenced by both computational modeling, driven by the rise of cognitive science and the increasing fusion of the methods of psychology with those of computer science, and by evidence arising from neurophysiological sources, especially neuroimaging. Computational models, including models of parallel distributed systems (or connectionist models; Rumelhart & McClelland, 1986), have proven useful in helping to further identify the source of bottlenecks for the control and production of movement (e.g., see Meyer & Kieras, 1997), and neurophysiological evidence from studies of brain imaging has helped to identify the role of different brain regions in different aspects of attentional processing (e.g., Fan, McCandliss, Fossella, Flombaum, & Posner, 2005; Fan & Posner, 2004; Posner, 2003). It is the convergent evidence from traditional experimental studies in conjunction with the evidence available from these newer techniques that has made possible new insights into how attention is allocated to different tasks and how attentional processes may become modified with skill learning and the acquisition of expertise.

AUTOMATIC PROCESSES IN SKILL LEARNING AND EXPERT PERFORMANCE

In this section, we examine the key concepts, investigative methods, findings, and theorizing pertaining to the issue of automatic and associated processing in skill learning and expert performance, drawing on evidence from an array of sources.

Controlled and Automatic Processing

Experience, observation, and conventional wisdom inform us that skill execution can sometimes require great effort and concentration, but at other times seems almost effortless. These observations essentially reflect the distinctions made, respectively, between controlled and automatic processing (Schneider & Shiffrin, 1977). Controlled processing reflects *conscious* efforts to appraise incoming information and select a suitable response. Under controlled processing, information is processed more or less serially; as a consequence, processing of this type tends to be slow, particularly when environmental cues and possible responses are numerous (Ackerman, 1988). Controlled processing is mediated by the actions of working memory, a modular cognitive construct that is thought to be at the heart of conscious attentional processes (Baddeley, 1999). In contrast, automatic processing takes place *unconsciously* and is associated with fluent movement production (Salmoni, 1989), apparent effortlessness, resistance to disruption (e.g., Abrams & Reber, 1988; Maxwell, Masters, & Eves, 2003), reduced physiological cost (Vereijken, van Emmerik, Whiting, & Newell, 1992), and less reliance on attentional resources (Curran & Keele, 1993; Schneider, Dumais, & Shiffrin, 1985), particularly those of working memory (Schmidt & Wrisberg, 2004).

Most, if not all, sport skills are performed with contributions from both controlled and automatic processes, rather than one process exclusively. As we shall see, the respective contributions depend both on skill level or stage of learning and on the nature and constraints of the task (see Anson, Elliot, & Davids, 2005; Bernstein, 1996). Assuming that controlled processing, but not automatic processing, relies heavily on the availability of a limited-capacity attentional resource (i.e., working memory), it follows that skilled performance depends on either efficient allocation of conscious attentional resources or automatization of certain subcomponents of the skill to free conscious resources. The applied benefit of understanding these processes is clear when considering the multiple attentional demands placed on athletes from many sports. Dribbling in basketball, for instance, requires the dribbler to maintain control of a moving ball while simultaneously running at speed, dissociating friend from foe, and evaluating possible attacking options.

Measuring Attentional Requirements

Assessment of the attentional demands of specific tasks requires the implementation of measures that fulfill several criteria. Specifically, measures must be sensitive to fluctuations in the availability of attentional resources, selective in terms of placing demands only on the structures of interest, unobtrusive in the sense of not interfering with the task of interest, diagnostic in the sense of being able to identify resources that are being taxed, and reliable (Sheriden & Stassen, 1979). The available behavioral, cognitive, and physiological measures of attentional demand vary in the extent to which they satisfy each of these, occasionally competing, criteria (Wickens, 1979).

Several techniques have been adopted in an attempt to measure the attentional demands involved in the performance of different tasks (Ogden, Levine, & Eisner, 1979; Wickens, 1992). These techniques predominantly measure controlled processing, from which automatic processing is inferred but not measured directly. The most common method of measuring attentional demand has been the dual-task paradigm. This paradigm involves performance of two tasks simultaneously, the primary task of interest and a secondary task that is hypothesized to selectively load conscious attentional resources. For example, a golfer may be asked to perform a putt (the primary task) and at the same time generate letters randomly from the alphabet (cf. Masters, 1992). The generation of random letters is mediated by working memory (Baddeley, 1966). Attentional capacity is limited; therefore, the ability of the golfer to perform both tasks simultaneously depends on their relative attentional demands. Should the putting action require conscious control, performance may deteriorate when competition for resources is provided by the secondary task; conversely, if putting is automatic, sufficient resources should be available to perform the secondary task without performance deterioration.

An enormous range of tasks are available both to measure human performance and select as potential secondary tasks. (For comprehensive reviews of human performance measures, see Gawron, 2000; Lysaght et al., 1989.) Random letter generation is an example of a continuous secondary task; other examples include monitoring audible tones, pursuit tracking, mental arithmetic, and shadowing speech. Continuous tasks have the advantage of placing demands on attentional resources throughout the execution of the primary task, and their difficulty can be systematically manipulated to provide an index of attentional load. However, continuous tasks are limited in their capacity to identify attentional fluctuations during specific phases of the primary task. For this reason, discrete secondary tasks have been adopted when the precise timing of attentional demands is of interest. Perhaps the most commonly utilized discrete dual task is probe reaction time (PRT), which involves measuring reaction time to a specific stimulus, usually an auditory tone (Lysaght et al., 1989). Quicker responses are thought to represent greater availability of attentional resources for allocation to the primary task (Abernethy, 1988).

The PRT paradigm has been used to identify attentional changes during learning (Wrisberg & Shea, 1978), differences between individuals (e.g., Wulf, McNevin, & Shea, 2001), and changing attentional demands throughout the duration of a movement (McLeod, 1980). Probes are ideally presented in such a way that their onset cannot be predicted. This can be accomplished by randomizing interstimulus intervals when the primary task is continuous (e.g., Wulf, McNevin, et al., 2001) or inserting catch trials (trials without probes) when the primary task is discrete (e.g., Salmoni, Sullivan, & Starkes, 1976). When attentional changes during the course of a single trial of the primary task are of interest, PRT can be plotted against time to provide an image of the primary task's attentional landscape (Posner & Keele, 1969). Attentional peaks and valleys (representing greater controlled and automatic processing, respectively) can be estimated by plotting PRT at stimulus onset (i.e., when the probe is presented) or when a response to the probe is completed, with the latter technique being commonly regarded as more conservative but nevertheless more accurate (Girouard, Laurencelle, & Proteau, 1984; McLeod, 1980).

Interactions between controlled and automatic processing are often difficult to interpret because they depend on the particular theoretical framework within which they are evaluated, and the degree of primary and secondary task integration cannot be easily predicted (Heuer & Wing, 1984). For these reasons, and those discussed previously, other measures of attentional capacity and load have been developed, although, to date, they have been little used in sport research. Subjective measures, such as the NASA Task Load Index (TLX; Hart & Staveland, 1987) and Pilot Objective/Subjective Workload Assessment Technique (Reid & Nygren, 1988), have been developed to assess attentional workload in ergonomic settings. The TLX assesses workload using self-report ratings of mental, physical, and temporal demand integrated with measures of performance, effort, and frustration. Subjective techniques have not been widely adopted by sport psychologists because there is doubt concerning concordance between the performer's verbal reports and the actual demand placed on processing resources, as well as problems with construct, concurrent, and predictive validity (Nygren, 1991).

Physiological indicators of attention have become increasingly popular because they have the advantage of being continuous and, in some cases, relatively unobtrusive. Pupil diameter, cardiac acceleration/deceleration, heart rate variability, and electroencephalographic (EEG) event-related potentials have been used with varying success to indirectly assess attentional resources (e.g., Janelle, Duley, & Coombes, 2004). Dilation of the pupils in response to the imposition of cognitively demanding tasks has been recorded (Beatty, 1982) but may have limited use in sport because dilations are also related to arousal increases and changes may not reflect the nature of the underlying resource conflict.

Although absolute heart rate (HR) does not appear to be a reliable indicator of attentional workload across a range of tasks (Wierwille & Connor, 1983), other cardiac indices may provide useful information. Jennings, Lawrence, and Kasper (1978) have argued that cardiac acceleration/deceleration (as assessed from relative changes in interbeat interval) may be systematically related to available processing capacity. Jennings et al. have demonstrated that although absolute HR is affected more by the overall response requirements of the task (a reaction time task, in their case), the relative acceleration/deceleration patterns in HR relate closely to PRT measures. Heart rate deceleration appears to accompany, and index, the presence of spare attentional capacity, whereas HR acceleration is more prevalent in conditions of processing overload. This approach is used occasionally in the sport context (e.g., Crews, 1989), although clearly this, like other potential cardiac measures of attention, can be of use only in those activities where the performer remains essentially stationary.

An increasingly popular measure of mental workload in the ergonomics literature is HR variability. Across a range of different methods of calculating variability, including spectral (e.g., Meshkati, 1988) and nonlinear (Sammer, 1998) analyses, HR variability appears to decrease with increasing attentional demands of tasks (Vicente, Thornton, & Moray, 1987), making it one of the more promising physiological indicators of attentional workload or effort. However, as with pupil diameter measures, HR variability appears to reflect more the total demand on all available processing resources than the specific competition between processing resources (Wickens & Derrick, 1981), and therefore may have limitations as a diagnostic device (Wickens, 1992). Heart rate variability has received little or no usage in assessing the attentional demands of different sport tasks, undoubtedly because the cardiac changes associated with any form of physical activity may confound and swamp the relatively small effects due to cognitive processing. However, the measure may be useful in sports in which the maintenance of body stability during preparation is important to performance. Nevertheless, all peripheral physiological measures of nervous system activity (such as HR variability and pupillometry) are necessarily limited in their utility in measuring attention to the extent that they are frequently (a) too slow or late, (b) too remote from the processes that are of primary interest, (c) too nonspecific, and (d) too closely influenced by activity and emotion (Näätänen, 1992).

Electroencephalography provides a measure of postsynaptic potentials in the cerebral cortex (Davidson, Jackson, & Larson, 2000; Janelle et al., 2004). The EEG signal contains frequency and amplitude components that may provide specific information about the underlying mental processes. Raw EEG signals are decomposed into sinusoidal waves of differing frequency (e.g., alpha, beta, and theta) using Fourier transformation (Smith, 1997), with each of these frequencies being associated with activities having different attentional requirement. Alpha activity is associated with low mental activity, whereas beta and theta activity increases with attentional demand (Janelle et al., 2004). Examining frequency characteristics provides a general measure of attentional workload, but the precise timing of attentional peaks cannot be identified. For this reason, event-related potentials (ERPs)—specific activation peaks relative to a specific event, such as movement initiation—are often examined to provide a temporal representation of attentional resource allocation.

The typical ERP is composed of exogenous and endogenous components representing generic and task-specific information processing, respectively. Endogenous components have been the focus of research concerning task-related attention, with a number of components appearing to reflect changes in attentional capacity and resource allocation (for a detailed discussion, see Hatfield & Hillman, 2001). Components are named according to the time of their appearance after an event and their polarity (positive or negative). One of the more important components in the context of attentional research appears to be the P300 component (Snyder, Hillyard, & Galambos, 1980). The P300 latency appears to be sensitive to the memory load imposed by the primary task (Kramer & Strayer, 1988), although reported correlations between P300 latency and reaction time vary considerably in their strength (Donchin, 1984; Donchin, Ritter, & McCallum, 1978). More important, the amplitude of the P300 appears to decrease as secondary task difficulty increases, suggesting that it is sensitive to attentional resource demands (e.g., Kramer, Wickens, & Donchin, 1983).

Although EEG measures have several limitations for the study of attention in sport, such as the requirement of minimal movement, poor concordance with other measures of attention, expense, and poor portability, they have nevertheless been successfully utilized in several sports, especially aiming sports such as rifle shooting (Hatfield, Landers, & Ray, 1984; Janelle et al., 2000; Rossi & Zani, 1991) and archery (Landers et al., 1994), baseball (Radlo, Janelle, Barba, & Frehlich, 2001), and self-paced skills such as golf putting (Crews & Landers, 1993). Integration of measurement techniques seems a logical strategy for assessing attentional workload at multiple levels (Abernethy, Summers, & Ford, 1998; Wilson & O'Donnell, 1988), consistent with the trend toward multilevel measurement and theorizing in other aspects of psychology and the behavioral sciences (e.g., Cacioppo & Berntson, 1992; McLeod & Driver, 1993).

Expertise and Attentional Resource Allocation

Cognitive approaches to skill acquisition are characterized by assorted variations of traditional stage theories of information processing of the type developed by Fitts and Posner (1967) and Anderson (1983, 1993, 1995). Such approaches are generally based on the distinction between processing of declarative and procedural knowledge; the application of declarative knowledge involves controlled processing, whereas procedural knowledge is processed automatically. In the sports context, declarative knowledge refers to verbalizable rules, techniques, or methods that are applied by controlled processes to achieve optimal performance. Procedural knowledge drives action and is typified by the idea of motor programs or schemas (e.g., Keele, 1968; Schmidt, 1975, 1982). According to stage theories, declarative rules are gradually transformed, through practice, into procedural knowledge that automatically guides performance without recourse to conscious attentional resources.

These theories predict that expert motor performance should place fewer demands on attentional resources than novice motor performance, and there is now ample evidence to suggest that this prediction is generally true. Leavitt (1979), for example, demonstrated that skating speed is considerably reduced when novice ice hockey players are required to complete concurrent secondary tasks (e.g., dribbling a puck), but is not reduced in experts. Beilock, Wierenga, and Carr (2002) reported that expert golfers were able to accurately perform an auditory word-search task without compromising putting performance, whereas novices were unable to maintain putting accuracy under such conditions. Beilock et al. also observed that the novices were more aware of their movements (assessed by self-report), suggesting more involvement of conscious control in the formative stages of learning.

The extent to which experts are robust to the effects of secondary task loading depends on the characteristics of the primary and secondary tasks, the overall availability of resources (capacity), and the degree to which the concurrent tasks can be integrated or structured (Heuer & Wing, 1984). Thus, interference from secondary tasks can be a result of capacity limitations (exceeding total available resources) or structural interference arising from concurrent demands on common processes (Kahneman, 1973). For example, working memory is conceived as a central executive supported by a phonological loop, visual-spatial sketchpad, and episodic buffer (Baddeley, 1986, 1996, 2000; Baddeley, Chincotta, & Adlam, 2001; Logie, 1995). The central executive governs and coordinates the functioning of the three slave systems. Capacity limitations are well researched in the motor domain (e.g., Maxwell, Masters, & Eves, 2000), but evidence for structural interference is limited. MacMahon and Masters (2002) provided some evidence of structural interference using a golf putting motor task and several secondary tasks that loaded differentially on the multiple components of working memory. Golf putting normally loads the central executive, episodic buffer, and visual-spatial sketchpad, but minimally loads the phonological loop. When participants were required to perform a phonological loop task (in this case, articulatory suppression, the repeated, continuous utterance of a single word), no interference of the primary task was observed; however, a secondary task requiring the central executive (random number generation) significantly reduced putting performance. MacMahon and Masters suggested that structural interference in the central executive was responsible for performance breakdown, although a capacity argument cannot be completely discounted.

The degree of interference from secondary tasks may also be affected by the particular focus of attention adopted by the performer. There is good evidence to suggest that adopting an external focus of attention (i.e., a focus on environmental information and the predicted outcome of a skilled action) promotes automatic control of body movement, whereas focusing internally or on skill execution promotes the use of controlled processing (e.g., McNevin, Shea, & Wulf, 2003; Poolton, Maxwell, Masters, & Raab, 2006; Shea & Wulf, 1999; Wulf, Höß, & Prinz, 1998; Wulf & Prinz, 2001). Gray (2004) showed that expert baseball batters were robust under secondary task loading that focused attention externally, but performed relatively poorly when the secondary task focused attention internally on skill execution. Novices, however, demonstrated the opposite pattern of results, exhibiting robust performance when focusing on skill execution.

Although experts have been consistently shown to employ automatic processing to a greater degree than novices, this does not imply that expert performance is completely automatic. Expert performance can be disrupted with a suitably taxing secondary load, and conscious control can act to inhibit automatic responses (Beek, 2000), possibly helping the performer adapt to novel situations (Schneider et al., 1985). The expert performer may also choose to impose conscious control over normally automatic actions when faced with certain demands (Masters, 2000; Masters & Maxwell, 2004). Masters, Polman, and Hammond (1993), for example, argue that performers may attempt to consciously control their actions when under pressure to perform optimally, despite the common recognition that "reinvesting" their attention in this manner may be an inappropriate strategy (Baumeister, 1984; Baumeister & Showers, 1986; Beilock & Gray, Chapter 19).

Attention and Learning: Implicit versus Explicit Motor Learning

The findings discussed thus far highlight the often complex interactions among task complexity, level of performance, strategic decisions, and cognitive architecture, each of which are further complicated by consideration of the sensory modality (visual, kinesthetic, or auditory), encoding strategy (verbal or spatial), stage of processing (perception, response selection, and responding), and response modality (manual or verbal) involved in execution of particular skills (Wickens, 1992). Recently, it has become apparent that the learning environment also has a profound impact on how skill execution is controlled. Based on the idea of progression from controlled to automatic processing over the course of learning, it would seem logical to restrict the amount of information that a novice must process so that attentional resources are not overloaded, and to direct the attention of learners to the intricacies of skill execution (e.g., Beilock et al., 2002; Gray, 2004); however, research to date does not comprehensively endorse this view.

An early study by Eysenck and Thompson (1966) that manipulated attentional resources during learning involved performance of a pursuit rotor task under varying degrees of distraction. Participants learned the pursuit rotor task under nondistracting conditions or under conditions of easy, medium, or difficult distraction. The distracting task required a foot pedal response to a high- or low-pitched tone. Difficulty of distraction was manipulated by varying the rate of tone presentation. Eysenck and Thompson discovered that performance deteriorated relative to the difficulty of the secondary task, but that learning, as measured by a retention test under nondistracted conditions, was surprisingly unaffected. They also found that performance of the distracter task during the rest interval between learning and retention did not affect consolidation processes. A similar study (McLeod, 1977) reported that level of difficulty of a secondary, mental arithmetic task did not differentially affect manual tracking performance, suggesting that the arithmetic and tracking tasks are supported by different, independent cognitive mechanisms.

In a related study, Pew (1974) had participants perform a pursuit-tracking task for 14 days, completing 24 trials per day. The task required participants to use a joystick to track a waveform presented on an oscilloscope. The waveform consisted of three sections of which the middle section was invariant and the first and last sections were randomly generated, and consequently variable, on each trial. Pew found that performance improved on the repeated section with practice; however, when questioned, participants were unaware of the presence of the repeating section. This effect has been replicated several times and appears to be independent of presentation order, variability of practice, and response modality (Hill & Raab, 2005; Magill & Hall, 1989; Magill, Schoenfelder-Zohdi, & Hall, 1990; Shea, Wulf, Whitacre, & Park, 2001; Wulf & Schmidt, 1997). Green and Flowers (1991) used a computerized catching task to identify differences in performance brought about by providing or withholding task instructions. Participants utilized a joystick to manipulate a cursor on a computer screen with which they attempted to catch a descending single-pixel ball. A "glitch" in the descent of the ball predicted a 75% probability of a fade (or sharp break) to the right in the final 300 ms of the ball's descent. Interestingly, participants who were not informed of this relationship performed the task in a qualitatively different manner to and more accurately than those who were informed of the relationship. Green and Flowers proposed that the uninformed participants had learned the glitch-fade relationship implicitly.

Implicit learning has been conceptualized by Reber (1989, p. 220) as the "process by which knowledge about the rule governed complexities of the stimulus environment is acquired independently of conscious attempts to do so." In other words, learning takes place automatically with minimal input from controlled processing. Explicit learning, on the other hand, relies heavily on controlled processing. The implication from the studies of Pew (1974) and others is that manual skills can be learned automatically, without input from controlled processing. This observation and the concept of implicit learning clearly present a serious problem for the wholesale application of stage theories of learning to the motor domain.

It is possible that the implicit learning effect found in tracking studies may be due to the primary (tracking) task being relatively simple, and therefore perhaps not requiring extensive contributions from controlled processing (Glover, 2004), although this seems increasingly unlikely. A growing body of literature now provides evidence of implicit motor learning of tasks that are more complex than pursuit tracking. In an early study, Masters (1992) required learners to perform a random letter generation (Baddeley, 1966), while concurrently performing the more complex task of golf putting. The random letter generation task was hypothesized to fully occupy controlled processes (i.e., those processes involving working memory) such that any contemporaneous learning of the primary task would be a function of implicit, automatic processes. The putting performance of the implicit group improved over trials, demonstrating that learning had indeed occurred. Furthermore, the participants failed to accrue explicit, declarative knowledge of the putting skill, providing initial evidence that the skill had been acquired implicitly. Masters, and later Hardy, Mullen, and Jones (1996), also demonstrated that the performance of the implicit learners improved under evaluation-induced psychological stress, whereas the performance of the explicit learners degraded, mirroring characteristics known to be true of implicit learning in the cognitive domain (e.g., Reber, 1993).

Promotion of implicit processing during the learning of complex motor skills has since been investigated using a variety of techniques, including error reduction, heuristic instruction, and feedback manipulations (e.g., Liao & Masters, 2001; Masters, Maxwell, & Eves, 2001; Maxwell et al., 2000, 2003; Maxwell, Masters, Kerr, & Weedon, 2001). Collectively, the findings from such studies suggest that learning need not progress from predominantly controlled processing to chiefly automatic processing, as stage theories suggest, but that learning involves a complex interplay of contributions from both. Several authors (e.g., Gentile, 1998; Masters & Maxwell, 2004; Sun, Slusarz, & Terry, 2005; Willingham & Goedert-Eschmann, 1999) have proposed adapted theories of skill acquisition, based on the concepts of implicit and explicit learning, to accommodate this principle. In the motor domain, Masters and Maxwell have argued that procedural knowledge can be acquired and applied automatically, independent of working memory resources (Maxwell et al., 2003), whereas the accrual and controlled application of declarative knowledge requires the availability of working memory. The acquisition of both types of knowledge may involve dedicated neural architectures and can occur in parallel, with the potential for either to dominate movement control.

The Ventral-Dorsal Processing Pathway Distinction

The notion of implicit and explicit modes of skill learning has much in common with emerging neuropsychological perspectives on human visuomotor control. Neuroanatomically, the human visual system contains two broad pathways emanating from the primary visual cortex: a ventral pathway that projects to the inferotemporal cortex and a dorsal pathway that projects to the posterior parietal cortex (Ungerleider & Mishkin, 1982). Although not without its critics (e.g., Glover, 2004), a widely accepted interpretation of the functional distinction between these two pathways is that the ventral pathway subserves the pick-up of information for the perception of objects, events, and places, whereas the dorsal pathway provides information for the control of action (Milner & Goodale, 1995).

The two visual functions have been differentiated on the basis of the spatial and temporal scale at which they operate. Identification and recognition of objects demands enduring information that is independent of an observer's momentary viewpoint. Hence, the ventral pathway chiefly relies on *allocentric* (or world-centered) information that specifies the location, motion, and size of an object in relation to other objects. To the extent that the visual perception of objects is exploited for communication (i.e., telling or being told about the environment), ventral pathway activity is associated with explicit awareness. By contrast, the control of action requires metrically precise information about the location, motion, orientation, and size of objects relative to the actor. The dorsal pathway's primary dedication, therefore, is to the detection of *egocentric* (or body-centered) sources of information. Further, because movement control requires information to be available almost immediately (information that is more than a fraction of a second old is of little use), the dorsal pathway's operations are necessarily fast, although the information it detects may be quickly lost.* On this basis, Milner and Goodale (1995) argued that, by and large, the control of action is automatic and implicit; people need not be consciously aware of how they move.

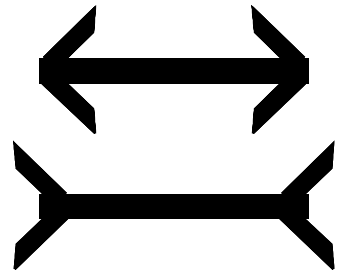


Figure 11.2 The Müller-Lyer illusion. Even though one sees the shaft of the bottom configuration to be larger than the one in the top figuration, the maximal hand apertures when grasping the shaft do not differ, or only marginally so.

An important part of the behavioral evidence underpinning the differences between the ventral and dorsal pathways has come from investigations of illusory effects on visual perception and the control of action in healthy participants (Milner & Goodale, 1995). For example, in the Müller-Lyer illusion (Figure 11.2) the perceived shaft length depends on the direction of the tails. Grip scaling when picking up the shaft, however, remains (almost) unaffected by the illusion (Otto-de Haart, Carey, & Milne, 1999). This dissociation between visual perception and action control is usually attributed to the differential reliance of the two streams on allocentric and egocentric sources of information. Because the dorsal pathway is dedicated to detecting egocentric information, the illusion does not bias grasping. Additionally, as the dorsal pathway operates within a short temporal frame, it is assumed that under circumstances where action cannot be performed under direct visual control, such as when moving without vision of the target or when pantomiming movements, the ventral pathway must participate in the control of action (Milner & Goodale, 1995). This is exactly what is found. Imposing a delay between viewing the shaft and initiating the grasping action results in bias of the grip aperture consistent with the perceptual effects of the Müller-Lyer illusion (Heath, Rival, & Neely, 2006). Engagement of the

*Related dichotomies exist. For example, Lewis and Miall (2003) distinguished between separate neural systems for time measurement: an automatic system that is linked to movement for subsecond durations and a cognitively controlled system that draws heavily on working memory and attention processes for the measurement of suprasecond intervals.

ventral pathway in movement control thus leads to an increased reliance on allocentric information.

Particularly important in the context of the current discussion of attentional processes, the ventral/dorsal dichotomy seems to have many features in common with the explicit and implicit (motor) learning distinction outlined in the previous section. In particular, both distinctions are associated with different degrees of conscious awareness and involvement of (working) memory. This has led some (e.g., van der Kamp, Savelsbergh, & Oudejans, 2003) to hypothesize that implicit learning may chiefly involve engagement of the dorsal visual pathway, whereas explicit learning may also engage the ventral visual pathway, especially early in skill learning. There is some experimental evidence to support this contention. Rossetti (1998), for example, reported evidence that concurrent explicit verbalization induced involvement of the ventral pathway. In his study, participants were presented with an array of visual stimuli, one of which (the target stimulus) changed color. In one condition, participants were required to point to the target stimulus the moment the array disappeared from screen, and at the same time speak aloud the number corresponding to the target location. Pointing errors in this verbalization condition were aligned with the surrounding stimulus array, indicating that the participants used allocentric information that specified target location relative to the other stimuli. By contrast, nonverbalization and task-irrelevant verbalization conditions resulted in egocentric pointing errors (i.e., errors that were aligned with the movement direction). Verbalization during action execution thus appeared to have encouraged ventral pathway involvement in normally dorsal movement control.

Unlike an implicit learner, a novice who consciously invokes explicit knowledge (perhaps based on instructions from a coach) would be expected to demonstrate a relatively strong reliance on the ventral pathway. The dedicated dorsal pathway would be fully responsible for control only after the action had become highly automatized (see Milner & Goodale, 1995). In such a scenario, learning would be characterized not only by a declining awareness of the movement during execution, but also by a concurrent change in guidance from allocentric to egocentric information (van der Kamp et al., 2003; Willingham, 1998). For example, actions may become progressively less susceptible to visual illusions. In this respect, it is noticeable that the highly automatized actions of grasping and reaching appear much less sensitive to illusions than hopping, which is arguably a less commonly performed action (Glover & Dixon, 2004). In these terms, implicit skill learning would be typified as a direct tuning of the dorsal pathway (Willingham, 1998), thereby reducing intervention by the ventral pathway (van der Kamp et al., 2003). It follows that if the goal is to enhance the learning of visuomotor control, approaches involving implicit rather than explicit learning may be beneficial because such approaches are more likely to invoke the essential dorsal pathways and minimize ventral pathway interference.

Alternative Approaches to Learning Perceptual-Motor Skills

Other approaches to the study of implicit motor learning over the past decade also raise the possibility that the rapidity of motor learning can be enhanced by the way attention is influenced during learning. In particular, it would appear that there may be merit in trying to develop learning conditions that are more implicit, and hence, by definition, less explicit, conscious, and dependent on verbal (and verbalizable) information, than those that are currently in vogue. This interest in implicit approaches to skill learning has been stimulated largely by the research suggesting that skills learned implicitly are more robust under stress (Hardy et al., 1996; Masters, 1992).

Errorless Learning

A major challenge to using implicit learning methods to facilitate skill acquisition is that the majority of implicit motor learning paradigms developed thus far, though promoting a form of learning that is more resistant to performance deterioration under stress, nevertheless produce learning at a much slower rate than occurs with conventional (explicit) learning. Masters (1992), for example, found that although benefits of robustness under psychological stress accompanied a golf putting skill learned implicitly via a concurrent secondary task paradigm, learning was up to 25% slower than a discovery learning, or an explicitly instructed treatment condition. Maxwell et al. (2000) showed that this remains the case over as many as 3,000 trials (see also MacMahon & Masters, 2002; Maxwell et al., 2001, 2003).

An important challenge is therefore to discover or develop alternative implicit motor learning approaches that may have a less disruptive effect on rate of learning. One possibility lies with the notion of errorless learning (Maxwell et al., 2001). Prather (1971) observed that errorless learners tend to learn in a more attentionally passive manner than typical trial-and-error learners and, in so doing, make relatively limited demands on working memory, as do implicit processes (Berry & Dienes, 1993). Most learners of movement skills typically adopt a problem-solving approach to movement issues (Glencross, 1992), paying considerable conscious attention to primarily visual sources of information regarding the success of their movements (Posner, Nissen, & Klein, 1976). On the basis of feedback showing discrepancies between movement intention and outcome, learners typically develop and test in a quite deliberate way alternative movement strategies (Anderson, 1987; Salmoni, 1989). Working memory is deployed to identify and correct the movement errors in a form of hypothesis testing (Baddeley & Wilson, 1994; Berry & Broadbent, 1984, 1988).

This process of hypothesis testing (Allen & Reber, 1980; Hayes & Broadbent, 1988; Ohlsson, 1996) involves the production of verbal proposals, which are tested as trial movements (e.g., "What will happen if I keep my weight over my left knee and tilt my right ear toward my right foot?"). If performance improves, the knowledge is stored as explicit, declarative "rules" for future reference, but if performance fails to improve (or worsens), the knowledge tends to be discarded or ignored. The potential difficulty with this approach is that it is both an attentionally demanding and a time-consuming way to learn. As Singer (1977, p. 494) points out, if there is "concern for economy in training time," a reduction in the commission of errors (especially early in learning) will prevent the tortuous business of "unlearning" them. Reduction of errors by provision of guidance during learning has been shown to result in performance superior to trial-and-error learning (e.g., Holding, 1970; Hunkin, Squires, Parkin, & Tidy, 1998; Prather, 1971; Wulf, Shea, & Whitacre, 1998), although often this superiority has not carried over into delayed retention or transfer tests of learning (Singer, 1977).

Maxwell et al. (2001) argued that errors in performance cause learners to test hypotheses about their movements. This results in a highly explicit, declarative mode of learning in which working memory is heavily involved. By constraining the learning environment in such a way that learners made few mistakes, Maxwell et al. were able to limit the role of working memory in the learning of a golf putting task, so deflating the accrual of declarative knowledge (explicit learning) and inflating procedural knowledge accumulation (implicit learning). This was reflected in superior performance for the errorless learners throughout the different stages of practice compared to errorful learners. The notion of implicit learning being encouraged through approaches that reduce the errors in learning is a powerful one, and one that can also be meaningfully applied to reinterpretation of some existing data on the attentional demands of movement.*

Discovery Learning

Researchers interested in the development of expert perceptual skills for sport have begun examining techniques both to create implicit learning conditions (e.g., Farrow & Abernethy, 2002; Raab, 2003) and to examine (guided) discovery learning (Smeeton, Williams, Hodges, & Ward, 2005; Williams, Ward, Knowles, & Smeeton, 2002). For example, Smeeton et al. compared the robustness of explicit, discovery, and guided discovery learning techniques in the anticipation of young intermediate tennis players. They found that the decision times of performers in the explicit group slowed significantly more than either the discovery or guided discovery group in the anxiety condition. They also became less accurate, suggesting that the results were not due to speed-accuracy trade-off. Furthermore, the increase in decision time in the explicit players was positively related to the number of rules accumulated during the learning period. Comparing the change in response accuracy under pressure for each group together with the number of self-reported rules further implicated explicit knowledge in this process. The discovery learning group generated the fewest rules (2.0) and had the smallest decrement in response accuracy (–9%), offset by faster decision times (–99 ms). The guided discovery group generated more rules (4.9) and had a larger decrement in accuracy (–12%), again offset by slightly faster decision times (–71 ms). The explicit group generated the most rules (9.5) and suffered the largest decrease in response accuracy (–17%), accompanied by an increase in decision time (+334 ms).

Research examining the benefits of implicit or less directed perceptual training interventions is in its infancy, and support remains equivocal (Jackson, 2003; Jackson & Farrow, 2005; Poulter, Jackson, Wann, & Berry, 2005). Jackson and Farrow highlighted conceptual, methodological, and practical issues for researchers in this area, noting the different views regarding how to conceptualize implicit learning research that have been expressed in other

*Interestingly, Leavitt's (1979) efforts to manipulate attention demands during ice hockey showed that performance when using an oversized puck was similar if the player was skating only or skating and concurrently dribbling the puck. Leavitt assumed that increasing the size of the puck decreased demands on attention, permitting better performance; however, a parallel explanation is that increased puck size reduced errors in performance, which directed attention away from hypothesis-testing behavior and permitted learning to proceed in a more implicit way.

domains. This is particularly relevant to training interventions that encompass different elements that may draw on both explicit and implicit processes. For example, perceptual training interventions have varied in frequency and duration (from a single 45-minute session to 16 20-minute sessions), mode of presentation (normal speed versus slow motion), the degree of explicit information given (from "tips" to formal biomechanical-based instruction), and the opportunity to practice using this information. It is possible that some of these factors influence the degree to which explicit and implicit processes are invoked during learning. It is clear that the extent to which implicit and explicit processes are active during both perceptual and motor learning will be dependent, at least to some degree, on the specific constraints of the task to be learned. In discovery learning, for example, emerging movement solutions may be predominantly implicit in nature if the underlying task-relevant information is not easily extracted, but more explicit if the information is easily extracted.

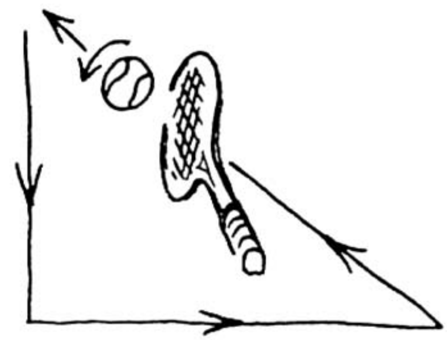


Figure 11.3 A right-angle triangle analogy used to help teach the top-spin forehand stroke in table tennis. The learner is asked to imagine a right-angle triangle and to swing his or her racket along its hypotenuse when striking the ball. *Source:* "Theoretical Aspects of Implicit Learning in Sport," by R. S. W. Masters, 2000, *International Journal of Sport Psychology, 31,* p. 539. Reprinted with permission.

Analogy Learning

Hodges and Franks (2002, p. 805) have called for the development of learning paradigms "that help the learner to constrain the degrees of freedom involved in the movement and focus on more general aspects of the response." One promising approach, which has been shown to facilitate the acquisition of a fundamentally accurate motor representation, is analogy learning (Liao & Masters, 2001; Masters, 2000; Masters & Liao, 2003; Sawada, Mori, & Ishii, 2002).

Information presented in an analogy is not rule-based, but reflects an implicit, higher-order relationship among the rules of the concept. The learner can apply the concept described by the analogy, despite an inability to explicate the rules underlying the concept (Donnelly & McDaniel, 1993). This phenomenon is a defining characteristic of implicit learning (Berry & Broadbent, 1984; Hayes & Broadbent, 1988) and was shown by Liao and Masters (2001) to be present when a top-spin table-tennis forehand was taught using a right-angled triangle analogy (see Figure 11.3). Unlike previous implicit learning paradigms, however, learning was no poorer than in an explicitly instructed treatment condition.

Masters and Liao (2003) argued that analogy learning reduces the amount of information explicitly attended to during motor learning by repackaging task relevant rules, cues, and knowledge into a single, heuristic algorithm (Todd & Gigerenzer, 2000), or biomechanical metaphor (Masters, 2000). By "chunking" discrete task relevant bits of information into an integrated and meaningful memory representation, the attention demands on working memory may be reduced. The concept of chunking, or knowledge compilation, in its various theoretical manifestations (e.g., Chase & Simon, 1973; Ericsson & Kintsch, 1995; Gobet & Simon, 1998; Miller, 1956), is a fundamental building block of memory and underlies practice effects in skill acquisition. Chunking, according to Rosenbloom and Newell (1987), occurs in a hierarchical, bottom-up manner, with smaller patterns of movement learned first, but subsumed by increasingly larger, more complex patterns. As motor competence develops, higher-level chunks are generated that represent the numerous bits of information required to successfully perform the skill. Working memory then needs only to process those higher-level chunks instead of dealing with information bit by bit. Masters and Liao provided preliminary evidence for this conceptualization by showing that the right-angled triangle analogy chunked only information (movement instructions) subsumed under the analogy (i.e., relevant bits of information), because chunking occurs only when the discrete bits of information are relevant to the learning process. They showed that a movement learned using only rules relevant to the analogy remained robust under secondary task loading (implying that working memory was processing only higher-level chunks). The same movement learned using rules irrelevant to the analogy did not remain robust.

From a theoretical point of view, it is possible to speculate that the technique of analogy learning should result in more rapid learning because it allows the coach to present more information than normal to the learner in a format that the learner can attend to with relative ease. The work of Liao and Masters (2001) and Masters and Liao (2003) is based on only limited numbers of learning trials, providing little evidence regarding the long-term implications of analogy learning for rapidity of learning. An extended period of learning, far in excess of any comparable learning studies documented in the literature, would be interesting to consider.

External Focus of Attention

The work of Wulf and her colleagues provides an additional avenue of investigation into the role of attention in skill acquisition that is reminiscent of the implicit-explicit distinction. Wulf has argued that focusing attention on the effects of body movements (external focus), rather than on the movements themselves (internal focus), is more efficacious for the acquisition of new movement skills (for a review, see Wulf & Prinz, 2001). This conceptualization evolved from Prinz's (1990, 1997) common coding principle, which postulates that for actions to be effective, afferent and efferent information must exhibit a high degree of compatibility; therefore, movements need to be planned in terms of their desired outcome, or in other words, their effect.

The advantageous nature of an external focus was first reported by Wulf, Höß, and Prinz (1998) using a ski-simulator task. They found that directing performers' attention externally to the effect their movement had on the apparatus produced superior performance throughout learning and in delayed retention compared to instructions to focus on the outer foot (internal focus) and to no attentional instructions (discovery learning control group). This basic finding has since been replicated several times and has also been generalized to more complex motor skills, such as golf chipping (Wulf, Lauterbach, & Toole, 1999), tennis (Wulf, McNevin, Fuchs, Ritter, & Toole, 2000), and volleyball and soccer (Wulf, McConnel, Gärtner, & Schwarz, 2002). Generally, external focus instructions enhance complex skill performance in novices when measured during both learning and delayed retention tests (Wulf, McNevin, et al., 2001). However, doubts have been raised over whether learners can maintain an external focus of attention throughout the duration of learning (Maxwell & Masters, 2002; Poolton et al., 2006).

McNevin et al. (2003, p. 22) postulated that advantages associated with external focus of attention arise as a consequence of the "utilization of more natural control mechanisms." This postulate led to the formation of the constrained action hypothesis, which states that "conscious attempts to control movements interfere with automatic motor control processes, whereas focusing on the movement effects allows the motor system to self-organize more naturally, unconstrained by conscious control" (Wulf, Shea, & Park, 2001, p. 342). The theory implies that external focus instructions promote the automatic processing of information subsuming motor control, whereas focusing on the movements themselves elevates this information to the level of conscious control, presumably by involving working memory (Baddeley, 1986; Baddeley & Hitch, 1974). This theory demonstrates a high degree of compatibility with implicit learning and ventral-dorsal distinctions.

CONCLUSION

Attention is one of the broadest and most researched topics in all of psychology. In this chapter, we have examined the role of attention as a limited resource in one specific context, that of skill learning and expert performance as it applies in the sport domain. It is apparent from a treatment of only this portion of the topic of attention that, although much effort has already been expended in attempts to conceptualize attentional processes, understand their function, and utilize this knowledge to guide the development of enhanced approaches to skill learning, our existing knowledge is nevertheless still at a quite rudimentary level. The development of suitable, robust models and theories of attention still remains controversial. Measurement approaches, though improved, still remain largely unidimensional and fragmented, and key issues such as the nature of implicit, automatic, and unattended processes, their interaction with explicit, controlled, attention-demanding processes, and their relative contributions to skill learning and expert performance are only beginning to receive the kind of detailed theorizing and experimental scrutiny that they warrant.

The rapid improvements in both the capability and accessibility of brain imaging techniques offer great promise as a means of extending existing knowledge about attention and helping sensibly integrate psychological theories of attention with neurobiological ones. Applications of these techniques to examining sport-specific attentional issues are currently rare but will hopefully become more commonplace over the decade. Relatedly, for knowledge about attention and automaticity to have a practical impact on skilled performance in sport, it is clear that, among other things, a research approach that increasingly uses natural sports activities rather than contrived laboratory tasks is highly desirable. Only with such an orientation is it likely that approaches to skill learning in sport can progress from practices based on tradition, folklore, and intuition to practices that are, more appropriately, evidence-based. The future challenge, in part, is for researchers of attentional processes in sport to make the study of attention *in* sport sufficiently relevant to attract the attention *of* sport.

REFERENCES

Abernethy, B. (1988). Dual-task methodology and motor skills research: Some applications and methodological constraints. *Journal of Human Movement Studies, 14,* 101–132.

Abernethy, B. (1993). Attention. In R. N. Singer, M. Murphey, & L. K. Tennant (Eds.), *Handbook of research on sport psychology* (pp. 127–170). New York: Macmillan.

Abernethy, B. (2001). Attention. In R. N. Singer, H. A. Hausenblas, & C. M. Janelle (Eds.), *Handbook of sport psychology* (2nd ed., pp. 55–85). New York: Wiley.

Abernethy, B., Summers, J. J., & Ford, S. (1998). Issues in the measurement of attention. In J. L. Duda (Ed.), *Advancements in sport and exercise psychology measurement* (pp. 173–193). Morgantown, WV: FIT Press.

Abernethy, B., Wann, J. P., & Parks, S. L. (1998). Training perceptual-motor skills for sport. In B. Elliott (Ed.), *Training in sport: Applying sport science* (pp. 1–68). Chichester, West Sussex, England: Wiley.

Abrams, M., & Reber, A. S. (1988). Implicit learning: Robustness in the face of psychiatric disorder. *Journal of Psycholinguistic Research, 17,* 425–439.

Ackerman, P. L. (1988). Determinants of individual differences during skill acquisition: Cognitive abilities and information processing. *Journal of Experimental Psychology: General, 117,* 288–318.

Allen, R., & Reber, A. S. (1980). Very long term memory for tacit knowledge. *Cognition, 8,* 175–185.

Allport, D. A. (1980a). Attention and performance. In G. Claxton (Ed.), *New directions in cognitive psychology* (pp. 112–153). London: Routledge & Kegan Paul.

Allport, D. A. (1980b). Patterns and actions: Cognitive mechanisms are content-specific. In G. Claxton (Ed.), *New directions in cognitive psychology* (pp. 26–64). London: Routledge & Kegan Paul.

Anderson, J. R. (1983). *The architecture of cognition.* Cambridge, MA: Harvard University Press.

Anderson, J. R. (1987). Skill acquisition: Compilation of weak-method problem solutions. *Psychological Review, 94,* 192–210.

Anderson, J. R. (1993). *Rules of the mind.* Hillsdale, NJ: Erlbaum.

Anderson, J. R. (1995). *Learning and memory: An integrated approach.* New York: Wiley.

Anson, G., Elliot, D., & Davids, K. (2005). Information processing and constraints-based views of skill acquisition: Divergent or complementary? *Motor Control, 9,* 217–241.

Baddeley, A. D. (1966). The capacity for generating information by randomization. *Quarterly Journal of Experimental Psychology, 18,* 119–129.

Baddeley, A. D. (1986). *Working memory.* New York: Oxford University Press.

Baddeley, A. D. (1996). Exploring the central executive. *Quarterly Journal of Experimental Psychology, 49A,* 5–28.

Baddeley, A. D. (1999). *Essentials of human memory.* Hove, England: Psychology Press.

Baddeley, A. D. (2000). The episodic buffer: A new component of working memory? *Trends in Cognitive Sciences, 4,* 417–423.

Baddeley, A. D., Chincotta, D., & Adlam, A. (2001). Working memory and the control of action: Evidence from task switching. *Journal of Experimental Psychology: General, 130,* 641–657.

Baddeley, A. D., & Hitch, G. (1974). Working memory. In G. A. Bower (Ed.), *Recent advances in learning and motivation* (Vol. 8, pp. 47–89). New York: Academic Press.

Baddeley, A. D., & Wilson, B. A. (1994). When implicit learning fails: Amnesia and the problem of error elimination. *Neuropsychologia, 32,* 53–68.

Baumeister, R. F. (1984). Choking under pressure: Self-consciousness and paradoxical effects of incentives on skillful performance. *Journal of Personality and Social Psychology, 46,* 610–620.

Baumeister, R. F., & Showers, C. J. (1986). A review of paradoxical performance effects: Choking under pressure in sports and mental tests. *European Journal of Social Psychology, 16,* 361–383.

Beatty, J. (1982). Task-evoked pupillary responses, processing load, and the structure of processing resources. *Psychological Bulletin, 91,* 276–292.

Beek, P. J. (2000). Toward a theory of implicit learning in the perceptual-motor domain. *International Journal of Sport Psychology, 31,* 547–554.

Beek, P. J., Jacobs, D. M., Daffertshofer, A., & Huys, R. (2003). Expert performance in sport: Views from the joint perspectives of ecological psychology and dynamical systems theory. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 321–342). Champaign, IL: Human Kinetics.

Beilock, S. L., Wierenga, S. A., & Carr, T. H. (2002). Expertise, attention, and memory in sensorimotor skill execution: Impact of novel task constraints on dual-task performance and episodic memory. *Quarterly Journal of Experimental Psychology, 55A,* 1211–1240.

Bernstein, N. A. (1996). On dexterity and its development. In M. L. Latash & M. T. Turvey (Eds.), *Dexterity and its development* (pp. 3–244). Hillsdale, NJ: Erlbaum.

Berry, D. C., & Broadbent, D. E. (1984). On the relationship between task performance and associated verbalisable knowledge. *Quarterly Journal of Experimental Psychology, 36,* 209–231.

Berry, D. C., & Broadbent, D. E. (1988). Interactive tasks and the implicit-explicit distinction. *British Journal of Psychology, 79,* 251–272.

Berry, D. C., & Dienes, Z. (1993). *Implicit learning: Theoretical and empirical issues.* Hove, England: Erlbaum.

Binet, A. (1890). La concurrence des états psychologiques [The competition among psychological states]. *Revue Philosophique de la France et de l'étranger, 24,* 138–155.

Bliss, C. B. (1892–1893). Investigations in reaction time and attention. *Studies of the Yale Psychological Laboratory, 1,* 1–55.

Boring, E. G. (1970). Attention: Research and beliefs concerning the concept in scientific psychology before 1930. In D. I. Mostofsky (Ed.), *Attention: Contemporary theory and analysis.* New York: Appleton-Century-Crofts.

Broadbent, D. E. (1958). *Perception and communication.* New York: Pergamon Press.

Bryan, W. L., & Harter, N. (1899). Studies on the telegraphic language: The acquisition of a hierarchy of habits. *Psychological Review, 6,* 345–375.

Cacioppo, J. T., & Berntson, G. G. (1992). Social psychological contributions to the decade of the brain: Doctrine of multilevel analysis. *American Psychologist, 47,* 1019–1028.

Chase, W. G., & Simon, H. A. (1973). Perception in chess. *Cognitive Psychology, 4,* 55–81.

Cherry, E. C. (1953). Some experiments on the recognition of speech, with one and with two ears. *Journal of the Acoustical Society of America, 25,* 975–979.

Crews, D. J. (1989). *The influence of attentive states on golf putting as indicated by cardiac and electrocortical activity.* Unpublished doctoral dissertation, Arizona State University, Tempe.

Crews, D. J., & Landers, D. M. (1993). Electroencephalographic measures of attentional patterns prior to the golf putt. *Medicine and Science in Sport and Exercise, 25,* 116–126.

Curran, T., & Keele, S. W. (1993). Attentional and nonattentional forms of sequence learning. *Journal of Experimental Psychology: Learning, Memory and Cognition, 19,* 189–202.

Dallenbach, K. M. (1928). Attention. *Psychological Bulletin, 25,* 493–511.

Davidson, R. J., Jackson, D. C., & Larson, C. L. (2000). Human electroencephalography. In J. T. Cacioppo, L. G. Tassinary, & G. G. Bernston (Eds.), *Handbook of psychophysiology* (2nd ed., pp. 27–52). New York: Cambridge University Press.

Deutsch, J. A., & Deutsch, D. (1963). Attention: Some theoretical considerations. *Psychological Review, 70,* 80–90.

Donchin, E. (1984). Dissociation between electrophysiology and behavior: A disaster or a challenge. In E. Donchin (Ed.), *Cognitive psychophysiology: Event-related potentials and the study of cognition* (pp. 107–118). Hillsdale, NJ: Erlbaum.

Donchin, E., Ritter, W., & McCallum, C. (1978). Cognitive psychophysiology: The endogenous components of the ERP. In E. Callaway, P. Tueting, & S. Koslow (Eds.), *Brain event-related potentials in man* (pp. 349–441). New York: Academic Press.

Donnelly, C. M., & McDaniel, M. A. (1993). Use of analogy in learning scientific concepts. *Journal of Experimental Psychology: Learning, Memory and Cognition, 19,* 975–987.

Ericsson, K. A., & Kintsch, W. (1995). Long-term working memory. *Psychological Review, 102,* 211–245.

Eysenck, H. J., & Thompson, W. (1966). The effects of distraction on pursuit rotor learning, performance and reminiscence. *British Journal of Psychology, 57,* 99–106.

Fan, J., McCandliss, B. D., Fossella, J., Flombaum, J. I., & Posner, M. I. (2005). The activation of attentional networks. *NeuroImage, 26,* 471–479.

Fan, J., & Posner, M. I. (2004). Human attentional networks. *Psychiatrische Praxis, 31,* S210–214.

Farrow, D., & Abernethy, B. (2002). Can anticipatory skills be learned through implicit video-based perceptual training? *Journal of Sports Sciences, 20,* 471–485.

Fitts, P. M., & Posner, M. I. (1967). *Human performance.* Belmont, CA: Brooks/Cole.

Gawron, V. J. (2000). *Human performance measures handbook.* Mahwah, NJ: Erlbaum.

Gentile, A. M. (1998). Implicit and explicit processes during acquisition of functional skills. *Scandinavian Journal of Occupational Therapy, 5,* 7–16.

Gibson, E. J. (1991). *An odyssey in learning and perception.* Cambridge, MA: MIT Press.

Girouard, Y., Laurencelle, L., & Proteau, L. (1984). On the nature of the probe reaction-time to uncover the attentional demands of movement. *Journal of Motor Behavior, 16,* 442–459.

Glencross, D. J. (1992). Human skill and motor learning: A critical review. *Sport Science Review, 1,* 65–78.

Glover, S. (2004). Separate visual representations in the planning and control of action. *Behavioral and Brain Sciences, 27,* 3–78.

Glover, S., & Dixon, P. (2004). A step and a hop on the Müller-Lyer illusion: Illusion effects on lower-limb movements. *Experimental Brain Research, 154,* 504–512.

Gobet, F., & Simon, H. A. (1998). Expert chess memory: Revisiting the chunking hypothesis. *Memory, 6,* 225–255.

Gopher, D., & Sanders, A. F. (1984). S-Oh-R: Oh stages! Oh resources. In W. Prinz & A. F. Sanders (Eds.), *Cognition and motor processes* (pp. 231–253). Berlin, Germany: Springer-Verlag.

Gray, R. (2004). Attending to the execution of a complex sensorimotor skill: Expertise differences, choking, and slumps. *Journal of Experimental Psychology: Applied, 10,* 42–54.

Green, T. D., & Flowers, J. H. (1991). Implicit versus explicit learning processes in a probabilistic, continuous fine-motor catching task. *Journal of Motor Behavior, 23,* 293–300.

Hamilton, W. (1859). *Lectures on metaphysics and logic.* Edinburgh, Scotland: William Blackwood & Sons.

Hardy, L., Mullen, R., & Jones, G. (1996). Knowledge and conscious control of motor actions under stress. *British Journal of Psychology, 87,* 621–636.

Hart, S. G., & Staveland, L. E. (1987). Development of NASA-TLX (Task Load Index): Results of empirical and theoretical research. In P. A. Hancock & N. Meshkati (Eds.), *Human mental workload* (pp. 139–183). Amsterdam: Elsevier.

Hatfield, B. D., & Hillman, C. H. (2001). The psychophysiology of sport: A mechanistic understanding of the psychology of superior performance. In R. N. Singer, H. A. Hausenblas, & C. M. Janelle (Eds.), *Handbook of sport psychology* (2nd ed., pp. 362–388). New York: Wiley.

Hatfield, B. D., Landers, D. M., & Ray, W. J. (1984). Cognitive processes during self-paced motor performance: An electroencephalographic profile of skilled marksmen. *Journal of Sport Psychology, 6,* 42–59.

Hayes, N. A., & Broadbent, D. E. (1988). Two modes of learning for interactive tasks. *Cognition, 28,* 249–276.

Heath, M., Rival, C., & Neely, K. (2006). Visual feedback schedules influence visuomotor resistance to the Müller-Lyer figures. *Experimental Brain Research, 168,* 348–356.

Heuer, H., & Wing, A. M. (1984). Doing two things at once: Process limitations and interactions. In M. M. Smyth & A. M. Wing (Eds.), *The psychology of human movement* (pp. 183–213). London: Academic Press.

Hill, H., & Raab, M. (2005). Analyzing a complex visuomotor tracking task with brain-electrical event related potentials. *Human Movement Science, 24,* 1–30.

Hodges, N. J., & Franks, I. M. (2002). Modelling coaching practice: The role of instruction and demonstration. *Journal of Sports Sciences, 20,* 793–811.

Holding, D. H. (1970). Repeated errors in motor learning. *Ergonomics, 13,* 727–734.

Hunkin, M. H., Squires, E. J., Parkin, A. J., & Tidy, J. A. (1998). Are the benefits of errorless learning dependent on implicit memory? *Neuropsychologia, 36,* 25–36.

Jackson, R. C. (2003). Evaluating the evidence for implicit perceptual learning: A re-analysis of Farrow and Abernethy. *Journal of Sports Sciences, 21,* 503–509.

Jackson, R. C., & Farrow, D. (2005). Implicit perceptual training: How, when, and why? *Human Movement Science, 24,* 308–325.

James, W. (1890). *Principles of psychology.* New York: Holt.

Janelle, C. M., Duley, A. R., & Coombes, S. A. (2004). Psychophysiological and related indices of attention during skill acquisition. In A. M. Williams & N. J. Hodges (Eds.), *Skill acquisition in sport: Research, theory, and practice* (pp. 282–308). London: Routledge.

Janelle, C. M., Hillman, C. H., Apparies, R., Murray, N. P., Meili, L., Fallon, E. A., et al. (2000). Expertise differences in cortical activation and gaze behavior during rifle shooting. *Journal of Sport and Exercise Psychology, 22,* 167–182.

Jennings, J. R., Lawrence, B. E., & Kasper, P. (1978). Changes in alertness and processing capacity in a serial learning task. *Memory and Cognition, 6,* 43–53.

Kahneman, D. (1973). *Attention and effort.* Englewood Cliffs, NJ: Prentice-Hall.

Keele, S. W. (1968). Movement control in skilled motor performance. *Psychological Bulletin, 70,* 387–403.

Kramer, A. F., & Strayer, D. L. (1988). Assessing the development of automatic processing: An application of dual-task and event-related brain potential methodologies. *Biological Psychology, 26,* 231–267.

Kramer, A. F., Wickens, C. D., & Donchin, E. (1983). An analysis of the processing demands of a complex perceptual-motor task. *Human Factors, 25,* 597–622.

Landers, D. M., Han, M., Salazar, W., Petruzzello, S. J., Kubitz, K. A., & Gannon, T. L. (1994). Effect of learning on electroencephalographic and electrocardiographic patterns of novice archers. *International Journal of Sport Psychology, 25,* 313–330.

Leavitt, J. L. (1979). Cognitive demands of skating and stickhandling in ice hockey. *Canadian Journal of Applied Sport Sciences, 4,* 46–55.

Lewis, P. A., & Miall, R. C. (2003). Distinct systems for automatic and cognitively controlled time measurement: Evidence from neuroimaging. *Current Opinion in Neurobiology, 13,* 250–255.

Liao, C., & Masters, R. S. W. (2001). Analogy learning: A means to implicit motor learning. *Journal of Sports Sciences, 19,* 307–319.

Logie, R. H. (1995). *Visuo-spatial working memory.* Hove, England: Erlbaum.

Lysaght, R. J., Hill, S. G., Dick, A. O., Plamondon, B. D., Linton, P. M., Wierwille, W. W., et al. (1989). *Operator workload: Comprehensive review and evaluation of operator workload methodologies* (Technical Report 851). Alexandria, VA: Army Research Institute for the Behavioral and Social Sciences.

MacMahon, K. M. A., & Masters, R. S. W. (2002). Implicit motor learning: A suppression solution? *International Journal of Sports Psychology, 33,* 307–324.

Magill, R. A., & Hall, K. G. (1989, November). *Implicit and explicit learning in a complex tracking task.* Paper presented at the annual meeting of the Psychonomic Society, Atlanta, GA.

Magill, R. A., Schoenfelder-Zohdi, B. G., & Hall, K. G. (1990, November). *Further evidence for implicit learning in a complex tracking task.* Paper presented at the annual meeting of the Psychonomic Society, New Orleans, LA.

Masters, R. S. W. (1992). Knowledge, knerves and know-how: The role of explicit versus implicit knowledge in the breakdown of a complex motor skill under pressure. *British Journal of Psychology, 83,* 343–358.

Masters, R. S. W. (2000). Theoretical aspects of implicit learning in sport. *International Journal of Sports Psychology, 31,* 530–541.

Masters, R. S. W., & Liao, C. (2003). Chunking as a characteristic of implicit motor learning. In R. Stelter (Ed.), *Proceedings of the 11th European Congress of Sport Psychology: New Approaches to Exercise and Sport Psychology—Theories, Methods and Applications* (pp. 137–138). Copenhagen, Denmark: University of Copenhagen, Institute of Exercise and Sport Sciences.

Masters, R. S. W., & Maxwell, J. P. (2004). Implicit motor learning, reinvestment and movement disruption: What you don't know won't hurt you. In A. M. Williams & N. J. Hodges (Eds.), *Skill acquisition in sport: Research, theory, and practice* (pp. 207–228). London: Routledge.

Masters, R. S. W., Maxwell, J. P., & Eves, F. F. (2001, May). *Implicit motor learning: Perception of outcome feedback without awareness.* Proceedings of the 10th World Congress of Sport Psychology, Skiathos, Greece.

Masters, R. S. W., Polman, R. C. J., & Hammond, N. V. (1993). "Reinvestment": A dimension of personality implicated in skill breakdown under pressure. *Personality and Individual Differences, 14,* 655–666.

Maxwell, J. P., & Masters, R. S. W. (2002). External versus internal focus instructions: Is the learner paying attention? *International Journal of Applied Sport Science, 14,* 70–88.

Maxwell, J. P., Masters, R. S. W., & Eves, F. F. (2000). From novice to no know-how: A longitudinal study of implicit motor learning. *Journal of Sport Sciences, 18,* 110–118.

Maxwell, J. P., Masters, R. S. W., & Eves, F. F. (2003). The role of working memory in motor learning and performance. *Consciousness and Cognition, 12,* 376–402.

Maxwell, J. P., Masters, R. S. W., Kerr, E., & Weedon, E. (2001). The implicit benefit of learning without errors. *Quarterly Journal of Experimental Psychology, 54A,* 1049–1068.

McLeod, P. (1977). A dual task response modality effect: Support for multiprocessor models of attention. *Quarterly Journal of Experimental Psychology, 29,* 651–667.

McLeod, P. (1980). What can probe RT tell us about the attentional demands of movement? In G. E. Stelmach & J. Requin (Eds.), *Tutorials in motor behavior* (pp. 579–589). Amsterdam: North Holland.

McLeod, P., & Driver, J. (1993). Filtering and physiology in visual search: A convergence of behavioral and neurophysiological measures. In A. Baddeley & L. Weiskrantz (Eds.), *Attention: Selection, awareness, and control* (pp. 72–86). Oxford: Clarendon Press.

McNevin, N. H., Shea, C. H., & Wulf, G. (2003). Increasing the distance of an external focus of attention enhances learning. *Psychological Research, 67,* 22–29.

Meshkati, N. (1988). Heart rate variability and mental workload assessment. In P. A. Hancock & N. Meshkati (Eds.), *Human mental workload* (pp. 101–115). Amsterdam: North-Holland.

Meyer, D. E., & Kieras, D. E. (1997). A computational theory of executive cognitive processes and multiple task performance: Pt. 1. Basic mechanisms. *Psychological Review, 104,* 3–65.

Miller, G. (1956). The magic number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review, 63,* 81–97.

Milner, A. D., & Goodale, M. A. (1995). *The visual brain in action.* Oxford: Oxford University Press.

Moray, N. (1967). Where is attention limited? A survey and a model. *Acta Psychologica, 27,* 84–92.

Näätänen, R. (1992). *Attention and brain function.* Hillsdale, NJ; Erlbaum.

Navon, D., & Gopher, D. (1979). On the economy of the human processing system. *Psychological Review, 86,* 214–255.

Nougier, V., Stein, J. F., & Bonnel, A. M. (1991). Information processing in sport and orienting of attention. *International Journal of Sport Psychology, 22,* 307–327.

Nygren, T. E. (1991). Psychometric properties of subjective workload measurement techniques: Implications for their use in the assessment of perceived mental workload. *Human Factors, 33,* 17–33.

Ogden, G. D., Levine, J. M., & Eisner, E. J. (1979). Measurement of workload by secondary tasks. *Human Factors, 21,* 529–548.

Ohlsson, S. (1996). Learning from performance errors. *Psychological Review, 103,* 241–262.

Otto-de Haart, E. G., Carey, D. P., & Milne, A. B. (1999). More thoughts on perceiving and grasping the Müller-Lyer illusion. *Neuropsychologia, 37,* 1437–1444.

Parasuraman, R., & Davies, D. R. (1984). *Varieties of attention.* Orlando, FL: Academic Press.

Pew, R. W. (1974). Levels of analysis in motor control. *Brain Research, 71,* 393–400.

Poolton, J. M., Maxwell, J. P., Masters, R. S. W., & Raab, M. (2006). Benefits of an external focus of attention: Common coding or conscious processing? *Journal of Sport Sciences, 24,* 89–99.

Posner, M. I. (2003). Imaging a science of mind. *Trends in Cognitive Science, 7,* 450–453.

Posner, M. I., & Boies, S. J. (1971). Components of attention. *Psychological Review, 78,* 391–408.

Posner, M. I., & Keele, S. W. (1969). Attentional demands of movements. *Proceedings of the 17th International Congress of Applied Psychology.* Amsterdam: Swets & Zeitlinger.

Posner, M. I., Nissen, M. J., & Klein, R. (1976). Visual dominance: An information processing account of its origins and significance. *Psychological Review, 83,* 157–171.

Poulter, D. R., Jackson, R. C., Wann, J. P., & Berry, D. C. (2005). The effect of learning condition on perceptual anticipation, awareness, and visual search. *Human Movement Science, 24,* 345–361.

Prather, D. C. (1971). Trial-and-error versus errorless learning: Training, transfer and stress. *American Journal of Psychology, 84,* 377–386.

Prinz, W. (1990). A common coding approach to perception and action. In O. Neumann & W. Prinz (Eds.), *Relationship between perception and action* (pp. 167–201). Berlin, Germany: Springer-Verlag.

Prinz, W. (1997). Perception and action planning. *European Journal of Cognitive Psychology, 9,* 129–154.

Raab, M. (2003). Implicit and explicit learning of decision making in sports is affected by complexity of situation. *International Journal of Sport Psychology, 34,* 273–288.

Radlo, S. J., Janelle, C. M., Barba, D. A., & Frehlich, S. G. (2001). Perceptual decision making for baseball pitch recognition: Using P300 latency and amplitude to index attentional processing. *Research Quarterly for Exercise and Sport, 72,* 22–31.

Reber, A. S. (1989). Implicit learning and tacit knowledge. *Journal of Experimental Psychology, 118,* 219–235.

Reber, A. S. (1993). *Implicit learning and tacit knowledge: An essay on the cognitive unconscious.* New York: Oxford University Press.

Reid, G. B., & Nygren, T. E. (1988). The subjective workload assessment technique: A scaling procedure for measuring mental workload. In P. A. Hancock & N. Meshkati (Eds.), *Human mental workload* (pp. 185–218). Amsterdam: North-Holland.

Rogers, W. A., Rousseau, G. K., & Fisk, A. D. (1999). Applications of attention research. In F. T. Durso, R. S. Nickerson, R. W. Schvaneveldt, S. T. Dumais, D. S. Lindsay, & M. T. H. Chi (Eds.), *Handbook of applied cognition* (pp. 33–55). Chichester, England: Wiley.

Rosenbloom, P. S., & Newell, A. (1987). An integrated computational model of stimulus response compatibility and practice. *Psychology of Learning and Motivation, 21,* 1–52.

Rossetti, Y. (1998). Implicit perception in action: Short-lived motor representation of space. *Consciousness and Cognition, 7,* 520–558.

Rossi, B., & Zani, A. (1991). Timing of movement-related decision processed in clay-pigeon shooters as assessed by event-related potentials and reaction times. *International Journal of Sport Psychology, 22,* 128–139.

Rumelhart, D. E., & McClelland, J. L. (Eds.). (1986). *Parallel distributed processing.* Cambridge, MA: MIT Press.

Salmoni, A. W. (1989). Motor skill learning. In D. H. Holding (Ed.), *Human skills* (2nd ed., pp. 261–332). London: Wiley.

Salmoni, A. W., Sullivan, J. J., & Starkes, J. L. (1976). The attentional demands of movement: A critique of the probe technique. *Journal of Motor Behavior, 8,* 161–169.

Sammer, G. (1998). Heart period variability and respiratory changes associated with physical and mental load: Non-linear analysis. *Ergonomics, 41,* 746–755.

Sawada, M., Mori, S., & Ishii, M. (2002). Effect of metaphorical verbal instruction on modeling of sequential dance skills by young children. *Perceptual and Motor Skills, 95,* 1097–1105.

Schmidt, R. A. (1975). A schema theory of discrete motor learning. *Psychological Review, 82,* 225–260.

Schmidt, R. A. (1982). More on motor programs. In J. A. S. Kelso (Eds.), *Human motor behavior: An introduction* (pp. 219–235). Hillsdale, NJ: Erlbaum.

Schmidt, R. A., & Wrisberg, C. A. (2004). *Motor learning and performance* (3rd ed.). Champaign, IL: Human Kinetics.

Schneider, W., Dumais, S. T., & Shiffrin, R. M. (1985). Automatic and controlled processing and attention. In R. Parasuraman & D. R. Davies (Eds.), *Varieties of attention* (pp. 1–27). New York: Academic Press.

Schneider, W., & Shiffrin, R. M. (1977). Controlled and automated human information processing: Pt. I: Detection, search and attention. *Psychological Review, 44,* 627–644.

Shea, C. H., & Wulf, G. (1999). Enhancing motor learning through external-focus instructions and feedback. *Human Movement Science, 18,* 553–571.

Shea, C. H., Wulf, G., Whitacre, C. A., & Park, J. H. (2001). Surfing the implicit wave. *Quarterly Journal of Experimental Psychology, 54,* 841–862.

Sheridan, T., & Stassen, H. (1979). Definitions, models, and measures of human workload. In N. Moray (Ed.), *Mental workload: Its theory and measurement* (pp. 219–233). New York: Plenum Press.

Shiffrin, R. M., Craig, J. C., & Cohen, E. (1973). On the degree of attention and capacity limitations in tactile processing. *Perception and Psychophysics, 13,* 329.

Singer, R. N. (1977). To err or not to err: A question for the instruction of psychomotor skills. *Review of Educational Research, 47,* 479–498.

Smeeton, N. J., Williams, A. M., Hodges, N. J., & Ward, P. (2005). The relative effectiveness of various instructional approaches in developing anticipation skill. *Journal of Experimental Psychology: Applied, 11,* 98–110.

Smith, S. W. (1997). *The scientist's and engineer's guide to digital processing* (2nd ed.). San Diego: California Technical Publishing.

Snyder, E., Hillyard, S. A., & Galambos, R. (1980). Similarities and differences in P3 waves to detected signals in three modalities. *Psychophysiology, 17,* 112–122.

Solomons, L., & Stein, G. (1896). Normal motor automatism. *Psychological Review, 3,* 492–512.

Sun, R., Slusarz, P., & Terry, C. (2005). The interaction of the explicit and the implicit in skill learning: A dual-process approach. *Psychological Review, 112,* 159–192.

Titchener, E. B. (1908). *Lectures on the elementary psychology of feeling and attention.* New York: Macmillan.

Todd, P. M., & Gigerenzer, G. (2000). Precis of simple heuristics that make us smart. *Behavioral and Brain Sciences, 23,* 727–741.

Treisman, A. (1969). Strategies and models of selective attention. *Psychological Review, 76,* 282–299.

Ungerleider, L. G., & Mishkin, M. (1982). Two cortical visual systems. In D. J. Ingle, M. A. Goodale, & R. J. W. Mansfield (Eds.), *Analysis of visual behavior* (pp. 549–586). Cambridge, MA: MIT Press.

van der Kamp, J., Savelsbergh, G. J. P., & Oudejans, R. D. D. (2003). The development and learning of the visual control of movement: An ecological perspective. *Infant Behavior and Development, 26,* 495–515.

Vereijken, B., van Emmerik, R. E. A., Whiting, H. T. A., & Newell, K. M. (1992). Free(z)ing degrees of freedom in skill acquisition. *Journal of Motor Behavior, 24,* 133–142.

Vicente, K. J., Thornton, D. C., & Moray, N. (1987). Spectral analyses of sinus arrhythmia: A measure of mental effort. *Human Factors, 29,* 171–182.

Wakelin, D. R. (1967). The role of the response in psychological refractoriness. *Acta Psychologica, 40,* 163–175.

Welch, J. C. (1898). On the measurement of mental activity through muscular activity and the determination of a constant of attention. *American Journal of Physiology, 1,* 253–306.

Welford, A. T. (1967). Single channel operation in the brain. *Acta Psychologica, 27,* 5–22.

Wickens, C. D. (1979). Measures of workload, stress, and secondary tasks. In N. Moray (Ed.), *Mental workload: Its theory and measurement* (pp. 79–99). New York: Plenum Press.

Wickens, C. D. (1992). *Engineering psychology and human performance* (2nd ed.). New York: HarperCollins.

Wickens, C. D., & Derrick, W. (1981). Workload measurement and multiple resources. *Proceedings of the IEEE Conference on Cybernetics and Society.* New York: Institute of Electrical and Electronics Engineers.

Wiener, N. (1948). *Cybernetics.* New York: Wiley.

Wierwille, W. W., & Connor, S. A. (1983). Evaluation of 20 workload measures using a psychomotor task in a moving-base aircraft simulator. *Human Factors, 25,* 1–16.

Williams, A. M., Ward, P., Knowles, J. M., & Smeeton, N. (2002). Anticipation skill in a real-world task: Measurement, training, and transfer in tennis. *Journal of Experimental Psychology: Applied, 8,* 259–270.

Willingham, D. B. (1998). A neuropsychological theory of motor skill learning. *Psychological Review, 105,* 558–584.

Willingham, D. B., & Goedert-Eschmann, K. (1999). The relation between implicit and explicit learning: Evidence for parallel development. *Psychological Science, 10,* 531–534.

Wilson, G. F., & O'Donnell, R. D. (1988). Measurement of operator workload with the neuropsychological workload test battery. In P. A. Hancock & N. Meshkati (Eds.), *Human mental workload* (pp. 63–100). Amsterdam: North-Holland.

Wrisberg, C. A., & Shea, C. H. (1978). Shifts in attentional demands and motor program utilisation during motor learning. *Journal of Motor Behavior, 2,* 149–158.

Wulf, G., Höß, M., & Prinz, W. (1998). Instructions for motor learning: Differential effects of internal versus external focus of attention. *Journal of Motor Behavior, 30,* 169–179.

Wulf, G., Lauterbach, B., & Toole, T. (1999). The learning advantages of an external focus of attention in golf. *Research Quarterly for Exercise and Sport, 70,* 120–126.

Wulf, G., McConnel, N., Gärtner, M., & Schwarz, A. (2002). Enhancing the learning of sport skills through external-focus feedback. *Journal of Motor Behavior, 34,* 171–182.

Wulf, G., McNevin, N. H., Fuchs, T., Ritter, F., & Toole, T. (2000). Attentional focus in complex motor skill learning. *Research Quarterly for Exercise and Sport, 71,* 229–239.

Wulf, G., McNevin, N. H., & Shea, C. H. (2001). The automaticity of complex motor skill learning as a function of attentional focus. *Quarterly Journal of Experimental Psychology, 54A,* 1143–1154.

Wulf, G., & Prinz, W. (2001). Directing attention to movement effects enhances learning: A review. *Psychonomic Bulletin and Review, 8,* 648–660.

Wulf, G., & Schmidt, R. A. (1997). Variability of practice and implicit motor learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 23,* 987–1006.

Wulf, G., Shea, C., & Park, J.-H. (2001). Attention and motor performance: Preferences for and advantages of an external focus. *Research Quarterly for Exercise and Sport, 72,* 335–344.

Wulf, G., Shea, C. H., & Whitacre, C. A. (1998). Physical-guidance benefits in a complex motor skill. *Journal of Motor Behavior, 30,* 367–380.

CHAPTER 12

A Social-Cognitive Perspective on Team Functioning in Sport

DAVID W. ECCLES and GERSHON TENENBAUM

The year is 2003. England and tournament hosts Australia are 17–17 in the final 25s of the Rugby Union World Cup Final. In a breathtaking finale, Matt Dawson spins the ball out of the England's line-out to Jonny Wilkinson. Under great pressure, Wilkinson drops the ball to his feet and performs a perfect drop goal to clinch the game and seal England's name in the history books as the first Northern Hemisphere side to win the World Cup.

After the game, Wilkinson was asked to reflect on his team's preparation with relation to the drop-goal. His response was, "We had a clear routine of how we'd get a drop-goal. It just went absolutely like clockwork. That's why you win these big games" (British Broadcasting Corporation, n.d.). Watching the game, we were left to ponder how extant concepts in sport psychology could account adequately for how teams achieve such routines. The research literature on teams, being predominantly social in perspective, and on cognition in sports, being predominantly individualistic in orientation, seems weak at offering insights into how team members achieve coordination. An understanding of this topic seems to require a consideration of both social and cognitive aspects of the way teams function and, in particular, of the interaction of these aspects.

Consequently, this chapter is concerned with how a social-cognitive perspective on teams might enhance the current understanding of team functioning in sport. The concepts discussed in the chapter are drawn predominantly from the research literature concerned with teams in industrial and organizational (I/O) psychology and on social cognition in general psychology. The chapter includes proposals for concepts relevant to insights into team coordination, but also considers more general implications of a social-cognitive perspective on team functioning in sport. In particular, consideration is given to how social processes might affect individual cognition, and how the social organization of a team might affect its collective cognitive properties.

The chapter begins with a discussion of how team functioning in sport has been considered predominantly from a social perspective, and how researchers interested in cognitive aspects of sports performance have been concerned predominantly with the individual, with little attention being paid to interactions between an individual's cognition and the team's social properties and processes. This section concludes with a discussion of the weaknesses of current approaches to studying the functioning of sports teams. In the second section, it is proposed that an understanding of such functioning might benefit from a consideration of interactions between social and cognitive aspects of teams. Following this, there is a discussion of three key concepts that have been proposed in the I/O research literature relating to such interactions. These include the cognitive affects of social processes, team cognition, and team coordination. The implications of these concepts for research on sports teams are also discussed. The third section comprises an extended discussion of the concept of team coordination because it is believed to offer the most potential for advancing the current understanding of team functioning in sport. This section also includes suggestions for developing methods for studying coordination in sports teams. It ends with the proposal of various best practice guidelines, based on the concepts described, for applied practitioners working with teams. The chapter concludes with a summary and recommendations for future research in this area.

CURRENT RESEARCH ON THE FUNCTIONING OF TEAMS IN SPORT

In this section, we first discuss how team performance in sport has been considered predominantly from a social perspective. Following this, we discuss how researchers interested in cognitive aspects of sports performance have been concerned predominantly with the individual performer. Finally, we attempt to articulate some weaknesses of these approaches in accounting for team functioning in sport.

The Predominance of a Social Perspective on Team Functioning in Sport

A recognized limitation of sport psychology is that research has been focused predominantly on individuals compared to groups of individuals, such as teams, even when the individuals being studied are members of a team (Woodman & Hardy, 2001). However, research into the psychology of teams in sport has been almost entirely social in nature (e.g., Carron & Hausenblas, 1998). This is apparent in most introductory texts on sport psychology that include sections on team functioning. For example, the text by Weinberg and Gould (2003) includes four chapters related to the topic of group processes, which are titled "Group and Team Dynamics," "Cohesion," "Leadership," and "Communication." The chapter on group and team dynamics covers concepts such as group development, group norms, team climate, and social loafing within groups. With regard to creating an effective team climate, the authors describe how the extant research has provided some support for how social support, team members' perceptions of their team's distinctiveness, and the extent to which coaches treat players fairly affect team climate. Thus, these concepts are predominantly social in nature, and this approach is reflected throughout the extant research literature on team functioning in sport.

Current Considerations of Cognitive Aspects of Sports Performance

In the past decade, much research has been devoted to the cognitive bases of skill acquisition and expert performance in sport (Starkes & Ericsson, 2003; Williams & Hodges, 2004). Research has shown that sport expertise is attained primarily through complex, domain-specific cognitive and physiological adaptations to the target domain. These adaptations are driven by practice in, and experience of, that domain, which often begins at a young age and is usually maintained at a high daily level for more than a decade. These adaptations include changes in the amount and organization of domain-specific knowledge and in memory for and access to that knowledge. These adaptations afford development of perceptual and cognitive skills that support an efficient search for and recognition and encoding of task-relevant information and an efficient integration of that information with a network of relevant, organized, and interrelated knowledge previously acquired in long-term memory. Consequently, experts are able to obtain rapid access to a variety of response strategies and options during performance. In addition, these skills support the monitoring, evaluation, and prediction of changes in the domain environment, allowing the expert to adapt flexibly and in anticipation of such changes. They also support the planning, monitoring, and evaluation of response strategies and selections, allowing the expert to better prepare for, execute, and evaluate the efficacy of responses. However, in the extant research on cognitive aspects of sports performance, little attention has been paid to interactions between an individual's cognition and the social processes and settings associated with the team environment.

A Common Weakness of the Two Approaches in Accounting for Team Functioning in Sport

A key weakness of the two approaches is that neither considers the other. Team functioning in sport has been considered predominantly from a social perspective, and research on cognitive aspects of sports performance has been focused predominantly on the individual. Consequently, we argue that the following questions are difficult to answer based on extant concepts in the discipline of sport psychology:

- How is individual cognition affected by many of the social processes on which the extant research on teams in sport has been focused? For example, does being assigned a particular role on a team affect a performer's processing of game-relevant information?
- How are decisions made in teams? How do the individuals on the team bring the knowledge bases unique to each individual to bear on the process of making a decision? Does the organization of and the communication within the team affect this process?
- How do the tasks that teams undertake actually get done? To elaborate, what information needs to be known by an individual for that individual to be able to function as part of a coordinated team?

Researchers have made similar criticisms of the discipline of cognitive psychology. Levine, Resnick, and Higgins (1993, p. 586) posited that cognitive psychology "has traditionally been a psychology of the individual," and "little attention has been paid to . . . cognitive functioning in interaction with others." As these researchers have argued, the human is a social animal, exhibiting a willingness to interact rarely paralleled in other species. Try to identify the number of different types of groups, teams, and larger organizations (e.g., family, work, and social) within which you are a member—it is usually harder to identify activities undertaken solely as an individual. Similarly, and following Hutchins (1991), try to identify an object that is not the product of human collaboration. Even when an individual is not engaged in an individual activity, researchers have argued that the individual's cognition is still affected by the social network and cultural context within which the individual operates (D'Andrade, 1981; Resnick, Levine, & Teasley, 1996). Thus, the human rarely thinks in a "social vacuum" and yet is often treated as such (Levine et al., 1993, p. 586).

To summarize, there have been important advances in our understanding of social aspects of team performance. Furthermore, important insights into skilled performance in sports have been provided by research on the perceptual-cognitive skills of individuals operating on sports teams (Starkes & Ericsson, 2003; Williams & Hodges, 2004). However, there has been little consideration of an approach that has, as a central feature, a consideration of how these aspects interact. However, we assert that team functioning in sport will be better understood by adopting a perspective from which these aspects are considered to interact. Accordingly, the next section comprises an overview of key concepts associated with a social-cognitive perspective on team functioning and suggestions for ways in which these concepts might relate to functioning in sports teams.

SOCIAL-COGNITIVE CONCEPTUALIZATIONS OF TEAMS

We present here three key concepts from the research literature in I/O psychology and on social cognition in general psychology that concern interactions between social and cognitive aspects of team functioning. These concepts have received no attention in sport psychology, but we believe that a consideration of the concepts by sport psychologists might provide new insights into team functioning in sports. The first concept is that social processes operating within a team can affect the cognition of an individual team member. The second is that the cognitive properties of a team cannot be defined simply as the sum of the properties of the individual members of that team. Social properties of the team, such as the way the team is organized, and social processes within the team, such as the nature of intrateam communication, affect the cognitive properties of the team. The third concept is that the ability of the team to achieve an organizational structure and to coordinate its operations is enhanced when the team is able to first achieve, and subsequently maintain, a specific social-cognitive state, termed a shared knowledge state.

Cognitive Affects of Social Processes

Levine et al. (1993) provided a review of research on the influence of social factors associated with groups and teams on individual cognition (see also Kerr & Tindale, 2004). These authors proposed a taxonomy of such factors, which included various categories, a selection of which is discussed next. Examples of a research study are also described briefly for each category, and suggestions are made for how each factor category might relate to sport team functioning.

Mere Presence of Others

A line of research that provides evidence for how the mere presence of others can affect an individual's cognition is concerned with group composition. For example, Lord and Saenz (1985) studied how individual cognition is affected by the presence of underrepresented "tokens" interacting within groups. Participants, who were students, were led to believe that they and three other students would be engaged in discussion with the experimenter. The participants were also told that the three other students would each be located in a separate room, and that all four people (the participant and the three students) would be able to see and hear each other on television monitors as they interacted with the experimenter. The three students were either all of the participant's own gender or, to create a token condition, all of the opposite gender. However, unknown to the participants, the three students were not interacting live with the experimenter but were previously videotaped confederates. In addition, an observer watched, but was not involved in, the "group interaction."

Following the interaction, participants and observers undertook a recognition-memory test relating to the opinions voiced during the interaction. Tokens remembered fewer opinions that they and the three other students had expressed than did nontokens. However, the observers remembered more of what was said by tokens than by nontokens. One explanation for this effect was that tokens, aware that they attract more attention than other members of the group (as shown by the observer data), devote more attentional resources to self-presentation, and thus less to the task, than the other group members. Thus, the study by Lord and Saenz (1985) provides evidence that individual cognition can be affected in a group setting by the nature of the members that constitute the remainder of the group. This concept might be applicable in sport team environments. Might minority members of teams attend to and recall less team-related information than their counterparts? For example, in football, the implications of a team member not attending well during a play-planning session during practice, or failing to recall plays during a game, could negatively affect how that team member executes the play and thus negatively affect the overall performance of the team.

Social Roles, Positions, and Identities within a Social Group

Individual cognitions also appear to be influenced by expectations associated with the role that the individual has been allocated. Anderson and Pichert (1978) asked participants to assume the role of a burglar or a potential house buyer while reading text about what two boys did at one of the boys' homes. Participants were then asked to write down as much as they could remember of the story content. Following this, they assumed the role opposite the role first assumed and rewrote the story. The results revealed that by assuming the new role, information relevant to the new role, and that was previously unrecalled, was now recallable.

In a similar study, Zukier and Pepitone (1984) contrasted the effects of asking participants, who were college students, to adopt either a "scientific" or a "clinical" orientation when making judgments about whether a person worked as an engineer or a lawyer based on a thumbnail description of that person. Participants were told that the thumbnails were drawn at random from a sample comprising a thumbnail for each of 30 engineers and 70 lawyers. The scientific orientation condition was created by asking participants to make judgments as a scientist analyzing data. The clinical orientation condition was created by asking participants to "try to understand the individual's personality, professional inclinations and interests" when making the judgment (p. 353). Two descriptions of individuals were then provided to the participants: One was intended to be the target description, which evoked the stereotype of an engineer, and the other to be a neutral description, which was intended to convey no information relevant to the question of whether the target was a lawyer or an engineer. Participants were then asked to assign to the description the probability that it belonged to one of the 30 engineers, on a scale of 0 to 100. The findings indicated that those in the scientific orientation condition were more scientific in their judgments, in that they judged the likelihood of the target's being an engineer as closer to the known proportion of lawyers to engineers in the sample (i.e., 30 to 70), than those in the clinical condition.

Thus, role allocation appears to affect cognition. This affect might also occur in team environments in sport. For example, might the role a player is allocated in sport affect his or her processing of game-relevant information?

An Individual's Mental Representations of Others

An individual's cognition can also be affected by his or her mental representations of others, such that cognition is affected even when those others are not physically present. For example, Baldwin, Carrel, and Lopez (1990) asked students to evaluate their own research ideas after first exposing them to images of either the disapproving face of their advisor or the approving face of another person. To avoid the students being consciously aware of the images, the images were presented for only 2 ms during a previously completed bogus reaction-time task. The results indicated that self-ratings were lower after the presentation of the disapproving image. Thus, processing information about significant others, even subliminally, can affect the cognitive processes underlying decision making. This phenomenon might also occur in team environments in sport. For example, how might thinking about the presence of a significant other, such as a stern coach, affect a player's process of self-evaluation during the game?

Social Interaction and Cognitive Change

Research on social interaction has provided evidence that an individual's thinking is actually formed during social interaction. For example, intragroup conflict has been shown to affect individual cognition. Nemeth and Kwan (1987) asked participants to identify words with capital letters embedded in letter strings, such as identifying "DOG" in the string "tDOGto." Participants were members of a group of four but were tested individually so that they were not aware of each others' responses. After initial trials, they were informed that either a majority or a minority of the other group members had used an unusual strategy to identify words, such as reading the letters backward. When the participants where then asked to identify as many words as possible from the letter strings, those informed about the minority strategy made use of a larger variety of identification strategies (e.g., reading the letters forward and backward) than those informed about the majority position. The conclusion was that minority views in a group can promote group members to engage in divergent thinking, and majority views in convergent thinking. Thus, individual cognition can be formed during social interaction. Might such interaction affect the cognitive processes that mediate performance in sport settings?

Summary

The research on social cognition has demonstrated that various social processes can affect individual cognition. By adopting a social-cognitive perspective, sports psychologists may be able to gain insights into how the cognitive processes of individual members of sports teams can be affected by the social processes inherent in the team and on which the extant research on teams in sport has been focused. To date, there have been few studies that have considered the interaction between social and cognitive aspects of teams in sport.

Team Cognition

Rather more radically, researchers have recently proposed that the team can be considered to be a cognitive system (Hinsz, Tindale, & Vollrath, 1997; Hutchins, 1991, 1995). To elaborate, each team member has certain cognitive properties. These properties include the knowledge held by the team member and the capacities of each team member for information processing (i.e., for perceiving, attending to, memorizing, and recalling information). The assertion of some social-cognitive theorists is that when multiple individuals work together as a team, a cognitive system, which is comprised of individual cognitive units (i.e., brains), is established. The *system* can then be considered to have cognitive properties. However, these properties are not just the result of the sum of multiple cognitive units comprised therein. Social factors such as the organizational structure of the team and the nature of the communication within the team, which is in part influenced by the team's organization, also affect the cognitive properties of the system.

For example, Roberts (1964; see also Hutchins, 1991) described how a cultural group could constitute a memory system that is more robust and has a larger capacity than any single member of that group. Roberts, a cultural anthropologist, studied four Native American tribes to identify, for each tribe, how information was retrieved when needed from the collective memories of the entire tribe. The tribes were preindustrial and nonliterate, and so the storage of information via artifacts (e.g., books) was not possible. Thus, information important to decision making was located only in the memories of the tribal members. Roberts concluded that some tribes were more efficient than others in storing, retrieving, and utilizing such information for decision making, and that the determinants of a tribe's efficiency were organizational and communicational in nature. These included tribe size, the distribution of information among tribal members, and the patterns and time course of the interactions among members.

Hutchins (1991) used connectionist models of group cognition to explore how organizational factors affected confirmation biases during group decision making. Confirmation bias is defined as the tendency to stick with prior interpretations of a situation and discount disconfirming evidence for the interpretation. The motivation to create the models arose from a real ship accident. The accident occurred after members of the ship's crew appeared to have reinforced beliefs among themselves that a nearby ship was sailing away from the crew's ship. By contrast, the nearby ship was actually being sailed toward the crew's ship. Even while holding constant the cognitive properties of the individuals that composed the two teams, the models showed that teams can display different cognitive properties depending on the nature of the communication within the team. They also showed that, in some circumstances, confirmation bias can be exacerbated at the team level compared to the individual level.

Another related area of research concerns how the distribution of information among group members affects group decision making. For example, Stasser and Titus (1985) showed that two members of the group must hold the same piece of information for it to be discussed by the group. If the information is available to only one member of the team, it tends to be treated as mere opinion and is less likely to be discussed, but there are more opportunities to provide social validation of the value of the information when more members hold the information. This process appears accentuated under time pressure, such that shared information receives attention early during discussion, but unshared information is mentioned relatively late in the discussion. These problems arising from time pressure may play a role in information-processing biases in teams.

The research on this topic has provided evidence that the cognitive properties of a team are affected by the social properties of the team. By adopting this perspective, sports psychologists may be able to gain insights into how decisions in sports teams are made, and how the organization of the team and the way team members communicate within such an organization affect this process. Researchers in sport psychology have been calling for the adoption of organizational, social, political, and cultural perspectives to gain broader insights into the psychological phenomena associated with sports performance (Woodman & Hardy, 2001).

The third concept pertaining to interactions between cognitive and social aspects of team performance is concerned with team coordination. We believe that team coordination is most relevant to an understanding of team functioning in sport; consequently, we devote the entire next section to this topic.

TEAM COORDINATION

The following builds on the proposal by Eccles and Tenenbaum (2004) of a conceptual framework for studying coordination in sports teams. We begin with an overview of the extant research on coordination in sports teams, and then discuss key concepts related to team coordination based on research in I/O psychology. We focus on the intracommunication required for coordination, and how coordination, and the communication required for coordination, is achieved in expert teams. Following this, suggestions are made for developing methods of studying coordination in sports teams. This section concludes with the proposal of various best practice guidelines for practitioners working with teams.

Existing Research on Coordination in Sport

Coordination in teams involves integrating the operations of the team in a timely way to form a composition of operations that achieves satisfactory performance. Considerations of team coordination in sport have been limited to simple descriptions of the construct and its relation to team productivity. For example, Carron and Hausenblas (1998) discussed Steiner's (1972) conceptual framework of group productivity in regard to sport. Steiner proposed that the potential for group productivity increases with group size, owing to the extra resources provided by the extra group members. However, the increase in group productivity decreases with each additional member, until productivity reaches a plateau so that any increase in membership has no additive effect on productivity. An unpublished but classic study by Ringlemann (cited in Kravitz & Martin, 1986) was used by Carron and Hausenblas (1998, pp. 32–38) as an example of Steiner's predictions. Ringlemann studied team tug-of-war performance wherein the addition of team members increased team productivity but decreased individual efficiency. Steiner proposed two reasons for the efficiency reduction. First, group size increases cause a reduction in personal accountability, which in turn causes a reduction in individual motivation and an increase in social loafing. Second, group size increases make difficult the coordination of group operations. The social orientation of sport team research is marked by the fact that only the constructs of motivation loss and social loafing have received subsequent research attention (e.g., Carron & Hausenblas, 1998, chap. 2). No consideration has been given to how a team actually achieves coordination (cf. Carron & Hausenblas, 1998, pp. 32–38).

Key Concepts Related to Team Coordination

When humans work together to achieve some task, they are cooperating; in sport, their collectivity is usually labeled a *team.* However, though necessary, cooperation is not sufficient for satisfactory team performance. The operations performed by each team member must be coordinated; that is, the operations must be integrated in a timely way to form a composition of operations that achieves satisfactory performance. Failing to coordinate team operations can result in performance that is worse than that which is possible in a team with fewer members (Kidd, 1961; Naylor & Briggs, 1965). For example, a single rower would easily outperform a team of two rowers if the team could not achieve the coordination of oar strokes required to steer and power the boat. Steiner (1972) argued that the actual productivity of a team is the result of its potential productivity, which includes the sum of the potential productivity of each of the members of the team minus its faulty processes, such as social loafing and poor coordination. He called the loss of productivity resulting from faulty processes *process loss,* and the loss of productivity resulting from poor coordination specifically has become known as a *coordination decrement* (Fiore, Salas, Cuevas, & Bowers, 2003). Clearly, the full potential of the human resources available within a team are wasted when process losses occur.

Several studies have provided evidence of process loss. An early example was provided by Comrey (1953) using a pegboard assembly task. In an individual condition, two men sat across from one another at a table. Each man undertook his own pegboard assembly task. Both men were given the same amount of time to complete the task. Immediately following this, and with the men still seated in their original positions, a team condition was created by positioning a board between the two men and asking that they complete overlapping operations as if working on a production line, so that the requirement to coordinate their activities was introduced. Similar to the finding of the tug-of-war study discussed earlier, the key finding of these studies was that, although the absolute performance of a team was superior to that of an individual, it was always less than the sum of the team members' individual performances.

Evidence of process loss was also provided by Kidd (1961). In this study, team performance was examined on a simulated air traffic control task. The size of the team was manipulated so that one-, two-, or three-person teams undertook simulated control tasks. Performance measures included the percentage of delay per aircraft, mean fuel consumption per aircraft, number of missed approaches, errors in keeping aircraft spaced correctly in the air, and errors in keeping aircraft spaced correctly on the runway. Even when workload per team member was held constant, performance actually decreased as team size increased. Naylor and Briggs (1965) found a similar result in a study that involved ground-based control of military airplanes as they intercepted enemy aircraft. Three-person teams received initial training on a board-based version of the task and were then asked to undertake a similar task on an electronic simulator. Various organizational aspects of the team were manipulated to observe their effects on performance during training and transfer. In one condition, a supervisor oversaw two subordinates who operated independently, in that they were each asked to monitor only half of the enemy aircraft. In a comparison condition, a supervisor oversaw two subordinates who were asked to monitor all the enemy aircraft as a team. Performance measures included amount of fuel consumed per session and number of successful interceptions per session. A key finding was that performance in the individual condition, which comprised the sum of each individual team members' performance, was superior to performance in the team condition.

Evidence of process loss in teams has also been provided in the sports domain. To investigate the effects of team size on team cohesion and performance, Widmeyer, Brawley, and Carron (1990) assigned college students to basketball teams of 3, 6, or 9 players that played 3-on-3 games in a basketball league on a weekly basis for a 10-week period. Teams of 6 outperformed teams of 3 and 9. It was asserted that the performance of the teams of 3 was negatively affected by fatigue, whereas the teams of other sizes were able to avoid this problem because they had enough players to rotate players in and out of play. The explanation of relative inferiority of performance by the teams of 9 was less clear, but Widmeyer et al. provided evidence that poor motivation as the explanation was unlikely. Instead, these authors argued that poor coordination was the most likely explanation, although coordination was not measured.

Knowledge Requirements for Achieving Coordination

In the studies just described, the process losses identified were often attributed to the need for team members in the team condition to coordinate their operations. In the studies by Kidd (1961) and Naylor and Briggs (1965), it was reported that the work required to achieve coordination impinged on the work associated with the task per se. By comparison, participants in the individual conditions were not required to coordinate their operations, and thus could focus exclusively on the task. In this regard, I/O psychologists have used the term *taskwork* to describe elements of a team member's task that are independent of fellow members' operations, and thus do not introduce the need for coordination. *Teamwork* is the term used to describe elements that are interdependent with fellow members' operations, and thus do introduce the need for coordination (McIntyre & Salas, 1995). Subsequently, the knowledge required to undertake taskwork has become known as *taskwork knowledge,* and that required to undertake teamwork as *teamwork knowledge.*

Consider this distinction in relation to football. A quarterback must acquire taskwork knowledge to be able to aim a pass so that it lands accurately in a given target location and time a pass so that it arrives punctually at a given target time. However, the ability of the quarterback to execute the pass accurately and punctually also relies on the acquisition of teamwork knowledge pertaining to the operations of the quarterback's receivers, because these operations dictate the target location and timing of the pass. Similarly, a team member who transfers between teams is able to rely on previously acquired taskwork knowledge in the new team to undertake taskwork elements of the task because these elements are unrelated to fellow team members, and thus are relatively constant across teams. However, the team member's previously acquired teamwork knowledge is of limited use in the new team because the teamwork elements of the task have changed. Furthermore, although the individual performer needs only taskwork knowledge to undertake his or her task, he or she must gain teamwork knowledge to work as part of a team, owing to the introduction of the requirement for coordination in team settings. An example is an individual rower who transfers to a four-person rowing team.

Teamwork knowledge can be further delineated as pertaining to (a) operations that are to be undertaken by the overall team, and more specifically, by those team members with which a given member must interact, over and above taskwork; and (b) how and when the given member's operations are to be integrated with those operations (Entin & Serfaty, 1999). Furthermore, both taskwork *and* teamwork require cognitive resources to undertake. Therefore, knowledge requirements, in the form of teamwork knowledge, and cognitive demands, imposed by teamwork processes, are imposed on team members that are not imposed on individual performers (Hutchins, 1991).

Team coordination is also facilitated if a subset of each team member's taskwork and teamwork knowledge is at least similar to a subset of this knowledge held by other team members, such that some taskwork and teamwork knowledge is *shared* by all team members (Cannon-Bowers, Salas, & Converse, 1993). The term *shared* in this instance means "held in common" (Dictionary.com, n.d.). To elaborate, considering just teamwork knowledge, a two-person team that includes you and me will achieve coordination more easily if the following state is obtained: Your knowledge of what you and I are going to do and when you and I are going to do it is similar to my knowledge of what you and I are going to do and when you and I are going to do it. If this state is met, coordination will be facilitated.

A key benefit of achieving a shared knowledge state is that each team member can generate accurate expectations about the behavior of the team and its constituent members, such that coordination can be achieved (Cannon-Bowers et al., 1993). These expectations afford each team member the ability to accurately anticipate the operations of the team so that the *appropriate team member* selects and undertakes *appropriate operations* at *appropriate times* in response to a given task. Consider a team that does not have a shared knowledge state. The members in the team possess knowledge about the operations that are to be undertaken by the overall team, and more specifically, by those team members with which a given member must interact, and about how and when the given member's operations are to be integrated with those operations. However, this knowledge differs among members. Consequently, although team members are as able to generate expectations about the team's operations as if the team had achieved a shared knowledge state, the expectations among the members are likely to be different. Thus, when the operations are undertaken, it is less likely that coordination will be achieved.

An interesting example of this occurs in the sport of mountaineering. A principal cause of mountaineering search-and-rescue operations is a situation in which a mountaineering team splits up during an expedition and arranges to meet again at some later time, but fails to achieve a shared knowledge state with regard to the meeting time and place. Consequently, the teams often fail to coordinate their operations and thus to meet. The subteams that result from the split often appear to possess knowledge about the meeting arrangements, but that knowledge is not shared among the members. In the words of the rescue services of the Alpine Club of Canada (n.d.), "A high number of searches result simply from parties splitting up while not coming to reasonable understandings about who is going to do what."

This concept is also manifested in the everyday language of individuals operating in teams in phrases such as "reading from the same page." A similar phrase, "playing from the same playbook," originates in football. A playbook is developed by football coaches and comprises plans of the movements of each player for discrete game plays. Players are required to study their team's playbook to gain knowledge of the team's operations for each play. Because the playbook is a stable source of information about planned operations, each player can study the playbook independently, but the knowledge each obtains should be the same as that obtained by other team members, which affords the team a shared knowledge state.

However, various researchers have asserted that not all knowledge possessed by a team member needs to be shared by other members (Entin & Serfaty, 1999). For example, although a quarterback possesses some knowledge of receiving, this knowledge is only a subset of a receiver's knowledge of receiving. Moreover, a trade-off exists in teams between specialization and generalization. Thus, all team members will share *general team knowledge* pertaining to overall team strategies, but team members who interact more regularly than others will additionally share more *specific knowledge* about each others' operations (Cannon-Bowers et al., 1993; Entin & Serfaty, 1999). For example, a rugby union forward player will share general team knowledge with the back players—such as knowing that the team strategy is to attack down the right wing—but will share more detailed knowledge with colocated forward players about each others' operations, owing to their more frequent interaction.

Factors Affecting the Requirement to Coordinate

Coordination requirements appear to be affected by the characteristics of both the team and the task that is being undertaken (Steiner, 1972; Widmeyer et al., 1990). One such characteristic is the size of the team. The relationship between team size and coordination is exponential if every team member's operations must be coordinated with every other member's operations. If the coordination of operations between two team members is considered a coordination link (Carron & Hausenblas, 1998), the number of coordination links for a given group size is determined by the following formula:

$$\text{Coordination links} = \frac{N(N-1)}{2} \qquad (12.1)$$

where N equals the number of team members. If two people crew a sailboat, there is only one coordination link between team members, but if eight people crew the same sailboat, providing four times the resources, there is the potential for 28 coordination links. Thus, as team size increases, there is the potential for an exponential increase in the cognitive resources required to undertake teamwork.

Some tasks involve minimal coordination because the task requires that team members engage mostly in taskwork (i.e., work independently); others involve substantial coordination because members must also engage in teamwork (i.e., work interdependently), exemplified by the concept of a coordination link (Saavedra, Earley, & Van Dyne, 1993). Sports involving a high level of teamwork, such as basketball and soccer, have been described as *interactive* and those involving a low level of teamwork, such as archery and golf, *coactive* (Cratty, 1983). Football and relay swimming contain both interactive and coactive task elements. There is a negative relationship between the coordination requirements of a sport and the contribution of individual performance to overall team performance. Jones (1974, cited in Cratty, 1983) found that the correlation between these variables was .94 in baseball but .60 in basketball. The difference was attributed to the high level of teamwork that characterizes basketball compared to baseball.

Tasks can also vary over their time course in terms of coordination requirements. Some periods of a task can require teamwork, such as during a relay race baton handover, and others just taskwork, such as relay race running. Tasks can also vary over their time course in terms of taskwork. Periods of high taskwork demand can cause a concurrent increase in teamwork, as team operations must be coordinated to ensure a successful response to the increase in taskwork (Bowers, Morgan, Salas, & Prince, 1993). The combined increases in taskwork and teamwork often lead to rapid escalations in cognitive demands (Patterson, Watts-Perotti, & Woods, 1999; Woods & Patterson, 2000).

Patterson et al. (1999) used observational methods to study the relationship between workload demands on and the coordination of the operations of NASA's ground-based space shuttle mission control crew. In one shuttle launch studied, an unexpected event occurred, which was a sudden drop in hydraulic fluid pressure in the shuttle. The sudden and unexpected increase in taskwork needed to resolve the problem required operations to be coordinated between the shuttle crew and multiple members of the physically distributed ground crew. Although no objective measures of coordination or performance were taken, Patterson et al. asserted that the team was suddenly presented with not only a high taskwork demand, but also a high teamwork demand. However, Patterson et al. described how the crew made use of voice loop technology to help coordinate their operations; this was a real-time auditory channel that enabled the distributed crew members to listen selectively and speak selectively to other members. It is the communication required for coordination that is the focus of the next section.

Communication for Coordination

Similar to considerations of coordination in sports teams, communication in sport teams have been considered primarily from a social perspective. Researchers have been concerned predominantly with the impact of social constructs on communication, or vice versa. For example, Carron and Hausenblas (1998) reviewed evidence of how intrateam communication is effective to the extent that the team is homogeneous in terms of characteristics such as age and educational attainments. Communication has also been studied in terms of its effect on team cohesion and conflict, and in terms of social pressure and conformity (Carron & Hausenblas, 1998). Consistent with this orientation, recommendations for improving team communication have included creating opportunities for team member socializing and promoting member discussions. Although not explicitly stated, the treatment of communication in the chapter on this topic by Weinberg and Gould (2003) relates to the impact of communication on team cohesion. The social orientation is further reflected in the only current measure of communication in sport, presented by Sullivan and Feltz (2003), which pertains predominantly to aspects of team cohesion. No consideration has been given to the role communication plays in achieving team coordination (cf. Carron & Hausenblas, 1998), and so the remainder of this section is concerned with this topic.

Communication is a key method by which teams achieve shared knowledge. Consequently, communication quality and quantity affect the ability of team members to acquire a shared knowledge state (MacMillan, Entin, & Serfaty, 2004). Communication can be conceptualized in cognitive terms as a process of information transfer characterized by stages (Adler & Rodman, 2002): First, the cognitions of the intended sender must be encoded as a message and sent via some channel; second, the message must be received by the intended recipient; third, the message must be decoded by the intended recipient and interpreted correctly. Communication can be disrupted at any stage: The message might be encoded incorrectly; the intended recipient might not receive a sent message owing to disruptions such as noise; and the receiver might lack sufficient knowledge of the sender's code or fail to interpret the message correctly. Thus, the process of communication takes time, requires cognitive resources, and is subject to disruption (Casali & Wierwille, 1983; Entin & Serfaty, 1999; MacMillan et al., 2004). Therefore, communication becomes problematic during performance owing to concurrent taskwork demands.

In Kidd's (1961) study of teams undertaking an air traffic control simulation task, the team leader in a three-person team spent 30% of his time communicating in order to coordinate team operations. This was one explanation for the lack of performance gain that occurred when the human resources brought to bear on this task were increased from one to three persons; as Naylor and Briggs (1965, p. 228) stated, "Interaction (verbal communications between operators) does not exist for a single operator working alone." Also, MacMillan et al.'s (2004) studies of military command and control settings revealed that teams reported more workload under high coordination conditions, which was attributed partly to the need for increased communication.

There are different types of communication, each of which has benefits in terms of achieving coordination and costs in terms of time and cognitive resources. Communication can be intentional or unintentional and verbal or nonverbal. Intentional communication occurs when a sender intentionally sends a message to one or more recipients. Intentional verbal communication is a flexible method of communication because humans share a vast code, in the form of natural language, with which to encode and decode cognitions. Intentional nonverbal communication can be used where verbal communication is not possible or desirable, such as when two team members are located distally so that hearing a verbal message is problematic. However, in inexperienced teams, messages transferred via intentional nonverbal communication have a less specific code, which can confuse team members. Both types of communication can also be used to encrypt messages so that only the intended recipient can interpret the message: The football quarterback communicates intended play configurations to the offensive line using a verbal code unknown to the opposing team; baseball coaches communicate intended pitches to the catcher using a nonverbal code unknown to the opposing team. However, encrypted messages generally have a smaller code than natural language, placing constraints on the flexibility of communication. The flexibility of intentional verbal communication might be of benefit to coordination, but it is a costly type of communication in terms of time and cognitive resources because of the need to encode cognitions and interpret messages. These resources might not be available owing to the demands imposed by concurrent taskwork. Studies of aircrew communication (e.g., Orasanu, 1993) have revealed that experienced teams avoid such communication during periods of high demand owing to its costs.

Unintentional communication occurs when an individual unintentionally sends messages to recipients. Unintentional verbal and nonverbal communication can provide important information to a team member about the operations of other team members (Wittenbaum, Vaughan, & Stasser, 1998). Unintentional verbal communication is rare, but unintentional nonverbal communication is always available to the extent that team operations are sensible. For example, team members (message recipients) can gain information by seeing or hearing the operations being undertaken by other members (message senders). A sensed operation might provide members with information about task status changes or serve as cues for members to perform operations that must be integrated with the sensed operation (Hutchins, 1995). On a sailboat, foredeck crew might be unable to hear commands spoken at the stern owing to noise from the sea. However, if they observe the tiller operator shifting into a position conducive to swinging the tiller from one side of the boat to the other, they can anticipate a tack or jibe maneuver and begin to undertake the foredeck operations required for such a maneuver.

Unlike intentional communication types, unintentional nonverbal communication has cognitive costs to the sender because it is incidental to their operations and is convenient for the receiver because it is often available. However, unlike intentional communication, the ability to interpret observed operations relies on the team's having achieved a shared knowledge state with regard to team operations (MacMillan et al., 2004).

Recently, researchers have compared the communication used by humans to achieve coordination to that used by animals to achieve the same end (e.g., Eccles & Groth, 2004; P. Feltovich, personal communication, August 27, 2003). Animals exhibit displays that, like those of humans, allow or disallow other animals to collaborate and allow the prediction of future operations (Smith, 1977). For example, animals have ways to display a readiness of opportunity to interact, which include various forms of chirping or bowing. By contrast, various forms of sticking out the tongue and vocalizations at unusual frequencies indicate an absence of opportunity to interact. Species that depend on coordinated locomotion, such as geese (which fly as a group), use locomotion displays to indicate that the animal is about to move; these include head tossing in geese and dances in honeybees (Smith, 1977).

Temporal Aspects of Achieving Team Coordination

A team can achieve a shared knowledge state prior to, during, and after performance, known as *pre-, in-,* and *post-process coordination,* respectively (Fiore et al., 2003). Preprocess coordination comprises preparatory behaviors that enable a team to achieve a shared knowledge state prior to performance. Such behaviors include deciding on goals, planning, and allocating role responsibilities (Weldon & Weingart, 1993; Wittenbaum et al., 1998). Preparatory behaviors often rely on intrateam communication, which is primarily in the form of intentional verbal communication (MacMillan et al., 2004) and is exemplified by a coach's talk to the team on team plans and strategies for an upcoming game.

Stout, Cannon-Bowers, Salas, and Milanovich (1999) studied teams of two undertaking surveillance missions in a helicopter simulator. The task was designed so that teamwork was required (i.e., operations were interdependent). In particular, the task necessitated that appropriate task information was communicated to appropriate team members at appropriate times. After receiving practice, the participants were provided with the mission requirements and a session for planning how to undertake the mission. Observers rated the planning quality of the teams on nine planning dimensions, which included clarifying roles and preparing information. Members in teams that were rated as having engaged in higher quality planning processes performed better, where performance was measured as the number of errors (e.g., errors in helicopter navigation) committed during the task. They were also better able to anticipate other members' information requirements during performance and communicated that information in advance of its being requested. It is likely that planning enabled team members to develop shared knowledge relating to other members' information requirements, which in turn afforded better anticipation of these requirements during performance.

Planning is a key component of preprocess coordination and involves deciding on, and subsequently specifying, the intended courses of team operations. Plans can specify operations at different levels of organization based on the level of plan abstraction, ranging from specific to general (cf. Hayes-Roth & Hayes-Roth, 1979). Plans at the general end of this continuum specify macrolevel rather than microlevel operations, such as overall team plans and strategies. Thus, general plans are useful in the coordination of sports that are continuous and in which the environment is dynamic, open, and difficult to predict. This is because general plans help achieve a relative degree of operational structure by specifying operations, in terms of their nature and timing, only at a macrolevel while allowing flexibility and adaptation in the nature and timing of operations at a microlevel. An example of such a sport is soccer, and an example of a general plan is to attack down the wings in the first half of the game. This plan specifies the nature of the operations, in that the team should attack down the wings, and the timing of these operations, in that the attacks should be made in the first half of the game; however, it does not specify in any detail the series of operations involved in attacking down the wings or when these attacks should be made in the second half. Thus, the team can be flexible and adaptive in the nature and timing of these attacks, which is necessary given that elements of the task of soccer are often difficult to predict (such as when a player unexpectedly makes a poor pass that travels to the feet of an opposing player) and that the team must be able to attack opportunistically as a consequence.

Plans at the specific end of this continuum specify microlevel operations, in that they include specifying in more detail the nature and timing of team members' operations. Thus, specific plans are useful in the coordination of team sports characterized by discrete sequences of operations because they achieve a high degree of operational structure at a microlevel. Football is an excellent example of a sport in which members' operations are preplanned in relative detail, as discussed earlier in the chapter. However, although football might be further toward the specific end of a general-to-specific planning continuum, this does not mean that team operations in football are fully specified, simply that they are more specified than, say, soccer. There remains in football flexibility, even in a specified receiver route. A receiver and quarterback memorize a planned route. The receiver will run this route and at its culmination prepare to receive the quarterback's pass. However, with regard to the spatial element of this plan, the plan allows that the route will culminate anywhere within an area of the field that is a subset of the area of the overall field, but this is rarely a definitively specified point. Thus, flexibility is still afforded by the plan and is necessary owing to a variety of reasons, such as the need for the receiver to evade defenders. For the same reasons, and with regard to the temporal element of this plan, the plan allows that the route will culminate within a period or window of time, but this is rarely a definitively specified point in time.

In many sports, in-process coordination is problematic compared to pre- or postprocess coordination because the time and cognitive resources required for coordination, and the communication required for coordination, are scarce owing to concurrent taskwork demands. These constraints mean that any planning undertaken during performance to coordinate responses to task status changes tends to result in plans that are limited in terms of complexity, and thus limited in terms of the plan's effects on performance over space and time. Consequently, planning is limited in effect to the coordination of a subset of the team, task, or performance duration (Patterson & Woods, 2001).

Teams also utilize knowledge of situational probabilities to achieve in-process coordination, especially when a reliance on plans is less appropriate, such as in many situations in dynamic sports. Team members combine sensed information about the current task status with previously acquired taskwork and teamwork knowledge to attach a hierarchy of probabilities to the likelihood of upcoming changes in the task status and upcoming responses by their fellow team members to the current and possible future task status (Ward & Williams, 2003). Consequently, team members are able to coordinate their own operations with the overall team operations.

Postprocess coordination comprises postperformance evaluative behaviors that facilitate the acquisition of shared knowledge by team members pertaining to coordination successes and failures (Smith-Jentsch, Zeisig, Acton, & McPherson, 1998). Team members often view films of previous performances to identify together "coordination breakdowns" (Smith-Jentsch, Zeisig, et al., 1998, p. 272). Such feedback is often used to inform remediation activities. Thus, postprocess coordination can inform preprocess coordination.

Blickensderfer, Cannon-Bowers, and Salas (1997) tested the effectiveness of training teams to evaluate their performance, identify errors, and plan to correct these errors in future performances. Three-person teams monitored a radar screen displaying allied and unidentified craft. The team had all the pieces of information required to complete the task, but each member possessed only a subset of the information, and thus interdependency was created within the team in the form of the requirement to share information. Teams completed a pretest on the task before being assigned to a self-correction training or control condition, the former of which involved a videotaped discussion on the role of self-correction, and directions for reviewing the task and planning future operations. Subsequently, self-correction practice sessions were undertaken involving a task requiring team coordination, such as preparing documents to be mailed. Teams then undertook several posttest sessions of the task and were allowed to engage in self-correction between the sessions. Teams completed a questionnaire developed to assess shared knowledge, which related to expectations about team roles, strategy, and communication patterns. Using a Likert-type scale ranging from "unlikely" to "very likely," each participant was asked to estimate the likelihood of the selection by the team of each of a range of possible responses to a given stimulus, such as "Your team will first examine the fastest moving contacts" versus "Your team will first examine contacts closest to the circle of fear." The results were interpreted as providing evidence that self-correction training had led to increased self-correction behaviors and subsequently had a higher degree of shared knowledge relating to expectations of team operations. However, there were no significant differences in performance between conditions.

In a similar study, Rasker, Post, and Schraagen (2000) examined the role of intrateam evaluation on team performance. Two-person teams undertook a computer-based firefighting task requiring coordination between team members. Teams were required to strategically allocate resources to contain several fires occurring in a city. One member was allocated the task of observing the display to track the status of the fires, and the other the task of allocating firefighting resources. Rasker et al. compared the performance of teams that were allowed to evaluate and self-correct their performance between trials to those that were not. Performance was superior for teams that were able to evaluate their performance. Thus, Rasker et al. concluded that teams that were given the opportunity to evaluate their performance were able to determine strategies that enabled members to better coordinate their operations in future trials.

Coordination and Communication in Expert Teams

Team properties and processes change as the team acquires expertise (Kraiger & Wenzel, 1997; McIntyre & Salas, 1995). Principally, team members' taskwork and teamwork knowledge becomes more refined and better shared with other team members. Through experience and practice, team members gain knowledge of the habits, preferences, and idiosyncrasies of their fellow members with regard to the operations they are likely to perform for a given task status change, which leads to a refined and shared knowledge of situational probabilities. Through experience and practice, team members also gain a refined and shared knowledge of an extensive repertoire of team plans and set routines across a range of specificity and contingent on a range of task statuses (Gersick & Hackman, 1990; MacMillan et al., 2004; Stout et al., 1999). In addition, members of expert teams can use this knowledge to interpret accurately and efficiently unintentional nonverbal communication from teammates and thus obtain information about task status changes and known and likely responses to those changes by team members.

Members of expert teams also develop memory adaptations that provide memory support for the creation and maintenance of elaborate problem representations that keep active taskwork knowledge pertaining to the current and possible future status of the task and teamwork knowledge pertaining to possible responses by fellow team members to the task status (cf. Ericsson & Kintsch, 1995; McPherson, 1999). These memory adaptations also support monitoring, evaluation, and planning processes that enable the expert to respond flexibly to changes in the task status. Ultimately, these changes enable expert teams to achieve in-process coordination implicitly (Entin & Serfaty, 1999). Implicit coordination, in contrast to explicit coordination, occurs when members are not required to describe or explain explicitly intended team operations to any other team member for a given task status change. Thus, teams rapidly and flexibly respond to such changes with a minimal coordination decrement (Cannon-Bowers, Salas, Blickensderfer, & Bowers, 1998; Entin & Serfaty, 1999; Gersick & Hackman, 1990). This is of particular benefit during periods of the task characterized by high workload (Wittenbaum et al., 1998) because the cognitive resources required for coordination during these periods are reduced and, in turn, made available for taskwork (Gersick & Hackman, 1990).

Even when expert teams must undertake explicit in-process coordination, and thus make greater use of intentional communication, the costs associated with this form of communication are reduced (McIntyre & Salas, 1995). Members of expert teams develop a shared knowledge of a highly specific code to achieve intentional verbal communication and intentional nonverbal communication, which is reflected by succinct, domain-specific, and standardized messages (Kanki, Folk, & Irwin, 1991; Kanki, Lozito, & Foushee, 1989; Smith-Jentsch, Johnston, & Payne, 1998). This reduces communication costs in various ways, such as by increasing the quality and quantity of information transferred in a given communication and increasing the accuracy and reliability of message interpretation.

Bastien and Hostager (1988) provided an interesting example of efficient, explicit in-process coordination in their study of music bands. These authors reported that what appeared to be spontaneous jamming was actually concurrently (i.e., in-process) coordinated through band members' communication in the form of intentional verbal and nonverbal codes that "have become a tradition in the profession" (p. 588). These codes could be interpreted correctly by other band members owing to the band's having achieved a shared knowledge of these codes. Examples of the nonverbal codes are turning to an individual, making eye contact at particular points in the performance, and changing the volume of one's playing. These codes allowed the musicians to communicate so that in-process coordination could be achieved but remained relatively undetectable to the viewing audience.

In a more traditional I/O setting, Kanki et al. (1991), through the use of aircraft simulators, studied the communication patterns of 18 aircrews with different error rates during landings. Errors were identified and tabulated by raters who inspected videotaped performances of the simulated flights. Crew communications were coded into categories, such as commands, questions, observations, replies, and acknowledgments. The frequencies of utterance dyads, defined as an initiating utterance followed by a response utterance, were then computed. One variable of interest in the study was communications variation, described as the degree to which a given crew varied from the overall expected frequencies generated from an analysis of all crews' communications. The communication variations of low-error crews were very low compared to high-error crews, suggesting that a standard and specific communication code had been adopted in low-error crews. Kanki et al. proposed that, by adopting such a code, the within-crew communications were less open to interpretation and thus had become more efficient, which aided coordination.

Lausic, Eccles, Jeong, Johnson, and Tenenbaum (2005) recently undertook a study of communication between winning and losing tennis doubles teams. College-level teams were videotaped while playing. Verbal communications were coded as uncertainty statements, action statements, acknowledgments, factual statements, non-task-related statements, or emotional statements. Sequential analysis methods were used to compute the transitional probabilities within all dyadic combinations of statement types and whether these probabilities departed from expected frequencies. The number of points played by winning and losing teams was equal, creating equal opportunity for the two teams to communicate. However, the results revealed that winning teams communicated twice as much as the losing teams but did not differ from losing teams in terms of the number of utterance dyad types in which they engaged. However, the winning teams made very frequent use of only a few dyads, which predominantly involved an action statement. An example of such a dyad is an initiating utterance, "What are you doing on this point?" which was coded as an uncertainty statement, and a response, "Let's play 'I' formation, go-out-wide," which was coded as an action statement. Note that the action statement appears to be the team members' attempt to achieve prior to the upcoming point a shared knowledge state relating to a planned sequence of coordinated operations. By comparison, the losing teams used all the dyads with a similar frequency, and thus used fewer dyads involving an action-related statement, which was interpreted as being less beneficial for coordination.

Methods and Measures Relating to the Study of Team Coordination and Communication

A key challenge when presenting any new conceptual framework is to develop objective, valid, and reliable measures to begin to test hypotheses afforded by the framework. There are currently no measures of coordination and only one measure of communication in sport. However, much research effort has been devoted to studying teams in the I/O psychology domain, and various methods and measures have been developed for the study of coordination. The relative merits of these methods are discussed in the next section. Following this, several specific methods are described in more detail.

Many studies of coordination in teams operating in I/O domains have been undertaken in the field. One reason is that the individuals operating in these domains have been unwilling or unable to be detached from the field to engage in controlled laboratory studies (e.g., military personnel are often too busy). However, many I/O domains, such as command and control, involve large human and machine systems that comprise multiple, interacting, and dynamic elements. Consequently, researchers in I/O psychology have argued that ecological validity is too heavily compromised when aspects of these environments are studied in the laboratory (Hutchins, 1995). Thus, many studies of team coordination in I/O domains have involved methods associated with anthropological and sociological field studies, such as observations, augmented by note taking and video recording and interviewing. This is the case in the studies of teams involved in space shuttle mission control (e.g., Patterson & Woods, 2001), naval ship operations (e.g., Hutchins, 1995), and simulations of expeditions on the planet Mars (e.g., Clancey, 2001). Furthermore, researchers studying cognition in these types of domains have proposed the terms *cognitive anthropology* (e.g., Hutchins, 1995), and *cognitive ethnography* (e.g., Ball & Ormerod, 2000) to describe their approaches.

The advantages of these approaches include providing a rich and detailed insight into the functioning of teams as they operate in the real world, yet they are not without their critics. Researchers more familiar with experimental approaches to scientific inquiry often criticize such methods as inherently subjective and remain skeptical of their scientific value. Furthermore, even when more controlled studies of team functioning have been undertaken in I/O domains, progress in developing objective measures of team processes or performance has not been substantial. Measures are often in the form of subjective ratings of a given variable (e.g., communication quality) undertaken by socially recognized subject-matter experts (see Ward et al., in press). However, given the nature of the teams and the environments in which they operate in these domains (i.e., comprising multiple, interacting, and dynamic elements), there has been limited progress in developing objective measures. The challenge facing sport psychologists is to develop methods and measures of coordination given the potential for the tradeoff between internal and ecological validity introduced by sport team environments. A brief description of a selection of these measures follows to provide insight into the variety of measures of team coordination and communication that have been used in I/O psychology. Note that the only goal of this section is to introduce these methods, and so, to achieve brevity, the results of some of the studies discussed are not provided.

Template-based analysis has been used to analyze coordination in tasks wherein operations are performed in discrete sequences (Xiao & The LOTAS Group, 2001). This involves creating a template of the nature and timing of a team's operations and of the team members who perform those operations for a prototypical task. For example, in football, there are a variety of discrete and sequenced plays learned by the team that could be (and usually are) specified in a template form. The actual performance of team operations is compared to the template. Expert observers, such as coaches, undertake the comparison process. Performance scores are allocated for each team member and correspond to each appropriate operation undertaken at the appropriate time. For example, a football receiver who runs an incorrect route would be allocated a poor score. Consequently, team members who undermine coordination can be identified and their actions corrected. Template-based analysis might be adapted for dynamic tasks by selecting segments of the task that can be treated as discrete, such as a tack or jibe in sailing.

Hutchins (1995) described a qualitative method of representing coordinated team operations called an *activity score.* The score is a graph on which is plotted the temporal pattern of operations for a given task and the team members involved in performing those operations. Depicting the operations on the score makes clear the relation of time, team member involvement, and operations that constitute coordinated behavior. In terms of its application, the graph could be used for comparisons between teams of different skill levels, as a graphic version of a template for template analysis, and as a diagnostic and evaluation tool for identifying coordination breakdowns. Advances in video and audio recording and analysis methods (e.g., *Observer,* 2003, and RATE software) have made measuring a variety of coordination variables for one team performance faster and less labor-intensive.

Achieving shared knowledge affords team members an accurate anticipation of other team members' operations. MacMillan et al. (2004) proposed that an indirect method of assessing the extent to which knowledge has been shared is to assess the team's anticipation ratio (AR), which is the ratio of members' frequency of requests for information to the frequency of transfers of information via intentional verbal communication. Shared knowledge is indicated by a team member offering information in advance of the recipient's request. Thus, if N_t represents the number of communications transferring information to members, and N_r represents the number of communications requesting information, then

$$AR = \frac{N_t}{N_r} \qquad (12.2)$$

MacMillan et al. argued that shared knowledge is indicated by a ratio less than 1 : 1. The anticipation ratio has been shown to predict team performance in military settings (Entin & Serfaty, 1999; Serfaty, Entin, & Johnson, 1998). This methodology might be suited to sports teams characterized by the need for and feasibility of verbal communication of task-relevant information, such as mountaineering teams.

Kraiger and colleagues (Kraiger, Ford, & Salas, 1993; Kraiger & Wenzel, 1997) proposed a knowledge-based method of assessing shared knowledge. Tasks are described to the team, for which a correct sequence of operations is known for each team member. Members are then asked what operations another member would be expected to perform at a given point in the sequence. Alternatively, members watch together a video of a recently played game. At selected segments of the game, subsequent segments are occluded, and members are asked what operations another member would be expected to perform during this segment. Shared knowledge (SK) would be indicated by the agreement rate between members. Thus, if in one "occluded situation" the total number of members' anticipated solutions was $N_{as,}$ and of shared solutions was $N_{ss,}$ then

$$SK_i = \frac{N_{ss}}{N_{as}} \qquad (12.3)$$

and across many anticipated situations

$$SK = \frac{\sum SK_i}{k} \qquad (12.4)$$

where k is the number of situations given.

Kraiger and colleagues (1993) also proposed a similar method in which members are presented with written sequences of other members' operations and asked to articulate reasons why those operations were necessary. Furthermore, these authors suggested using a card-sorting task to measure shared knowledge. A task is described to the team, and members are provided individually with cards denoting various task elements. Team members are then asked to sort the cards into categories of similar concepts and then label the concepts and any similarity between them. Concepts that overlap with other members' concepts should indicate shared knowledge. This method could also be used to discriminate between teams with different experience levels (cf. Chi, Feltovich, & Glaser, 1981).

With regard to measures of communication, Bowers, Jentsch, Salas, and Braun (1998) explored how the *type* of intentional verbal communication differed between high- and low-performing aircraft crew members operating in a simulator. Crews undertook low-level reconnaissance missions involving the identification of buildings, and performance was measured as the number of buildings identified. The task required crew members to coordinate their operations. The communication between the crew members was video recorded and assigned by observers to preselected categories. These included uncertainty statements, such as direct and indirect questions; acknowledgments, such as yes and no; responses, which differed from acknowledgments only in that they conveyed more than one bit of information; planning statements; factual statements, which include verbalized, readily observable realities of the environment; and non-task-related statements. Analyses of single-statement and statement-response data were made and compared across teams.

Serfaty et al. (1998) explored the relationship between intrateam intentional verbal communication *quality* and team coordination by devising a communication quality scale. This comprised seven points ranging from poor to good communication, on which observers rate the communication of performing teams on dimensions such as the ability to pass information, clarify information, and use proper terminology. Smith-Jentsch, Johnston, et al. (1998) devised a similar scale with dimensions such as inaudible and incomplete communication and excess chatter. Xiao and The LOTAS Group (2001) explored the relationship between intrateam intentional verbal communication *direction* and team coordination by employing flow pattern analysis, by which the frequency of the direction of intentional verbal communication between team members was tabulated for a given task. A schematic diagram of intrateam flow is often created to better identify flow differences between members.

Implications of Coordination Concepts for Sport Psychology Practitioners and Coaches

Based on team research in I/O psychology, various recommendations for enhancing team coordination are offered next. These have received only limited testing in real-world sporting contexts, so some trialing is recommended to test their efficacy.

Use Pre- as Well as Postmortems

In sports postmortems, coaches and team members discuss video footage of prior games to identify causes of coordination breakdowns and generate solutions to remediate these problems. Military researchers have been testing the use of premortems to critique military plans. Where, when, and why might coordination break down? How might the breakdowns be rectified at the time? Attempts to perform premortems with sports teams might provoke members into thinking about possible errors and contingent recovery strategies.

Use Check-Backs to Evaluate Comprehension

During pregame planning, there might be a benefit in developing methods to check whether each team member understands the plans and his or her role in them. Coaches might normally allow players to come forward with queries about plans while they are being developed or explained; developing a routine of checking back with each team member that he or she fully understands the plans is likely to reduce miscomprehensions and also increase members' accountability. In this regard, military teams use check-backs that vary in terms of thoroughness, and their use will depend on time constraints and the implications for performance of comprehension failures. These include structured opportunities for team members to say "I don't understand" when plans are described to the team. Reducing team members' confusion about team plans is likely to enhance coordination.

Train Situational Probabilities

Recent studies (see Ward & Williams, 2003; Williams, Ward, Herron, & Smeeton, 2004) have provided evidence that having team members study videos and match statistics from previous games can enhance their knowledge about situational probabilities. From these sources, the team together identifies players' typical responses in a given situation. Another method is to describe to a team a sequence of actions for which a correct sequence is known for each team member. Team members are then asked what actions another player would be likely to perform at a given point in the sequence. Alternatively, members watch a video of a recently played game. At selected segments of the game, subsequent segments are occluded, and members are asked what actions another member would be expected to perform during this segment. Remediation activities can be targeted at players' weaknesses in knowledge.

Use Cross-Training

I/O psychologists have advocated cross-training in the development of shared teamwork knowledge. This involves team members spending time in another member's role or position so that they gain a better appreciation of how to coordinate their own actions with other members' actions.

Develop a Shared Language

This language should be short and not easily confused with other messages and should convey specific information so that everyone understands exactly what message is being transferred. The language can be both verbal (shouts) and nonverbal (gestures) and can also be encrypted. Message senders can better signal which team member is the intended recipient by having the team develop succinct nicknames. These can also be encrypted so that the opposing team does not know who is being sent messages.

CONCLUSION

In this chapter, we have argued that an understanding of team functioning in sport will be enhanced if the topic is studied from a social-cognitive perspective. Traditionally, team functioning in sport has been considered predominantly from a social perspective, and research on cognitive aspects of sports performance has been concerned predominantly with the individual. Consequently, little attention has been paid to interactions between an individual's cognition and the social processes and settings of teams. Specifically, we have proposed that the adoption of a social-cognitive perspective on team functioning will allow greater insight into (a) the cognitive affects of social processes inherent to teams and on which the extant research on teams in sport has been focused; (b) how the social properties and process inherent to teams affect team cognition, such as that underlying team decision making; and (c) how a team achieves coordination.

There are limitations to the research in I/O psychology and on social cognition. The concepts proposed in these domains have tended to be theoretically well developed but lacking in extensive empirical support. This claim is made even by those from within the domain (Rentsch & Davenport, in press). Furthermore, although it would be difficult to argue against the claim that it is self-evident that coordination is an important component of team performance, there have been few attempts in the I/O domain to measure coordination and successfully relate it to performance outcome measures. In addition, some authors (e.g., Eccles & Ward, in press) have taken issue with the use of various terms for concepts in the I/O psychology literature, labeling them confusing or nebulous (e.g., preprocess coordination, premortem). However, the goal of this chapter has been to introduce to sport psychologists a range of concepts from research on teams in I/O psychology and on social cognition, and thus it would have been inappropriate to describe these concepts without using the terms given to them by researchers in these domains.

A key challenge for future research in this area is to develop valid and reliable methods and measures that will facilitate investigations of the interactions between social and cognitive aspects of team functioning in sport. A social-cognitive perspective on team functioning, which has not been considered previously in sport psychology, provides a substantial extension of what is known today about teams in sport.

REFERENCES

Adler, R. B., & Rodman, G. (2002). *Understanding human communication* (8th ed.). New York: Oxford University Press.

Alpine Club of Canada. (n.d.). *Alpine accidents in Canada.* Retrieved June 6, 2006, from http://alpineclub-edm.org/accidents.

Anderson, R. C., & Pichert, J. W. (1978). Recall of previously unrecallable information following a shift in perspective. *Journal of Verbal Learning and Verbal Behavior, 17,* 1–12.

Baldwin, M. W., Carrel, S. E., & Lopez, D. F. (1990). Priming relationship schemas: My advisor and the pope are watching me from the back of my mind. *Journal of Experimental Social Psychology, 26,* 435–454.

Ball, L. J., & Ormerod, T. C. (2000). Putting ethnography to work: The case for a cognitive ethnography of design. *International Journal of Human-Computer Studies, 53,* 147–168.

Bastien, D. T., & Hostager, T. J. (1988). Jazz as a process of organizational innovation. *Communication Research, 15,* 582–602.

Blickensderfer, E., Cannon-Bowers, J. A., & Salas, E. (1997). Theoretical bases for team self-correction: Fostering shared mental models. In M. Beyerlein, D. Johnson, & S. Beyerlein (Eds.), *Advances in interdisciplinary studies of work teams* (Vol. 4, pp. 249–279). Greenwich, CT: JAI.

Bowers, C. A., Jentsch, F., Salas, E., & Braun, C. C. (1998). Analyzing communication sequences for team training needs assessment. *Human Factors, 40,* 672–679.

Bowers, C. A., Morgan, B. B., Salas, E., & Prince, C. (1993). Assessment of coordination demand for aircrew coordination training. *Military Psychology, 5,* 95–112.

British Broadcasting Corporation. (n.d.). *Wilkinson: Team spirit won the world cup.* Retrieved June 6, 2006, from http://news

.bbc.co.uk/sport2/hi/rugby_union/rugby_world_cup/3230650.stm.

Cannon-Bowers, J. A., Salas, E., Blickensderfer, E. L., & Bowers, C. A. (1998). The impact of cross-training and workload on team functioning: A replication and extension of initial findings. *Human Factors, 40,* 92–101.

Cannon-Bowers, J. A., Salas, E., & Converse, S. A. (1993). Shared mental models in expert decision making teams. In N. J. Castellan Jr. (Ed.), *Current issues in individual and group decision making* (pp. 221–246). Hillsdale, NJ: Erlbaum.

Carron, A. V., & Hausenblas, H. A. (1998). *Group dynamics in sport* (2nd ed.). Morgantown, WV: Fitness Information Technology.

Casali, J. G., & Wierwille, W. W. (1983). A comparison of rating scale, secondary-task, physiological, and primary-task workload estimation techniques in a simulated flight task emphasizing communications load. *Human Factors, 25,* 623–641.

Chi, M. T. H., Feltovich, P. J., & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. *Cognitive Science, 5,* 121–152.

Clancey, W. J. (2001). Field science ethnography: Methods for systematic observation on an expedition. *Field Methods, 13,* 223–243.

Comrey, A. (1953). Group performance in a manual dexterity task. *Journal of Applied Psychology, 37,* 85–97.

Cratty, B. J. (1983). *Psychology in contemporary sport: Guidelines for coaches and athletes* (2nd ed.). Englewood Cliffs, NJ: Prentice-Hall.

D'Andrade, R. (1981). The cultural part of cognition. *Cognitive Science, 5,* 179–195.

Dictionary.com. (n.d.). Retrieved June 6, 2006, from www.dictionary.com.

Eccles, D. W., & Groth, P. (2004, October). *Wolves, football, and ambient computing: Facilitating collaboration in problem solving systems through the study of human and animal groups.* Proceedings of the NordiCHI annual conference, Tampere, Finland (pp. 296–275). Available from http://portal.acm.org/citation.cfm?id=1028055&dl=GUIDE&coll=. Retrieved June 6, 2006.

Eccles, D. W., & Tenenbaum, G. (2004). Why an expert team is more than a team of experts: A cognitive conceptualization of team coordination and communication in sport. *Journal of Sport and Exercise Psychology, 26,* 542–560.

Eccles, D. W., & Ward, P. (in press). Commentary on special issue on team cognition and expert teams: Emerging insights into learning and performance for exceptional teams. *International Journal of Sport and Exercise Psychology.*

Entin, E. E., & Serfaty, D. (1999). Adaptive team coordination. *Human Factors, 41,* 312–325.

Ericsson, K. A., & Kintsch, W. (1995). Long-term working memory. *Psychological Review, 102,* 211–245.

Fiore, S. M., Salas, E., Cuevas, H. M., & Bowers, C. A. (2003). Distributed coordination space: Toward a theory of distributed team process and performance. *Theoretical Issues in Ergonomic Science, 4,* 340–364.

Gersick, C., & Hackman, J. R. (1990). Habitual routines in task-performing groups. *Organizational Behavior and Human Decision Processes, 47,* 65–97.

Hayes-Roth, B., & Hayes-Roth, F. (1979). A cognitive model of planning. *Cognitive Science, 3,* 275–310.

Hinsz, V. B., Tindale, R. S., & Vollrath, D. A. (1997). The emerging conceptualization of groups as information processors. *Psychological Bulletin, 121,* 43–64.

Hutchins, E. (1991). The social organization of distributed cognition. In L. B. Resnick, J. M. Levine, & S. D. Teasley (Eds.), *Perspectives on socially shared cognition* (pp. 283–307). Washington, DC: American Psychological Association.

Hutchins, E. (1995). *Cognition in the wild.* Cambridge, MA: MIT Press.

Jones, M. B. (1974). Regressing group on individual effectiveness. *Organizational Behavior and Human Performance, 11,* 426–451.

Kanki, B. G., Folk, V. G., & Irwin, C. M. (1991). Communication variations and aircrew performance. *International Journal of Aviation Psychology, 1,* 149–162.

Kanki, B. G., Lozito, S., & Foushee, H. (1989). Communication indexes of crew coordination. *Aviation, Space, and Environmental Medicine, 60,* 56–60.

Kerr, N. L., & Tindale, R. S. (2004). Group performance and decision making. *Annual Review of Psychology, 55,* 623–655.

Kidd, J. S. (1961). A comparison of one-, two-, and three-man work units under various conditions of workload. *Journal of Applied Psychology, 45,* 195–200.

Kraiger, K., Ford, J. K., & Salas, E. (1993). Application of cognitive, skill-based, and affective theories of learning outcomes to new methods of training evaluation. *Journal of Applied Psychology, 78,* 311–328.

Kraiger, K., & Wenzel, L. H. (1997). Conceptual development and empirical evaluation of measures of shared mental models as indicators of team effectiveness. In M. T. Brannick, E. Salas, & C. Prince (Eds.), *Team performance assessment and measurement: Theories, methods, and applications* (pp. 63–84). Mahwah, NJ: Erlbaum.

Kravitz, D. A., & Martin, B. (1986). Ringlemann rediscovered: The original article. *Journal of Personality and Social Psychology, 50,* 936–941.

Lausic, D., Eccles, D. W., Jeong, A., Johnson, T., & Tenenbaum, G. (2005). *Explicit and implicit types of communication: A* *conceptualization of intra-team communication in the sport of tennis.* Manuscript in preparation.

Levine, J. L., Resnick, L. B., & Higgins, E. T. (1993). Social foundations of cognition. *Annual Review of Psychology, 44,* 585–612.

Lord, C. G., & Saenz, D. S. (1985). Memory deficits and memory surfeits: Differential cognitive consequences of tokenism for tokens and observers. *Journal of Personality and Social Psychology, 49,* 918–926.

MacMillan, J., Entin, E. E., & Serfaty, D. (2004). Communication overhead: The hidden cost of team cognition. In E. Salas & S. M. Fiore (Eds.), *Team cognition: Understanding the factors that drive process and performance* (pp. 61–82). Washington, DC: American Psychological Association.

McIntyre, R. M., & Salas, E. (1995). Measuring and managing for team performance: Emerging principles from complex environments. In R. Guzzo & E. Salas (Eds.), *Team effectiveness and decision making in organizations* (pp. 9–45). San Francisco: Jossey Bass.

McPherson, S. L. (1999). Tactical differences in problem representations and solutions in collegiate varsity and beginner female players. *Research Quarterly for Exercise and Sport, 70,* 369–384.

Naylor, J. C., & Briggs, G. E. (1965). Team training effectiveness under various conditions. *Journal of Applied Psychology, 49,* 223–229.

Nemeth, C., & Kwan, J. L. (1987). Minority influence, divergent thinking, and detection of correct solutions. *Journal of Applied Social Psychology, 17,* 786–797.

Observer [Computer software]. (2003). Wageningen, The Netherlands: Noldus Information Technology.

Orasanu, J. M. (1993). Decision making in the cockpit. In E. Wiener, B. Kanki, & R. Helmreich (Eds.), *Cockpit resource management* (pp. 137–172). San Diego, CA: Academic Press.

Patterson, E. S., Watts-Perotti, J., & Woods, D. D. (1999). Voice loops as coordination aids in space shuttle mission control. *Computer Supported Cooperative Work, 8,* 353–371.

Patterson, E. S., & Woods, D. D. (2001). Shift changes, updates, and the on-call model in space shuttle mission control. *Computer Supported Cooperative Work, 10,* 317–346.

Rasker, P. C., Post, W. M., & Schraagen, J. M. C. (2000). Effects of two types of intra-team feedback on developing a shared mental model in command and control teams. *Ergonomics, 43,* 1167–1189.

Rentsch, J. R., & Davenport, S. W. (in press). Sporting a new view: Team member schema similarity in sports. *International Journal of Sport and Exercise Psychology.*

Resnick, L. B., Levine, J. M., & Teasley, S. D. (Eds.). (1996). *Perspectives on socially shared cognition.* Washington, DC: American Psychological Association.

Roberts, J. M. (1964). The self-management of cultures. In W. Goodenough (Ed.), *Explorations in cultural anthropology: Essays in honor of George Peter Murdock* (pp. 433–454). New York: McGraw-Hill.

Saavedra, R., Earley, P. C., & Van Dyne, L. (1993). Complex interdependence in task-performing groups. *Journal of Applied Psychology, 78,* 61–72.

Serfaty, D., Entin, E. E., & Johnston, J. H. (1998). Team coordination training. In J. A. Cannon-Bowers & E. Salas (Eds.), *Making decisions under stress: Implications for individual and team training* (pp. 221–245). Washington, DC: American Psychological Association.

Smith, W. J. (1977). *The behavior of communicating.* Cambridge, MA: Harvard University Press.

Smith-Jentsch, K. A., Johnston, J. H., & Payne, S. C. (1998). Measuring team-related expertise in complex environments. In J. A. Cannon-Bowers & E. Salas (Eds.), *Making decisions under stress: Implications for individual and team training* (pp. 61–87). Washington, DC: American Psychological Association.

Smith-Jentsch, K. A., Zeisig, R. L., Acton, B., & McPherson, J. A. (1998). A strategy for guided team self-correction. In J. A. Cannon-Bowers & E. Salas (Eds.), *Making decisions under stress: Implications for individual and team training* (pp. 271–297). Washington, DC: American Psychological Association.

Starkes, J. L., & Ericsson, K. A. (Eds.). (2003). *Expert performance in sport: Advances in research on sport expertise.* Champaign, IL: Human Kinetics.

Stasser, G., & Titus, W. (1985). Pooling of unshared information in group decision making: Biased information sampling during discussion. *Journal of Personality and Social Psychology, 48,* 1467–1478.

Steiner, I. D. (1972). *Group process and productivity.* New York: Academic Press.

Stout, R. J., Cannon-Bowers, J. A., Salas, E., & Milanovich, D. M. (1999). Planning, shared mental models, and coordinated performance: An empirical link is established. *Human Factors, 41,* 61–71.

Sullivan, P. J., & Feltz, D. L. (2003). The preliminary development of the scale for effective communication in team sports. *Journal of Applied Social Psychology, 33,* 1693–1715.

Ward, P., Farrow, D., Harris, K. R., Williams, A. M., Eccles, D. W., & Ericsson, K. A. (in press). Training perceptual-cognitive skills: Can sport psychology research inform military decision training? *Military Psychology.*

Ward, P., & Williams, A. M. (2003). Perceptual expertise: Development in sport. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sport: Advances in research on sport expertise* (pp. 220–249). Champaign, IL: Human Kinetics.

Weinberg, R. S., & Gould, D. (2003). *Foundations of sport and exercise psychology* (3rd ed.). Champaign, IL: Human Kinetics.

Weldon, E., & Weingart, L. R. (1993). Group goals and group performance. *British Journal of Social Psychology, 32,* 129–152.

Widmeyer, W. N., Brawley, L. R., & Carron, A. V. (1990). The effects of group size in sport. *Journal of Sport and Exercise Psychology, 12,* 177–190.

Williams, A. M., & Hodges, N. J. (Eds.). (2004). *Skill acquisition in sport: Research, theory, and practice.* London: Routledge.

Williams, A. M., Ward, P., Herron, K., & Smeeton, N. J. (2004). Using situational probabilities to train perceptual and cognitive skill in novice soccer players. *Journal of Sports Sciences, 22,* 575–576.

Wittenbaum, G. M., Vaughan, S. I., & Stasser, G. (1998). Coordination in task-performing groups. In R. S. Tindale & L. Heath (Eds.), *Theory and research on small groups: Social psychological applications to social issues* (Vol. 4, pp. 177–204). New York: Plenum Press.

Woodman, T., & Hardy, L. (2001). A case study of organizational stress in elite sport. *Journal of Applied Sport Psychology, 13,* 207–238.

Woods, D. D., & Patterson, E. S. (2000). How unexpected events produce an escalation of cognitive and coordinative demands. In P. A. Hancock & P. A. Desmond (Eds.), *Stress, workload, and fatigue* (pp. 290–304). Hillsdale, NJ: Erlbaum.

Xiao, Y., & The LOTAS Group. (2001). Understanding coordination in a dynamic medical environment: Methods and results. In M. McNeese, E. Salas, & M. Endsley (Eds.), *New trends in cooperative activities: Understanding system dynamics in complex environments* (pp. 242–283). Santa Monica, CA: Human Factors and Ergonomics Society.

Zukier, H., & Pepitone, A. (1984). Social roles and strategies in prediction: Some determinants of the use of base-rate information. *Journal of Personality and Social Psychology, 47,* 349–360.

PART IV

Interventions and Performance Enhancement

CHAPTER 13

Mental Skills Training in Sport

ROBIN S. VEALEY

Sport psychology has evolved from a fledgling academic discipline narrowly focused on motor behavior research in laboratory settings to a broad, interdisciplinary profession in which psychological services are provided to a range of physical activity participants. The focus of this chapter is on mental skills training with athletes, coaches, and teams, with the objective of assisting sport participants in the development of mental skills to achieve performance success and personal well-being. A comprehensive review of the literature pertaining to mental skills training in sport is undertaken to address the following questions: What has the field of sport psychology learned from almost 3 decades of mental skills training with athletes? How has mental training evolved, and have the objectives of mental training in sport been achieved? What future directions should the field consider to enhance the significance and impact of mental skills training in sport?

The chapter is divided into five sections. First, the historical development of mental training in sport is described. Second, a model of mental skills for athletes and coaches is offered, and third, a framework for understanding mental skills training in sport is presented. Fourth, the uses and effectiveness of mental skills training in sport are reviewed, and finally, suggestions for the future of mental training in sport are provided. The theme of the chapter is that mental skills training has evolved from the decontextualized application of specific techniques to enhance performance (e.g., imagery, self-talk) into a comprehensive intervention process whereby various philosophies, models, strategies, techniques, and consultant styles are utilized in specific social-cultural contexts to help athletes and coaches achieve significant personal development as well as performance success.

HISTORICAL DEVELOPMENT OF MENTAL SKILLS TRAINING IN SPORT

Published literature indicates that the Soviet Union was the first country to systematically engage in mental skills training with athletes and coaches in the 1950s (Ryba, Stambulova, & Wrisberg, 2005; J. M. Williams & Straub, 2006). Avksenty Puni was a key leader in Soviet sport psychology, and his 1963 article “Psychological Preparation of Athletes for Competition” and other writings (cited in Ryba et al., 2005) formalized perhaps the earliest mental training model, which included self-regulation of arousal, confidence, attentional focusing, distraction control, and goal setting. The Soviet emphasis on mental training with athletes was systematically applied to other Eastern Bloc countries, including East Germany and Romania, during the 1970s and 1980s (Salmela, 1984; J. M. Williams & Straub, 2006).

Although the systematic practice and study of mental training in sport in North America did not emerge until the 1980s, several pioneers began work in mental training prior to this time. Coleman Griffith was hired by the Chicago Cubs professional baseball team in 1938 to improve the performance of the team. The mental training techniques used by Griffith included practice management strategies for enhanced learning and automation of skills, communication skills for coaches, team dynamics and leadership development, goal setting, confidence building, competitive simulation, a test battery for measuring players' basic physical and "visual" skills, and a recommendation that psychological testing and observation be included in scouting (Green, 2003). Another American mental training pioneer from this historical era was Dorothy Hazeltine Yates, who engaged in mental skills training with boxers and aviators, primarily focusing on a "relaxation set-method" and mental preparation (Kornspan & MacCracken, 2001; Yates, 1943). Like Griffith, Yates (1943) also engaged in controlled experimental investigations of the effectiveness of her mental training interventions, with positive results.

David Tracy was hired as a mental training consultant with the St. Louis Browns professional baseball team in 1950, and his work with the players included relaxation, thought management through self-talk and thought stopping, and hypnosis (Kornspan & MacCracken, 2002). Bruce Ogilvie, a clinical psychologist, began consulting work with athletes in the 1960s (Ogilvie & Tutko, 1966), and another clinical psychologist, Richard Suinn, published one of the first intervention studies that assessed the effectiveness of mental training with athletes. Suinn's (1972) intervention using relaxation, imagery, and behavioral rehearsal improved race performance in a group of elite skiers and led to subsequent mental training work with the U.S. Ski Team (Suinn, 1977).

Mental skills training became a major focus for research and practice in North American sport psychology in the 1980s. Several events are indicative of this professionalization, in which sport psychology moved from an academic research discipline to an interdisciplinary professional field offering services to consumers. These events include the establishment of guidelines and a registry for the provision of sport psychology services by the U.S. Olympic Committee in 1983, the first systematic provision of sport psychology services to the U.S. Olympic Team in 1984 (Suinn, 1985), the hiring of a full-time sport psychologist by the USOC and the formation of the Association for the Advancement of Applied Sport Psychology (AAASP) in 1985, the formation of a division of Exercise and Sport Psychology within the American Psychological Association in 1987, the establishment of two new applied journals (the *Sport Psychologist* in 1987 and the *Journal of Applied Sport Psychology* in 1989), the development of a certification program for sport psychology consultants by AAASP in 1991, and the publication of numerous books devoted to mental training interventions (e.g., Harris & Harris, 1984; Nideffer, 1981; Orlick, 1980, 1986, 1990). Massive debate occurred during this time period regarding *who* could offer *what types* of psychological services to consumers (Brown, 1982; Clarke, 1984; Danish & Hale, 1981, 1982; Gardner, 1991; Harrison & Feltz, 1979; Heyman, 1982, 1984; Nideffer, DuFresne, Nesvig, & Selder, 1980; Nideffer, Feltz, & Salmela, 1982; Silva, 1989; "U.S. Olympic Committee," 1983) and whether there was adequate scientific evidence to justify mental training interventions in sport ("ABC Nightline News Telecast," 1988; Dishman, 1983; R. E. Smith, 1989).

Today, sport psychology is widely acclaimed as an interdisciplinary field in which professionals across the globe use training from both the sport sciences and psychology to engage in mental skills training that is guided by established training standards and professional competencies (Morris, Alfermann, Lintunen, & Hall, 2003; Tenenbaum, Lidor, Papaioannou, & Samulski, 2003), ethical guidelines for service delivery (Petitpas, Brewer, Rivera, & Van Raalte, 1994), and a rapidly accumulating body of knowledge on which appropriate and effective mental training interventions are developed and implemented (e.g., Andersen, 2000, 2005; L. Hardy, Jones, & Gould, 1996; Lidor & Henschen, 2003; Meyers, Whelan, & Murphy, 1996; Morris, Spittle, & Watt, 2005; S. Murphy, 2005; Vealey, 2005).

MENTAL SKILLS FOR ATHLETES AND COACHES

What knowledge have we gained in the past 25 years about mental skills that are important for athletes and coaches? The objective of mental training is to assist sport participants in the development of mental skills to achieve performance success and personal well-being. Thus, it seems important to identify key mental skills that are related to performance success and personal well-being to guide the development of mental training interventions. A model of mental skills for athletes and coaches is shown in Figure 13.1. An extension of a previous model (Vealey, 1988), it serves to emphasize that multiple types of mental skills are important for success and well-being in athletes and coaches, including foundation, performance, personal development, and team skills.

Foundation Skills

Foundation skills are intrapersonal resources that are the basic foundation mental skills necessary to achieve success in sport. *Achievement drive* is the urgent, compelling desire to apply effort and persistence to overcome obstacles to accomplish something of worth or importance. Achievement drive also leads to committed behavioral management

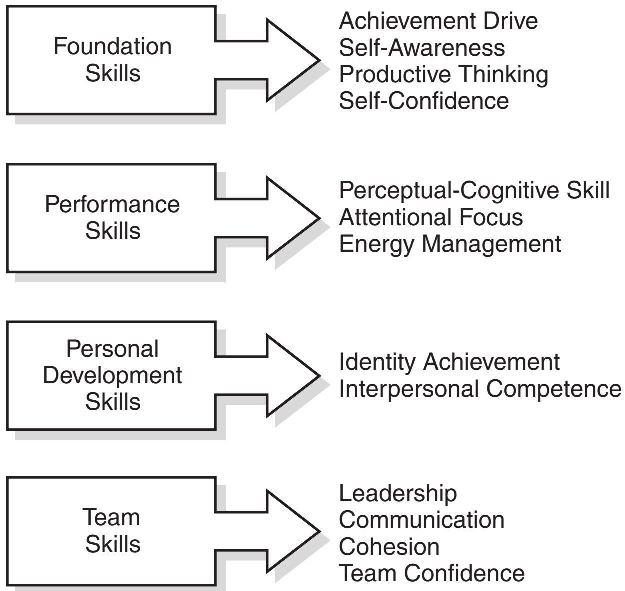


Figure 13.1 Mental skills for athletes and coaches.

to organize and manage daily living in the pursuit of important goals. An overwhelming amount of research has shown that highly successful elite athletes possess strong achievement drives that fuel their daily commitment to pursuing and achieving important goals (Bull, Shambrook, James, & Brooks, 2005; DeFrancesco & Burke, 1997; Durand-Bush & Salmela, 2002; Gould, Dieffenbach, & Moffett, 2002; Greenleaf, Gould, & Dieffenbach, 2001; Jones, Hanton, & Connaughton, 2002; Orlick & Partington, 1988). This skill involves meticulous planning, time management and prioritization, hard and smart training, a willingness to sacrifice and delay gratification, taking personal responsibility for training, designing and following behavioral strategies such as routines, and the ability to set and achieve goals (Durand-Bush & Salmela, 2002; Gould, Dieffenbach, et al., 2002; Gould, Eklund, & Jackson, 1992a, 1992b; Gould, Eklund, & Jackson, 1993; Gould, Finch, & Jackson, 1993; Greenleaf et al., 2001; Holt & Dunn, 2004). Expert athlete performance results from many hours of specific and focused training at a high level (Baker, Côté, & Abernethy, 2003; Durand-Bush & Salmela, 2002), and success in coaching requires a passion to coach, commitment to learning, perseverance in the face of obstacles, and strong planning and organizational skills (Vallée & Bloom, 2005; Vealey, 2005).

Self-awareness is the ability to engage in introspection and retrospection to understand one's thoughts, feelings, and behaviors. The ability to engage in honest self-appraisal to enhance self-awareness has been identified as an important mental skill by elite athletes (Bull et al., 2005; Calmels, d'Arripe-Longueville, Fournier, & Soulard, 2003) and sport psychology consultants (Ravizza, 2006). Self-monitoring and self-evaluation are critical precursors to effective self-regulation and success in sport (Chen & Singer, 1992; Kirschenbaum & Wittrock, 1984).

Productive thinking is the ability to manage thoughts to effectively prepare for and respond to life events in a way that facilitates personal success and well-being. Research has substantiated that successful athletes think more productively than less successful athletes. Successful athletes focus more on task-relevant thoughts and are less likely to be distracted (Eklund, 1994, 1996; Gould et al., 1992a, 1992b; Gould, Eklund, et al., 1993; Gould, Dieffenbach, et al., 2002; Greenleaf et al., 2001; Jones et al., 2002; Orlick & Partington, 1988). A unique study by McPherson (2000) examined the thinking of collegiate tennis players by recording their thoughts during and after each point in a tennis match based on the questions "What were you thinking during that point?" and "What are you thinking now?" The elite athletes' thoughts were task-oriented, involved planning strategies, focused on problem solving, and focused confidently on enabling feelings and beliefs about their competence and ability to succeed. The novice athletes' thoughts included more expressions of frustration and emotion and were indicative of low confidence and having negative expectations and a consistent desire to quit.

Successful elite athletes have also been shown to be optimistic, hopeful, and adaptively perfectionistic in setting high personal standards, but not being overly concerned with making mistakes (Gould, Dieffenbach, et al., 2002). Research with professional baseball, professional basketball, and collegiate swimming teams found that optimistic teams performed better than pessimistic teams (Seligman, 1998). Rational thinking and perspective have been shown to be important mental skills for the mental resilience needed to cope with the uncontrollable obstacles and setbacks inherent in competitive sport (Bull et al., 2005; Gould, Eklund, et al., 1993; Gould, Finch, et al., 1993; Greenleaf et al., 2001; Jones et al., 2002; Thelwell, Weston, & Greenlees, 2005). Finally, expert athletes have demonstrated adaptive attributional patterns to explain their performance successes and failures (Cleary & Zimmerman, 2001; Kitsantas & Zimmerman, 2002), which serves to enhance their motivation. Expert coaches demonstrate several forms of productive thinking, including mental rehearsal of competition plans, maintaining a positive focus, and knowing how to occupy their thoughts in productive ways prior to competition (Bloom, Durand-Bush, & Salmela, 1997).

Self-confidence is the belief that one has the internal resources, particularly abilities, to achieve success. International-level elite athletes identified resilient and robust self-confidence, or the unshakable belief in one's ability to achieve, as the most critical mental skill defining mental toughness (Bull et al., 2005; Jones et al., 2002; Thelwell et al., 2005). Self-confidence consistently appears as a key skill possessed by successful elite athletes (DeFrancesco & Burke, 1997; Durand-Bush & Salmela, 2002; Gould, Dieffenbach, et al., 2002; Gould, Greenleaf, Chung, & Guinan, 2002; Kitsantas & Zimmerman, 2002), and fluctuations in confidence account for differences in best and worst performances (Eklund, 1994, 1996; Gould et al., 1992a, 1992b; Greenleaf et al., 2001). Elite field hockey players identified the development and maintenance of self-confidence as one of their biggest needs in terms of mental training (Grove & Hanrahan, 1988).

Performance Skills

Performance skills are mental abilities critical to the execution of skills during sport performance. *Perceptual-cognitive* skill refers to the cognitive knowledge structure that enables optimal strategic processing of task-relevant information. Although perceptual-cognitive expertise is discussed extensively in Chapter 11, it is included in this chapter as a critical performance skill that must be included in the mental skills model shown in Figure 13.1. Highly skilled athletes demonstrate expertise in tactical/strategic knowledge and perceptual and decision-making skill in sport, including superior recall and recognition of patterns of play, faster detection and recognition, more efficient and appropriate visual search behaviors, and better anticipation of likely events in their specific sports (McPherson & Kernodle, 2002; Tenenbaum, 2002; Tenenbaum & Bar-Eli, 1993; A. M. Williams & Ward, 2003). Also, the ability to generate and use vivid and controllable mental images of performance responses is associated with better sport performance (K. A. Martin, Moritz, & Hall, 1999).

Attentional focus is the ability to selectively direct and sustain a focus of attention required for the successful execution of a specific activity. The ability to direct and sustain a nondistractible focus of attention is widely observed in and cited by athletes as a mental skill critical to performance (DeFrancesco & Burke, 1997; Durand-Bush & Salmela, 2002; Gould, Dieffenbach, et al., 2002; Gould, Eklund, & Jackson, 1993; Greenleaf et al., 2001; Jones et al., 2002; Kitsantas & Zimmerman, 2002; Orlick & Partington, 1988; Thelwell et al., 2005). Athletes' attentional focusing skills have differentiated between peak and failing performance (Eklund, 1994, 1996; Gould et al., 1992a, 1992b; Privette & Bundrick, 1997) and effective and ineffective coping (Nichols, Holt, & Polman, 2005) and have been identified by coaches as the most important mental skill needed in sport (Gould, Medbery, Damarjian, & Lauer, 1999).

Energy management is the ability to effectively manage various feeling states (e.g., arousal, anxiety, anger, excitement, fear) to achieve personally optimal physical and mental energy levels for performance. The structure of competitive sport and the highly valued rewards inherent in sport elicit a range of intense emotions or feeling states that must be effectively managed to create the optimal energy level for performance. The ability to cope with and manage negative feeling states, such as anxiety and pressure, is a key mental skill possessed by elite athletes (Bull et al., 2005; Gould, Dieffenbach, et al., 2002; Gould, Eklund, et al., 1993; Jones et al., 2002; Thelwell et al., 2005). Athletes have identified "normal nervousness" and optimal emotional arousal as associated with high-level performances and inappropriate or negative emotional states as associated with low levels of performance (Eklund, 1994, 1996; Gould et al., 1992a, 1992b). A key component of mental toughness as identified by elite athletes is the ability to push back the boundaries of physical and emotional pain to maintain effective performance under distress (Jones et al., 2002). Successful expert coaches have the ability to remain composed and manage their energy levels during and after competition to remain effective (Bloom et al., 1997; Vallée & Bloom, 2005). Elite coaches have also identified emotional control and management of nervousness and tension as the biggest mental training need for their athletes (Grove & Hanrahan, 1988).

Personal Development Skills

Personal development skills are mental skills that represent significant maturational markers of personal development and that allow for high-level psychological functioning through clarity of self-concept, feelings of well-being, and a sense of relatedness to others. Life skills (Danish & Nellen, 1997; Danish, Petitpas, & Hale, 1992) that are athlete-centered (P. S. Miller & Kerr, 2002) and child-centered (Weiss, 1991), life engagement (Newburg, Kimiecik, Durand-Buch, & Doell, 2002), philosophical counseling (Corlett, 1996), and sociocultural (Brustad & Ritter-Taylor, 1997; Ryba & Wright, 2005) approaches to mental training interventions all focus on personal development skills as outcomes of interest. Successful coaches have identified both performance enhancement and personal development as important objectives for coaches (Vallée & Bloom, 2005).

Two personal development skills seem to be important for mental training in sport (see Figure 13.1). *Identity achievement* is the establishment of a clear sense of identity, or "who I am," that allows the individual to experience psychological well-being and feelings of self-worth, usually after exploration and introspection about life experiences (Marcia, 1994). This skill requires long-term development but seems important for athletes because it involves resistance to conformity and subcultural pressure based on the controlling nature of elite sport (Coakley, 1992; G. M. Murphy, Petitpas, & Brewer, 1996; Sparkes, 1998). *Interpersonal competence* is the ability to interact effectively with others by demonstrating effective communication skills. Interpersonal competence was identified as an important mental skill for elite athletes in terms of providing and using social support (Holt & Dunn, 2004).

Team Skills

The final category of mental skills shown in Figure 13.1 is team skills. Team skills are collective qualities of the team that are instrumental to an effective team environment and overall team success. *Team confidence* is the belief that the team has the collective resources, or team abilities, to achieve team success. Team confidence is a better predictor of team success than the aggregate of individual levels of confidence for all team members (Feltz & Lirgg, 1998; Gould, Greenleaf, et al., 2002). *Cohesion* is the team's ability to stick together and remain united in the pursuit of its goals, which is an important predictor of team performance (Carron, Colman, Wheeler, & Stevens, 2002; Greenleaf et al., 2001). *Communication* is the process of interpersonal interaction within the team that facilitates team success and athletes' well-being. *Leadership* is the ability of individuals (coaches and athletes) to influence others on the team to think and act in ways that facilitate team success and the quality of the team's social psychological environment. Successful Olympic teams have been shown to possess coaches who instilled confidence and trust in their athletes and who coped well with crisis situations, whereas unsuccessful Olympic teams had coaches who failed to develop trust and effective communication and who were inconsistent in their behaviors in pressure situations (Gould, Guinan, Greenleaf, Medbery, & Peterson, 1999).

The mental skills model shown in Figure 13.1 is not meant to definitively identify and categorize mental skills needed in sport. The point of the model is to clarify the objectives for mental training programs by emphasizing that mental skill foundations, personal development abilities, and team skills, along with performance skills, are key mental training targets for sport psychology consultants. As discussed in the next section, the mental training process includes many different approaches that consultants may adopt as they target specific mental skills or sets of skills for enhancement.

A FRAMEWORK FOR UNDERSTANDING MENTAL SKILLS TRAINING IN SPORT

A framework for understanding mental skills training in sport is shown in Figure 13.2. The targets for mental training are foundation, performance, personal development, and team skills. The process of mental training includes the philosophy, model, strategies, and techniques that define the consultant's approach to enhancing mental skills. This process is mediated by the interpersonal and technical effectiveness of the consultant.

The two arrows on each side of the framework represent the influence of physical training and the social-cultural influences of sport and society on the mental

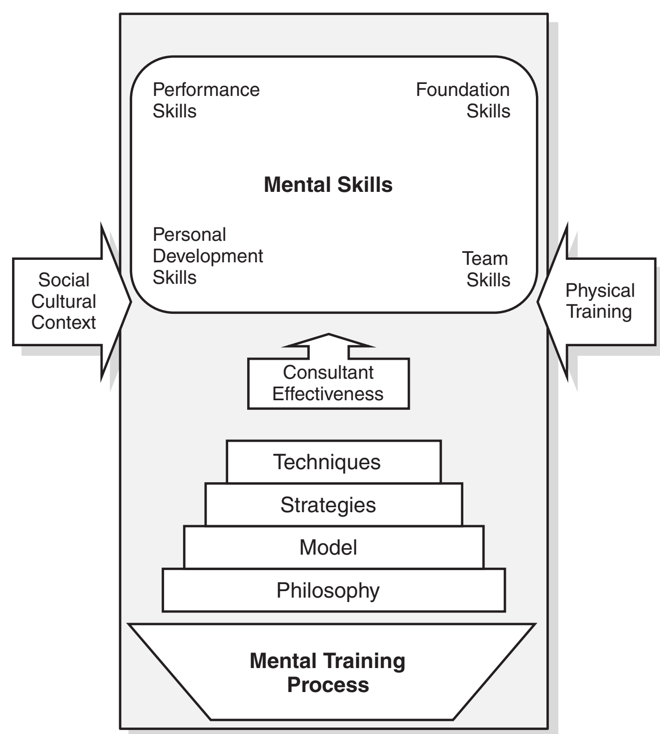


Figure 13.2 A framework for understanding mental skills training in sport.

training process. Mental skills in athletes are obviously developed and enhanced through high-quality physical training regimens designed by innovative master coaches (e.g., Dorrance & Averbuch, 2002; Gould, Hodge, Peterson, & Giannini, 1989; Krzyzewski, 2000). However, many coaches need guidance and training to learn specific ways that they can integrate mental training into their physical training sessions with athletes (Gould, Damarjian, & Medbery, 1999), and the mental training literature should begin to address this important need (e.g., Vealey, 2005). In addition, mental training consultants must understand the specific physical training requirements for the athletes with whom they are working, and they must be able to readily and creatively integrate mental and physical training into one integrative process. Sinclair and Sinclair (1994) provide an excellent "mental management" model that embeds mental skills training in the process of learning physical skills, using the premise that mental skills are more easily taught, learned, and remembered if they are developed along with physical skills.

A critical point that needs much more attention by the field of sport psychology and mental training consultants is that the process of mental skills development and training occurs within a social-cultural context. This includes the unique subcultures of various types of sport, as well as the broader cultural factors that influence athletes' mental skills and their participation in mental skills training. For example, the insular and "macho" subculture of sport creates a climate whereby mental training is stigmatized and distrusted (S. B. Martin, 2005; S. B. Martin, Lavallee, Kellmann, & Page, 2004) and also perpetuates dysfunctional self-perceptions and behaviors such as negative body image, hazing, substance abuse, homophobia, hyperconformity, identity foreclosure, burnout, and violence (e.g., Brustad & Ritter-Taylor, 1997). Many issues faced by mental training consultants are rooted in problematic aspects of the social-cultural structure of society and sport, and mental training consultants must broaden their perspective to help athletes achieve significant personal development by understanding how the culture in which they live and perform directly influences their thoughts, feelings, and behaviors. (This is discussed at the end of the chapter as an important future direction for mental skills training.)

The Mental Training Process

The mental training process shown at the bottom of Figure 13.2 is a complex, multilayer, integrative approach to developing mental skills in athletes. Indeed, mental skill training has matured from early interventions that focused on the random application of mental training techniques, such as imagery and goal setting, to programmatic intervention models that utilize specific mental training strategies and techniques within a coherent guiding intervention model.

Philosophy

The mental training process begins with the consultant's *philosophy,* or his or her set of ideas and beliefs about the nature of mental skills and mental training, usually including program objectives and the respective roles of the consultant, athlete, and coach in the process. Poczwardowski, Sherman, and Ravizza (2004) have conceptualized a hierarchical structure of professional philosophy for sport psychology service delivery, which is very similar to the hierarchical layers of the mental training process shown in Figure 13.2. Multiple examples of mental training consultant philosophies, and resulting mental training models, strategies, and techniques, were published in three special issues of the *Sport Psychologist* on delivering services to Olympic athletes (December 1989 issue), professional athletes (December 1990 issue), and special populations (December 1991 issue).

The main philosophical differences in mental skills training in sport have been educational versus clinical approaches, program-centered versus athlete-centered approaches, and performance enhancement versus personal development approaches. The educational approach is based on the philosophy that athletes possess the mental skills needed for success in sport, but that they often need assistance in optimizing these skills, systematically training them to hold up under increasing competitive pressure, and developing additional skills required to successfully navigate the competitive demands of sport (e.g., Danish, Petitpas, & Hale, 1995; Orlick, 2000; Ravizza & Hanson, 1994; Vealey, 2005). The clinical approach focuses on psychopathology or dysfunctional personality processes and behaviors, with the objective of providing remedial therapeutic assistance to athletes (Gardner & Moore, 2006; Marchant & Gibbs, 2004; Ward, Sandstedt, Cox, & Beck, 2005). Consultants embracing the clinical philosophy of remedial therapeutic assistance require training and licensure as psychologists.

Program-centered approaches to mental skills training use a preplanned sequence of intervention activities designed by the professional consultant; athlete-centered approaches take a more interactive, needs-based approach to interventions. L. Hardy and Parfitt (1994) evaluated their participation in two philosophically different mental training programs. The first program used a program-centered prescriptive approach in which consultants served as the experts to formally assess athletes' mental skills and needs using inventories, interviews, and observation, and then provided written reports and tutorials to athletes and coaches, prescribing the mental training activities for athletes based on their individual profiles. The second program scrapped the "consultant as expert" formal prescriptive approach of assessment and reports and focused on the needs of athletes and coaches from their perspective. A key philosophical tenet of this athlete-centered approach was that the consultants, athletes, and coaches were all equal in terms of knowledge and expertise. Consultants focused on being available to meeting athletes' and coaches' needs when requested and responded to the valuable insights and experiences that athletes and coaches brought to the consulting relationship using a collaborative, problem-solving intervention philosophy.

L. Hardy and Parfitt (1994) admitted that the athlete-centered program was more difficult for them as consultants in that they had to serve in unforeseen and multiple roles, yet their effectiveness as consultants was evaluated more positively by athletes in the athlete-centered program. However, this is not to say that one philosophy is better than another, as intervention philosophies should be carefully developed with regard to program objectives, the social-cultural context, and consultant skills and training. Program-centered philosophical approaches that delineate pragmatic intervention models and user-friendly strategies should not be denigrated, because these canned programs provide specific and innovative ways that athletes and coaches can incorporate mental training into their lives without the direct involvement of a sport psychology consultant (e.g., Moore & Stevenson, 1994; Singer, 1988; Vealey, 2005).

The third philosophical issue in mental skills training is whether the objective of interventions should target performance enhancement or personal development in athletes. Clearly, these two objectives are not mutually exclusive and are often noted as important companion objectives of mental skills training (e.g., P. S. Miller & Kerr, 2002; Vealey, 1988, 2005; J. M. Williams, 2006). Research examining the effectiveness of mental skills training is slowly moving beyond performance as the only outcome of interest to examine intervention effects on other important outcomes such as successful life transition (Lavallee, 2005), the quality of sport experiences (Lindsay, Maynard, & Thomas, 2005; Newburg et al., 2002), life skills (Danish & Nellen, 1997), and sociomoral growth of children (S. C. Miller, Bredemeier, & Shields, 1997).

Model

The second layer in the mental training process, emanating from philosophy, is one's *model* of intervention, or the overarching thematic framework from which specific mental training strategies and techniques are developed and utilized. The mental skills training literature abounds with the description of many models of intervention. These include systems models for team, organizational, and family interventions (Hellstedt, 1995; Zimmerman, Protinsky, & Zimmerman, 1994), self-regulatory or cognitive-behavioral models (Boutcher & Rotella, 1987; Hanin, 2000; Kirschenbaum & Wittrock, 1984; Moore & Stevenson, 1994; Singer, 1988), behavioral management models (G. L. Martin & Toogood, 1997; S. B. Martin, Thompson, & McKnight, 1998; Tkachuk, Leslie-Toogood, & Martin, 2003), educational mental skills models (Orlick, 2000; Vealey, 1988, 2005), developmental models (Danish & Hale, 1981; Danish & Nellen, 1997; Danish et al., 1992; M. Greenspan & Andersen, 1995; Weiss, 1995), sport-specific mental skills models (Ravizza & Hanson, 1994; R. E. Smith & Johnson, 1990; Thomas & Over, 1994), clinical intervention models (Gardner & Moore, 2004), and perceptual training models (A. M. Williams & Ward, 2003).

The models identified in the preceding paragraph are categorized based on theoretical emphases in psychology to help readers appreciate the broad scope of mental training models in the literature. However, perhaps the most important function of mental training models is their ability to creatively present a big picture of mental skills training to athletes and coaches to enhance their understanding of and interest in mental training. Models can be represented by motivational acronyms such as GOAL (Going for the Goal) and SUPER (Sports United to Promote Education and Recreation; Danish & Nellen, 1997), pictorial models such as the Wheel of Excellence (Orlick, 2000) and Inner Edge (Vealey, 2005), or popular descriptions such as the Mental Toughness Plan (Bull, Albinson, & Shambrook, 1996).

Strategies

The third layer of the mental training process is the strategies that logically emanate from one's intervention philosophy and model. These are the organizational plans of action that operationalize how the intervention specifically works, typically using sequential steps, multiple phases, or the practical packaging of mental training techniques into a coherent, integrative program. Example strategies in the mental skills training literature include the Five-Step Strategy (Singer, 1988), the four-phase psychological skill program for close-skill performance enhancement (Boutcher & Rotella, 1987), P^3 Thinking and goal mapping (Vealey, 2005), centering (Nideffer & Sagal, 2006), competition focus plans (Orlick, 1986), the five-step approach to mental training using biofeedback (Blumenstein, Bar-Eli, & Tenenbaum, 2002), and visuomotor behavioral rehearsal (Suinn, 1993). Assessment strategies are an important part of this layer of the mental training process, as consultants decide how and when to assess the mental skill training needs of athletes (Vealey & Garner-Holman, 1998). The overall assessment strategy then leads to the use of specific assessment techniques, such as observation, interviews, questionnaires, and psychophysiological measures. Although the majority of AAASP-certified consultants use some type of written survey in mental training with athletes (O'Connor, 2004), these instruments are used sparingly, and interviews and observations are used most frequently to assess athletes (Vealey & Garner-Holman, 1998).

Techniques

The final layer of the mental training process is the techniques, or specific procedures or methods used in a mental training strategy. These methods are the familiar tools known to all mental training consultants, including imagery, relaxation, goal setting, self-talk, biofeedback training, performance profiling, and behavior management techniques. The traditional four mental training techniques of imagery, goal setting, thought management, and physical relaxation/arousal regulation have been most widely used by consultants (Gould, Murphy, Tammen, & May, 1991; Sullivan & Nashman, 1998; Vealey, 1988), although other techniques, such as performance profiling (Jones, 1993), have emerged, and variations on the traditional four techniques have proliferated (Sullivan & Nashman, 1998). These specific techniques have been the focus of most of the intervention research in sport psychology, yet they represent only the final layer in the mental training process. Although it is important to test the effectiveness of specific mental training techniques, the field has matured to the point where future research and professional practice initiatives are needed to study how to most effectively utilize specific techniques within particular strategies and models and as targeted toward specific mental skill development.

Summary of the Mental Training Process

In summary, the mental training process is made up of layers that unfold as part of a comprehensive mental training approach. Mental skills training starts with the philosophical foundations embraced and valued by the consultant, and then unfolds into the conceptualization of an intervention model with appropriate and useful strategies and techniques. There are many ways to conceptualize the multilayer mental training process (e.g., Poczwardowski et al., 2004), but what is important is that it involves a comprehensive process as opposed to starting at the bottom and simply applying mental training techniques without an overall framework to guide the intervention. Examples of layers of the mental training process from four approaches are presented in Table 13.1, with each program moving from a broad philosophy and model to strategies that incorporate many different types of specific mental training techniques in unique ways.

Consultant Effectiveness

Athletes and coaches often use mental training strategies and techniques on their own without the use of a mental training consultant. However, when mental training is coordinated by consultants, the interpersonal and technical skills of the consultants are critical in the effectiveness of the mental training process (as shown in Figure 13.2). Research has shown that athletes and coaches rate interpersonal skills, particularly listening skills, being able to relate to athletes and coaches, and being open, flexible, and trustworthy, as consultant characteristics critical for success (Dunn & Holt, 2003; Gould et al., 1991; Orlick & Partington, 1987; Partington & Orlick, 1987). A study of the verbal interactions between an eminent mental training consultant and athletes found that the consultant spent over 60% of the time listening and facilitating the interactions so that athletes would spend the majority of the time expressing themselves (Lloyd & Trudel, 1999).

Technical competence displayed by effective mental training consultants includes the ability to relevantly apply concepts to create concrete, useful strategies for athletes and coaches, the ability to adapt mental training strategies and techniques to fit specific personalities and situations, understanding competitive demands and timing of services in relation to competition preparation, and serving as facilitators to enhance communication and help resolve conflict within teams (Orlick & Partington, 1987; Partington &

Table 13.1 Examples of the Mental Skills Training Process

Authors	Philosophy	Model	Strategies	Techniques
Vealey, 2005	Help athletes attain optimal development, experiences, and performance; coaches serve as educational mental trainers.	Getting the Inner Edge, foundations to mental training toolbox to big three mental skills.	P^3 Thinking Goal Mapping Energy Management Special Recipes sample programs.	Self-monitoring, thought-stopping self-talk, imagery, physical relaxation, goal setting, behavior management.
Martin, Thompson, and McKnight, 1998	Goal is to teach athletes to teach/manage themselves; focus is on education and mental health (not illness).	Integrative psychoeducational approach; combines reality therapy and behavioral counseling.	Problem-focused process: 1. Identify problem category. 2. Identify problem type. 3. Determine problem cause. 4. Select problem solution.	Goal setting, goal attainment scaling, self-management plans, self-talk.
Danish & Nellen, 1997; Danish, Petitpas, and Hale, 1992	Optimization, not remediation; teacher/skill trainer, not therapist; problems as imbalances that precede personal growth; developmental-educational focus.	Live development intervention; life skills, GOAL (Going for the Goal), SUPER (Sports United to Promote Education and Recreation).	Ten 1-hour skill-based workshops, peer teaching and modeling, STAR (stop and chill out, think of choices, anticipate consequences of choices, respond effectively).	Goal setting, skits for mastery modeling, imagery, self-talk, physical relaxation, behavior management.
Singer, 1988	Direct instruction of mental strategies can enhance learning and performance by activating appropriate cognitive processes.	Information-processing metastrategy for self-paced sport skills.	Five-step strategy: 1. Readying. 2. Imaging. 3. Focusing. 4. Executing. 5. Evaluating.	Self-talk, imagery, focus plans, centering, physical relaxation.

Orlick, 1987; Tod & Andersen, 2005). Overall, effective mental training requires interpersonally and technically skilled consultants who are able to personally and professionally fit mental training programs to meet the special needs of athletes, coaches, teams, and organizations.

EFFECTIVENESS AND USE OF MENTAL SKILLS TRAINING IN SPORT

How effective is mental training in sport? Comprehensive reviews of the mental training literature have supported the effectiveness of mental training in enhancing the performance of athletes (M. J. Greenspan & Feltz, 1989; Meyers et al., 1996; Vealey, 1994). These reviews examined published research reports using either group or single-subject research designs. In these early reviews, the needs for appropriate controls, manipulation checks, maintenance data, and specific descriptions of interventions were identified, and it is apparent that the experimental mental training research conducted today is more sophisticated as a result of these previous review articles.

Another question related to mental skills training is how much athletes and coaches use mental training strategies and techniques. Research indicates that successful elite athletes (Durand-Bush & Salmela, 2002; Gould, Eklund, et al., 1993; Gould, Finch, et al., 1993) and coaches (Bloom et al., 1997) use mental training techniques and strategies to help them achieve success in sport. However, Heishman and Bunker (1989) found that although 81% of elite athletes from various countries rated mental preparation as very important, only 44% made frequent use of mental preparation strategies and techniques. In addition, athletes tend to use mental training techniques more in competition than in practice (Frey, Laguna, & Ravizza, 2003). Overall, this research indicates that athletes believe in the efficacy of mental training, but most fail to use it systematically as part of their physical training regimen.

Several personal characteristics have been shown to influence the use of mental training by athletes. Obviously, self-motivation is a big factor in predicting adherence to mental training (Bull, 1991), and type of motivation influences use of mental training as well. Harwood, Cumming, and Fletcher (2004) found that high task/moderate ego-oriented athletes (in terms of achievement goal orientations) used more imagery, goal setting, and positive self-talk as compared to low task/high ego- and moderate task/low ego-oriented athletes. This research indicates that athletes who define success as mastering skills and improving incorporate mental training as part of their skill development more than athletes who focus more on comparison with others. Mental training is also used to a greater degree by international-caliber athletes as compared to national-caliber athletes (Calmels et al., 2003). International-caliber athletes used a wider range and more elaborate and complex mental strategies and techniques than national-caliber athletes. But interestingly, the national-caliber athletes who engaged in mental skills training with consultants developed and used strategies as complex as the international-caliber athletes. Research has substantiated that mental training programs increase the importance that athletes place on using mental training techniques and strategies, as well as their intentions to use these techniques and strategies (Brewer & Shillinglaw, 1992; Gould, Petlichkoff, Hodge, & Simons, 1990; Grove, Norton, Van Raalte, & Brewer, 1999).

Effectiveness and Use of Imagery in Mental Training

Imagery, or the mental creation or re-creation of sensory experiences in the mind, is the most popular mental training technique used by athletes as well as the most widely studied technique in the mental training literature (Morris et al., 2005). Of 235 Canadian athletes who participated in the 1984 Olympic Games, 99% reported using imagery (Orlick & Partington, 1988). These athletes estimated that during training they engaged in systematic imagery at least once a day, 4 days per week, for about 12 minutes each time. At the Olympic site, some reported engaging in imagery for 2 to 3 hours in preparation for their events. Coaches have indicated that they use imagery more than any other mental training technique and felt that imagery was the most useful technique that they used with their athletes (Bloom et al., 1997; Hall & Rodgers, 1989). Overall, more successful elite athletes use imagery more extensively and more systematically and have better imagery skill than less successful athletes (Calmels et al., 2003; Cumming & Hall, 2002; Hall, Rodgers, & Barr, 1990; Salmon, Hall, & Haslam, 1994). All athletes have the potential to increase their imagery abilities through systematic practice (Evans, Jones, & Mullen, 2004; Orlick & Partington, 1988; Rodgers, Hall, & Buckolz, 1991), with increases in imagery ability enhancing the effectiveness of imagery training (Isaac, 1992).

Athletes use imagery for many different reasons, including skill learning and practice, strategy development and rehearsal, competition preparation, including familiarization with venues and mental warm-ups, mental skill development and refinement, and coping with various sport stressors or obstacles, such as injuries, heavy training, and distractions (Morris et al., 2005; White & Hardy, 1998). An important consideration in using imagery is the imagery perspective (internal or external) adopted by athletes, although research has shown that performance may be enhanced using either perspective. Research on this topic indicates that the type of task athletes are engaging in should dictate the imagery perspective that will best facilitate the effectiveness of imagery on enhancing performance (e.g., L. Hardy & Callow, 1999).

Imagery training is effective in enhancing athletes' performance on sport skills (Feltz & Landers, 1983; K. A. Martin et al., 1999; Morris et al., 2005). Often termed "mental practice," this involves practicing imagery over a period of time in an intermittent learning style similar to a distributed physical practice schedule. Research has also shown that preparatory imagery, or using imagery immediately before performance, can improve performance on strength tasks, muscular endurance tasks, and golf putting (Vealey & Greenleaf, 2006). Imagery has been shown to be effective in enhancing self-confidence (Callow, Hardy, & Hall, 2001; Evans et al., 2004; Garza & Feltz, 1998; Hale & Whitehouse, 1998; McKenzie & Howe, 1997; Short et al., 2002), motivation (K. A. Martin & Hall, 1995), attentional control (Calmels, Berthoumieux, & d'Arripe-Longueville, 2004), and visual search abilities (Jordet, 2005) of athletes during competition. Specific types of imagery were effective in changing athletes' perceptions of anxiety from harmful and negative to facilitative and challenging (Evans et al., 2004; Hale & Whitehouse, 1998; Page, Sime, & Nordell, 1999).

Explanations for how imagery facilitates the performance and self-perceptions of athletes include cognitive, psychological state, and neurophysiological explanations (Morris et al., 2005). Cognitive explanations focus on information processing and how information is acquired, stored, retrieved, and used in the brain. Bioinformational theory has been a popular cognitive theoretical explanation for how imagery enhances sport performance, due to its intuitive appeal and pragmatic implications for using imagery to create "mental blueprints for perfect responses" (Vealey, 2005). Athlete performance has been improved to a greater degree through imagery that emphasizes productive responses, as opposed to imagery that focuses just on stimulus characteristics of the situation (D. Smith & Collins, 2004; D. Smith, Holmes, Whitemore, Collins, &

Devenport, 2001). Also, response-oriented imagery has created more "priming" responses in the brain, as measured by electroencephalographic activity when compared to stimulus-oriented imagery (D. Smith & Collins, 2004).

Psychological state explanations focus on the motivational function of imagery, in helping athletes feel more confident, optimally aroused, and clearly focused for competition. Neurophysiological explanations focus on the premise of functional equivalence, meaning that imagery and actual movement recruit common structures and processes in the brain, with the only difference being that during imagery the performance skill is not executed (Finke, 1980; Holmes & Collins, 2001; Jeannerod, 1994). In an imagery training program designed to improve golf putting, performance was enhanced more by mental practice using audiotapes and videotapes than by mental practice using written scripts that were read by the golfers (D. Smith & Holmes, 2004). The interpretation of this finding was that imagery training using the audio- and videotapes engaged more functionally equivalent neural processes in relation to the actual execution of putting as compared to written scripts.

Imagery is a technique that is incorporated into many different mental training strategies and models. These include the applied model of imagery use in sport (K. A. Martin et al., 1999; Paivio, 1985), the PETTLEP model (Holmes & Collins, 2001), the three-level model of sport imagery (S. M. Murphy & Martin, 2002), and the sport imagery ability model (Watt, Morris, & Andersen, 2004). Specific mental training strategies incorporating imagery include visuomotor behavior rehearsal (Suinn, 1984), the Five-Step Strategy (Singer, 1988), and the AIM strategy (Korn, 1994). Because the technique of imagery has been shown to effectively enhance performance, research efforts should begin to examine how effective imagery is for athletes as packaged in different ways using specific strategies or models of intervention.

Effectiveness and Use of Goal Setting in Mental Training

Another technique popularly used in mental training interventions is goal setting. Research with elite, collegiate, and adolescent athletes has confirmed that almost all athletes set goals, but most of them rate goals as only moderately effective in enhancing their performance (Burton, Weinberg, Yukelson, & Weigand, 1998; Weinberg, Burke, & Jackson, 1997; Weinberg, Burton, Yukelson, & Weigand, 1993, 2000). This finding emphasizes the important point that goals by *themselves* do nothing to enhance athletes' performance. A goal is simply a target, or a specific standard or accomplishment that one strives to attain. Goals must be incorporated into a systematic mental training program that enables athletes to plan, set, focus on, evaluate, and manage their behavior and thoughts in relation to their goals (Burton, 1989; Burton, Naylor, & Holliday, 2001; Gould, 2006; Vealey, 2005). When used systematically, goal setting works because it focuses attention on specific task demands, increases effort and intensity, encourages persistence when adversity is encountered, and promotes the development of strategies and problem solving to move toward goal achievement (Locke & Latham, 1990).

When compared to no goals or do-your-best goals, specific goal setting enhances athletes' performance (Burton & Naylor, 2002; Kyllo & Landers, 1995). Besides examining the overall effectiveness of goal setting, research has also examined what types of goals are most effective in what types of situations. The important distinction between outcome, performance, and process goals indicates that mental skills are enhanced when athletes focus on the right goals at the right time (Kingston & Hardy, 1997). Because outcome goals are uncontrollable, yet attractive and exciting, they are useful in enhancing motivation for the exhausting physical and mental preparation needed to achieve typical outcomes goals, such as winning championships or medals. Performance goals are more flexible and controllable for athletes, which allows them to continually raise and lower goal difficulty levels to remain challenged and successful in their pursuit of exciting outcome goals. Process goals are used in immediate situations to enable athletes to focus on specific task demands in productive ways, such as occupying their minds with key verbal cues that lock in optimal performance images and plans. This distinction in goal focus should be an important part of any intervention that uses goal setting as a mental training technique. Other attributes of effective goal setting are the use of specific, difficult, and measurable goals, an emphasis on desired behavioral outcomes as opposed to a focus on problem statements, the use of short- and long-term goals, and a congruency between individual and team goals (Burton et al., 2001).

The technique of goal setting has been incorporated into several intervention models for sport. Burton and colleagues (2001) devised a seven-phase model from which goal setting may be implemented with athletes. These steps include setting goals, identifying obstacles, securing a commitment, developing an action plan, gaining feedback on goal attainment, evaluating goal attainment, and reinforcing goal attainment. Vealey (2005) has proposed a four-phase model of goal mapping, defined as a systematic approach to acting and thinking in purposeful ways to achieve specific accomplishments and personal fulfillment. Personal and team goal maps are developed that include milestone, challenge, and focus goals, as well as goal achievement strategies and a progress log. Gould (2006) offers a three-phase goal-setting system for coaches, including planning, meeting, and follow-up/evaluation phases. Goal setting is a primary technique used with the life development intervention model and Going for the Goal strategy (Danish & Nellen, 1997), which includes such phases as setting goals, making your goal reachable, making a goal ladder, roadblocks to reaching goals, overcoming roadblocks, and rebounds and rewards. Again, as shown in Figure 13.2, research should begin to examine the effectiveness of comprehensive mental training programs that incorporate various mental training techniques, as opposed to simply studying the effectiveness of one isolated technique on athletes' performance. For example, a life development intervention was shown to be effective in enhancing the career transition adjustment for recently retired professional soccer players (Lavallee, 2005).

Effectiveness and Use of Self-Talk in Mental Training

A third mental training technique studied in sport psychology is self-talk, or the verbal dialogue in which athletes interpret their feelings and perceptions, evaluate themselves, and give themselves instructions or reinforcement (Hackfort & Schwenkmezger, 1993). Eighty percent of U.S. Olympic wresters used thought management strategies such as positive thinking, coping thoughts, blocking distractions, and perspective taking (Gould, Eklund, et al., 1993), and rational thinking and self-talk were two common coping strategies used by U.S. national champion figure skaters (Gould, Finch, et al., 1993). Highly skilled athletes use self-talk in a more planned and consistent manner than less skilled athletes, who tend to think reactively (J. Hardy, Hall, & Hardy, 2004; McPherson, 2000).

Researchers have found that planned self-talk enhances skill acquisition and performance in sport (J. Hardy, Gammage, & Hall, 2001; Johnson, Hrycaiko, Johnson, & Halas, 2004; Landin & Hebert, 1999; A. Miller & Donohue, 2003; Ming & Martin, 1996; Perkos, Theodorakis, & Chroni, 2002; Rushall, Hall, Roux, Sasseville, & Rushall, 1988; Wrisberg & Anshel, 1997). Research indicates that different types of self-talk (e.g., instructional versus motivational) may be effective in enhancing different types of sport performance (e.g., precision versus power tasks); thus, future research should pursue the specificity or matching of type of self-talk with type of task (Hatzigeorgiadis, Theodorakis, & Zourbanos, 2004).

Planned, productive self-talk is also effective for using strategy, psyching up for emotion and effort, relaxation and calming down, attentional focusing, maintaining confidence, and self-evaluation/self-reinforcement (e.g., J. Hardy et al., 2001; Landin & Hebert, 1999; Mallett & Hanrahan, 1997; Zinsser, Bunker, & Williams, 2006). Several other mental training techniques are associated with self-talk, including thought stopping, thought replacement, countering, reframing, and cognitive restructuring (e.g., Zinsser et al., 2006). Many of these techniques are used in multimodal mental training interventions or in specific mental training strategies such as P^3 Thinking (Vealey, 2005), rational-emotive education (Elko & Ostrow, 1991), and energy management (Hanton & Jones, 1999).

Effectiveness and Use of Physical Relaxation Techniques in Mental Training

Because the stressors inherent in sport often create physical tension in athletes, physical relaxation techniques may be useful to help athletes manage their physical energy levels to allow them to perform their best. Research concurs that successful elite athletes regularly use relaxation techniques to manage their physical energy (Durand-Bush & Salmela, 2002; Gould, Eklund, et al., 1993; Gould, Finch, et al., 1993). Most mental training programs incorporate relaxation as one of several techniques within a multimodal approach; thus, it is difficult to ascertain the specific effectiveness of physical relaxation as a mental training technique.

Research has been directed to test the "matching hypothesis" from multidimensional anxiety theory that suggests that effective anxiety management requires a match between the type of intervention strategy/technique used and the type of anxiety experienced by the athletes (cognitive or somatic). Physical relaxation strategies specifically targeted for athletes experiencing somatic anxiety were more effective than cognitive relaxation strategies in reducing this type of anxiety (Maynard & Cotton, 1993; Maynard, Hemmings, & Warwick-Evans, 1995; Maynard, MacDonald, & Warwick-Evans, 1997), although the physical relaxation intervention did not enhance the athletes' performance. Annesi (1998) developed a specific precompetitive anxiety regulation intervention for elite tennis players based on the individual zones of optimal functioning model. Physical and cognitive energy management strategies were used to help athletes remain within their individual optimal zones, which served to enhance their performance. The technique of flotation REST (restricted environmental stimulation technique) has been shown to be effective in reducing muscle tension and perceived exertion and enhancing performance on fine motor tasks (Norlander, Bergman, & Archer, 1999; Suedfeld, Collier, & Hartnett, 1993). Flotation REST involves athletes immersing themselves in a water tank filled with saltwater of an extremely high salt concentration, with the objective of inducing a deep state of relaxation by reducing external stimuli and preserving warmth.

Effectiveness of Multimodal Mental Skills Training

A plethora of research studies have examined the effects of multimodal mental training interventions on athletes' performance and mental skills. Multimodal interventions combine several mental training techniques into an integrated strategy that targets specific psychobehavioral outcomes of interest, such as performance improvement or mental skill enhancement. Multimodal interventions have enhanced athletes' attentional focus (Kerr & Leith, 1993), self-confidence (Prapavessis, Grove, McNair, & Cable, 1992; Savoy, 1997), motivation (Beauchamp, Halliwell, Fournier, & Koestner, 1996; Holm, Beckwith, Ehde, & Tinius, 1996), energy management (Crocker, Alderman, & Smith, 1988; Hanton & Jones, 1999; Holm et al., 1996; Kerr & Goss, 1996; Kerr & Leith, 1993; Kirschenbaum, Owens, & O'Connor, 1998; Mamassis & Doganis, 2004; Prapavessis et al., 1992; Savoy, 1993, 1997; Thomas & Fogarty, 1997), anger management (Brunelle, Janelle, & Tennant, 1999), productive thinking (Crocker et al., 1988; Kirschenbaum et al., 1998), and performance (Bakker & Kayser, 1994; Beauchamp et al., 1996; Daw & Burton, 1994; Groslambert, Candau, Grappe, Dugue, & Rouillon, 2003; Hanton & Jones, 1999; Kendall, Hrycaiko, Martin, & Kendall, 1990; Kerr & Leith, 1993; Kirschenbaum et al., 1998; G. L. Martin & Toogood, 1997; Patrick & Hrycaiko, 1998; Prapavessis et al., 1992; Savoy, 1993, 1997; Thelwell & Greenlees, 2003; Thomas & Fogarty, 1997; Wrisberg & Anshel, 1989; Zhang, Ma, Orlick, & Zitzelsberger, 1992).

Hypnosis, as a multimodal intervention strategy incorporating imagery, relaxation, and self-talk triggers, has been shown to be effective in enhancing basketball shooting performance (Pates, Cummings, & Maynard, 2002; Pates, Maynard, & Westbury, 2001) and golf putting (Pates, Oliver, & Maynard, 2001). Another multimodal intervention strategy is the use of biofeedback with other mental training techniques such as physical relaxation and imagery. These strategies have been shown to enhance athletes' abilities to manage their physiological energy as well as to enhance performance (Blumenstein, Bar-Eli, & Tenenbaum, 1995; Landers et al., 1991; Petruzzello, Landers, & Salazar, 1991).

SUGGESTIONS FOR THE FUTURE OF MENTAL SKILLS TRAINING IN SPORT

Despite significant advances and a growing knowledge base, mental skills training in sport must continue to evolve in socially significant ways. As discussed, mental training in sport must begin to address issues that arise with athletes and coaches due to their inclusion in a specific social-cultural context. Coakley (1992) has criticized mental training in sport as "psychodoping," or the use of mental training strategies and techniques that "dope" athletes into blindly accepting the social-structural conditions that negatively affect them. Coakley offers evidence for the overriding influence of the oppressive and controlling sport structure as a key causal factor in burnout in adolescent athletes. Interventions using a cultural praxis approach (Ryba & Wright, 2005) would help athletes understand their identities in problematic subcultures that spawn negative self-perceptions and unhealthy behaviors.

Brustad and Ritter-Taylor (1997) stated that the social-cultural context serves as the backdrop against which all thoughts, feelings, and behaviors of athletes and coaches take on meaning. They provide excellent suggestions that could enhance the social relevance of mental training by focusing on the underserved mental skills in athletes, such as identity development and achievement and self-awareness related to membership in specific subcultures, and team skills such as leadership processes and enhanced team functioning. As stated by mental training consultant Gloria Balague (1999, p. 89), "Regardless of the techniques (e.g., relaxation, imagery) I may be using in [mental training] work with athletes, understanding the larger issues of their identities and value systems and what sport and competition mean to them in their lives plays a central role in determining the quality and effectiveness of services that I deliver." Balague provides a provocative discussion about understanding the context within which athletes exist and the need to help athletes achieve balance within the problematic "imbalanced" world of elite sport. Philosophical counseling (Raabe, 2001), a fairly new approach that focuses on helping individuals come to a better philosophical understanding of themselves in relation to their personal context, seems to be a fruitful approach for mental training consultants to consider when working with athletes in mental skills training in sport.

Although performance success will always be a primary outcome of interest for mental training interventions in sport, an expanded mental skills model was presented in this chapter (see Figure 13.1) to call attention to the need to focus on foundation, personal development, and team skills. The life skills model for mental training has been adopted to focus on the development of personal development skills in sport participants (Lavallee, 2005; Papacharisis, Goudas, Danish, & Theodorakis, 2005; Petitpas, Van Raalte, Cornelius, & Presbrey, 2004), and additional programs are emerging that focus on psychosocial development in young athletes (Petitpas, Cornelius, Van Raalte, & Jones, 2005). By broadening the focus of mental training to enhance important foundation and personal development skills, the social relevance and credibility of sport psychology will also be enhanced. Mental skills training will not simply be a sophist-oriented (Corlett, 1996), decontextualized intervention in sport, as defined by the professionalized performance by a small minority of elite athletes. Rather, mental skills training represents a broad spectrum of programs and interventions specifically targeted toward certain populations in certain contexts (e.g., college athletes, children entering organized sport programs, older adults involved in sport, at-risk youth athletes) that integrates mental and physical skill development for performance success and personal well-being.

Although cohesion is a popular research topic and team building is a popular intervention topic, the development of specific team skills has received very little attention in the mental training literature, with most of the focus on team building but without specific outcomes (e.g., team confidence, leadership, communication, cohesion) that could be targeted beyond the abstract notion of building a team. Two team intervention programs to enhance cohesion did not produce clear results (Cogan & Petrie, 1995; Prapavessis, Carron, & Spink, 1996), and additional research is needed on team interventions. A communication skills training program for interactive teams was evaluated positively by athletes (Sullivan, 1993), and other team interventions, such as using performance profiling (Dale & Wrisberg, 1996) and teaching assertiveness skills (Connelly & Rotella, 1991), have been reported. A special issue of the *Journal of Applied Sport Psychology* (March 1997) provided several examples of team building, yet research is needed to examine the effects of mental training interventions on specifically targeted team skills. Eccles and Tenenbaum (2004) provide a comprehensive conceptual framework for team communication and coordination that could serve as a model for team interventions.

Another suggested direction for mental skills training is the development of models, approaches, and/or programs that address transitions, or key events representing significant change, for athletes and coaches. These may include mental skills models for entry into new sport structures (e.g., high school, college, professional sport), departure from sport such as retirement, role changes, and participation interruptions (e.g., injury, ineligibility, transfer; Danish, Owens, Green, & Brunelle, 1997), and life crisis events (Buchko, 2005; Vernacchia, Reardon, & Templin, 1997). Finally, technology should continue to be developed and utilized to enhance the delivery of mental skills training to athletes and coaches. Current approaches include Internet Web-based interventions (Farres & Stodel, 2003; Zizzi & Perna, 2002) and innovative uses of video technology (Ives, Straub, & Shelley, 2002; Omodei, McClennan, & Whitford, 1998). Technological advancements seem particularly important for the future of perceptual training of athletes, where the transfer of positive training effects from laboratory settings to the field has been problematic (Jordet, 2005; Singer et al., 1994; A. M. Williams & Grant, 1999; A. M. Williams, Ward, & Chapman, 2003).

CONCLUSION

Mental training in sport has significantly evolved in the past 30 years as the knowledge base has expanded with a plethora of books describing the practice of mental training as well as journal articles focusing on mental skills, mental training interventions, and professional practice issues. Overall, mental training has been found to be effective in enhancing the performance success and mental skills in athletes. The external validity of intervention research has been enhanced by focusing on behavior in competitive contexts, using athlete-centered approaches in which mental training is individualized based on the needs and abilities of athletes and utilizing idiographic designs to assess intervention effects with individual athletes. Multiple models and programs are available in the literature to help athletes, coaches, and consultants integrate mental and physical training in specific sport environments in creative and user-friendly ways. Professional development resources are available for mental training consultants to enhance their interpersonal and technical skills and to increase their awareness of and commitment to ethical practice.

A mental skills model and a mental skills training framework were presented in this chapter to provide an organizational structure within which the literature on mental skills training in sport was reviewed. Of course, additional models and frameworks may be developed, but the intent has been to stimulate critical thinking about this important service delivery component of sport psychology. The evolution of mental skills training in the past 30 years is impressive, as the knowledge base has grown and mental training practice has become more sophisticated. However, greater sophistication means greater complexity; thus, the challenge remains for sport psychology professionals to continue to creatively grow mental skills training in productive and socially relevant new directions.

REFERENCES

ABC Nightline News Telecast Focus on Sport Psychology. (1988). *Sport Psychologist, 2,* 95–96.

Andersen, M. B. (Ed.). (2000). *Doing sport psychology.* Champaign, IL: Human Kinetics.

Andersen, M. B. (Ed.). (2005). *Sport psychology in practice.* Champaign, IL: Human Kinetics.

Annesi, J. J. (1998). Applications of the individual zones of optimal functioning model for the multimodal treatment of precompetitive anxiety. *Sport Psychologist, 12,* 300–316.

Baker, J., Côté, J., & Abernethy, B. (2003). Learning from the experts: Practice activities of expert decision makers in sport. *Research Quarterly for Exercise and Sport, 74,* 342–347.

Bakker, F. C., & Kayser, C. S. (1994). Effect of a self-help mental training programme. *International Journal of Sport Psychology, 25,* 158–175.

Balague, G. (1999). Understanding identity, value, and meaning when working with elite athletes. *Sport Psychologist, 13,* 89–98.

Beauchamp, P. H., Halliwell, W. R., Fournier, J. F., & Koestner, R. (1996). Effects of cognitive-behavioral psychological skills training on the motivation, preparation, and putting performance of novice golfers. *Sport Psychologist, 10,* 157–170.

Bloom, G. A., Durand-Bush, N., & Salmela, J. H. (1997). Pre- and postcompetition routines of expert coaches of team sports. *Sport Psychologist, 11,* 127–141.

Blumenstein, B., Bar-Eli, M., & Tenenbaum, G. (1995). The augmenting role of biofeedback: Effects of autogenic, imagery, and music training on physiological indices and athletic performance. *Journal of Sport Sciences, 13,* 343–354.

Blumenstein, B., Bar-Eli, M., & Tenenbaum, G. (2002). *Brain and body in sport and exercise: Biofeedback applications in performance enhancement.* Eastbourne, East Sussex, England: Wiley.

Boutcher, S. H., & Rotella, R. J. (1987). A psychological skills educational program for closed-skill performance enhancement. *Sport Psychologist, 1,* 127–137.

Brewer, B. W., & Shillinglaw, R. (1992). Evaluation of a psychological skills training workshop for male intercollegiate lacrosse players. *Sport Psychologist, 6,* 139–147.

Brown, J. M. (1982). Are sport psychologists really psychologists? *Journal of Sport Psychology, 4,* 13–18.

Brunelle, J. P., Janelle, C. M., & Tennant, L. K. (1999). Controlling competitive anger among male soccer players. *Journal of Applied Sport Psychology, 11,* 283–297.

Brustad, R. J., & Ritter-Taylor, M. (1997). Applying social psychological perspectives to the sport psychology consulting process. *Sport Psychologist, 11,* 107–119.

Buchko, K. J. (2005). Team consultation following an athlete's suicide: A crisis intervention model. *Sport Psychologist, 19,* 288–302.

Bull, S. J. (1991). Personal and situational influences on adherence to mental skills training. *Journal of Sport and Exercise Psychology, 13,* 121–132.

Bull, S. J., Albinson, J. G., & Shambrook, J. (1996). *The mental game plan: Getting psyched for sport.* Brighton, England: Sports Dynamic.

Bull, S. J., Shambrook, C. J., James, W., & Brooks, J. E. (2005). Towards an understanding of mental toughness in elite English cricketers. *Journal of Applied Sport Psychology, 17,* 209–227.

Burton, D. (1989). Winning isn't everything: Examining the impact of performance goals on collegiate swimmers' cognitions and performance. *Sport Psychologist, 3,* 105–132.

Burton, D., & Naylor, S. (2002). The Jekyll/Hyde nature of goals: Revisiting and updating goal-setting in sport. In T. S. Horn (Ed.), *Advances in sport psychology* (2nd ed., pp. 459–499). Champaign, IL: Human Kinetics.

Burton, D., Naylor, S., & Holliday, B. (2001). Goal setting in sport: Investigating the goal effectiveness paradox. In R. N. Singer, H. A. Hausenblas, & C. M. Janelle (Eds.), *Handbook of sport psychology* (2nd ed., pp. 497–528). New York: Wiley.

Burton, D., Weinberg, R., Yukelson, D., & Weigand, D. (1998). The goal effectiveness paradox in sport: Examining the goal practices of collegiate athletes. *Sport Psychologist, 12,* 404–418.

Callow, N., Hardy, L., & Hall, C. (2001). The effects of a motivational general-mastery imagery intervention on the sport confidence of high-level badminton players. *Research Quarterly for Exercise and Sport, 72,* 389–400.

Calmels, C., Berthoumieux, C., & d'Arripe-Longueville, F. (2004). Effects of an imagery training program on selective attention of national softball players. *Sport Psychologist, 18,* 272–296.

Calmels, C., d'Arripe-Longueville, F., Fournier, J. F., & Soulard, A. (2003). Competitive strategies among elite female gymnasts: An exploration of the relative influence of psychological skills training and natural learning experiences. *International Journal of Sport and Exercise Psychology, 1,* 327–352.

Carron, A. V., Colman, M. M., Wheeler, J., & Stevens, D. (2002). Cohesion and performance in sport: A meta-analysis. *Journal of Sport and Exercise Psychology, 24,* 168–188.

Chen, D., & Singer, R. N. (1992). Self-regulation and cognitive strategies in sport participation. *International Journal of Sport Psychology, 23,* 277–300.

Clarke, K. S. (1984). The USOC sports psychology registry: A clarification. *Journal of Sport Psychology, 6,* 365–366.

Cleary, T. J., & Zimmerman, B. J. (2001). Self-regulation differences during athletic practice by experts, non-experts, and novices. *Journal of Applied Sport Psychology, 13,* 185–206.

Coakley, J. (1992). Burnout among adolescent athletes: A personal failure or social problem. *Sociology of Sport Journal, 9,* 271–285.

Cogan, K. D., & Petrie, T. A. (1995). Sport consultation: An evaluation of a season-long intervention with female collegiate gymnasts. *Sport Psychologist, 9,* 282–296.

Connelly, D., & Rotella, R. J. (1991). The social psychology of assertive communication: Issues in teaching assertiveness skills to athletes. *Sport Psychologist, 5,* 73–87.

Corlett, J. (1996). Sophistry, Socrates, and sport psychology. *Sport Psychologist, 10,* 84–94.

Crocker, P. R. E., Alderman, R. B., & Smith, F. M. R. (1988). Cognitive-affective stress management training with high performance youth volleyball players: Effects on affect, cognition, and performance. *Journal of Sport and Exercise Psychology, 10*(4), 448–460.

Cumming, J. L., & Hall, C. (2002). Athletes' use of imagery in the off-season. *Sport Psychologist, 16,* 160–172.

Dale, G. A., & Wrisberg, C. A. (1996). The use of a performance profiling technique in a team setting: Getting the athletes and coach on the "same page." *Sport Psychologist, 10,* 261–277.

Danish, S. J., & Hale, B. D. (1981). Toward an understanding of the practice of sport psychology. *Journal of Sport Psychology, 3,* 90–99.

Danish, S. J., & Hale, B. D. (1982). Let the discussions continue: Further considerations of the practice of sport psychology. *Journal of Sport Psychology, 4,* 10–12.

Danish, S. J., & Nellen, V. C. (1997). New roles for sport psychologists: Teaching life skills through sport to at-risk youth. *Quest, 49,* 100–113.

Danish, S. J., Owens, S. S., Green, S. L., & Brunelle, J. P. (1997). Building bridges for disengagement: The transition process for individuals and teams. *Journal of Applied Sport Psychology, 9,* 154–167.

Danish, S. J., Petitpas, A. J., & Hale, B. D. (1992). A developmental-educational intervention model of sport psychology. *Sport Psychologist, 6,* 403–415.

Danish, S. J., Petitpas, A., & Hale, B. D. (1995). Psychological interventions: A life development model. In S. M. Murphy (Ed.), *Sport psychology interventions* (pp. 19–38). Champaign, IL: Human Kinetics.

Daw, J., & Burton, D. (1994). Evaluation of a comprehensive psychological skills training program for collegiate tennis players. *Sport Psychologist, 8,* 37–57.

DeFrancesco, C., & Burke, K. L. (1997). Performance enhancement strategies used in a professional tennis tournament. *International Journal of Sport Psychology, 28,* 185–195.

Dishman, R. K. (1983). Identity crisis in North American sport psychology: Academics in professional issues. *Journal of Sport Psychology, 5,* 123–134.

Dorrance, A., & Averbuch, G. (2002). *The vision of a champion.* Ann Arbor, MI: Huron River Press.

Dunn, J. G., & Holt, N. L. (2003). Collegiate ice hockey players' perceptions of the delivery of an applied sport psychology program. *Sport Psychologist, 17,* 351–368.

Durand-Bush, N., & Salmela, J. H. (2002). The development and maintenance of expert athletic performance: Perceptions of world and Olympic champions. *Journal of Applied Sport Psychology, 14,* 154–171.

Eccles, D. W., & Tenenbaum, G. (2004). Why an expert team is more than a team of experts: A cognitive conceptualization of team coordination and communication in sport. *Journal of Sport and Exercise Psychology, 26,* 542–560.

Eklund, R. C. (1994). A season-long investigation of competitive cognition in collegiate wrestlers. *Research Quarterly for Exercise and Sport, 65,* 169–183.

Eklund, R. C. (1996). Preparing to compete: A season-long investigation with collegiate wrestlers. *Sport Psychologist, 10,* 111–131.

Elko, P. K., & Ostrow, A. C. (1991). Effects of a rational-emotive education program on heightened anxiety level of female collegiate gymnasts. *Sport Psychologist, 5,* 235–255.

Evans, L., Jones, L., & Mullen, R. (2004). An imagery intervention during the competitive season with an elite rugby union player. *Sport Psychologist, 18,* 252–271.

Farres, L. G., & Stodel, E. J. (2003). WebExcellence in mental skills education: A framework for designing quality Web-based mental skills education environments. *International Journal of Sport and Exercise Psychology, 1,* 353–371.

Feltz, D. L., & Landers, D. M. (1983). The effects of mental practice on motor skill learning and performance: A meta-analysis. *Journal of Sport Psychology, 5,* 25–57.

Feltz, D. L., & Lirgg, C. D. (1998). Perceived team and player efficacy in hockey. *Journal of Applied Psychology, 83,* 557–564.

Finke, R. A. (1980). Levels of equivalence of mental images and perception. *Psychological Review, 87,* 113–132.

Frey, M., Laguna, P. L., & Ravizza, K. (2003). Collegiate athletes' mental skill use and perceptions of success: An exploration of the practice and competition settings. *Journal of Applied Sport Psychology, 15,* 115–128.

Gardner, F. L. (1991). Professionalization of sport psychology: A reply to Silva. *Sport Psychologist, 5,* 55–60.

Gardner, F. L., & Moore, Z. E. (2004). The multi-level classification system for sport psychology (MCS-SP). *Sport Psychologist, 18,* 89–109.

Gardner, F. L., & Moore, Z. E. (2006). *Clinical sport psychology.* Champaign, IL: Human Kinetics.

Garza, D. L., & Feltz, D. L. (1998). Effects of selected mental practice on performance, self-efficacy, and competition confidence in figure skaters. *Sport Psychologist, 12,* 1–15.

Gould, D. (2006). Goal setting for peak performance. In J. M. Williams (Ed.), *Applied sport psychology: Personal growth to peak performance* (5th ed., pp. 240–259). Boston: McGraw-Hill.

Gould, D., Damarjian, N., & Medbery, R. (1999). An examination of mental skills training in junior tennis coaches. *Sport Psychologist, 13,* 127–143.

Gould, D., Dieffenbach, K., & Moffett, A. (2002). Psychological characteristics and their development in Olympic champions. *Journal of Applied Sport Psychology, 14,* 172–204.

Gould, D., Eklund, R. C., & Jackson, S. A. (1992a). 1988 U.S. Olympic wrestling excellence: Pt. I. Mental preparation, precompetitive cognition, and affect. *Sport Psychologist, 6,* 358–382.

Gould, D., Eklund, R. C., & Jackson, S. A. (1992b). 1988 U.S. Olympic wrestling excellence: Pt. II. Thoughts and affect occurring during competition. *Sport Psychologist, 6,* 383–402.

Gould, D., Eklund, R. C., & Jackson, S. A. (1993). Coping strategies used by U.S. Olympic wrestlers. *Research Quarterly for Exercise and Sport, 64,* 83–93.

Gould, D., Finch, L. M., & Jackson, S. A. (1993). Coping strategies used by national champion figure skaters. *Research Quarterly for Exercise and Sport, 64,* 453–468.

Gould, D., Greenleaf, C., Chung, Y., & Guinan, D. (2002). A survey of U.S. Atlanta and Nagano Olympians: Variables perceived to influence performance. *Research Quarterly for Exercise and Sport, 73,* 175–186.

Gould, D., Guinan, D., Greenleaf, C., Medbery, R., & Peterson, K. (1999). Factors affecting Olympic performance: Perceptions of athletes and coaches from more or less successful teams. *Sport Psychologist, 13,* 371–394.

Gould, D., Hodge, K., Peterson, K., & Giannini, J. (1989). An exploratory examination of strategies used by elite coaches to enhance self-efficacy in athletes. *Journal of Sport and Exercise Psychology, 11,* 128–140.

Gould, D., Medbery, R., Damarjian, N., & Lauer, L. (1999). A survey of mental skills training knowledge, opinions, and practices of junior tennis coaches. *Journal of Applied Sport Psychology, 11,* 28–50.

Gould, D., Murphy, S., Tammen, V., & May, J. (1991). An evaluation of U.S. Olympic sport psychology consultant effectiveness. *Sport Psychologist, 5,* 111–127.

Gould, D., Petlichkoff, L., Hodge, K., & Simons, J. (1990). Evaluating the effectiveness of a psychological skills educational workshop. *Sport Psychologist, 4,* 249–260.

Green, C. D. (2003). Psychology strikes out: Coleman R. Griffith and the Chicago Cubs. *History of Psychology, 6,* 267–283.

Greenleaf, C., Gould, D., & Dieffenbach, K. (2001). Factors influencing Olympic performance: Interviews with Atlanta and Nagano U.S. Olympians. *Journal of Applied Sport Psychology, 13,* 154–184.

Greenspan, M., & Andersen, M. B. (1995). Providing psychological services to student athletes: A developmental psychology model. In S. M. Murphy (Ed.), *Sport psychology interventions* (pp. 177–191). Champaign, IL: Human Kinetics.

Greenspan, M. J., & Feltz, D. L. (1989). Psychological interventions with athletes in competitive situations: A review. *Sport Psychologist, 3,* 219–236.

Groslambert, A., Candau, R., Grappe, F., Dugue, B., & Rouillon, J. D. (2003). Effects of autogenic and imagery training on the shooting performance in biathlon. *Research Quarterly for Exercise and Sport, 74,* 337–341.

Grove, J. R., & Hanrahan, S. J. (1988). Perceptions of mental training needs by elite field hockey players and their coaches. *Sport Psychologist, 2,* 222–230.

Grove, J. R., Norton, P. J., Van Raalte, J. L., & Brewer, B. W. (1999). Stages of change as an outcome measure in the evaluation of mental skills training programs. *Sport Psychologist, 13,* 107–116.

Hackfort, D., & Schwenkmezger, P. (1993). Anxiety. In R. N. Singer, M. Murphy, & L. K. Tennant (Eds.), *Handbook of research on sport psychology* (pp. 328–364). New York: Macmillan.

Hale, B. D., & Whitehouse, A. (1998). The effects of imagery-manipulated appraisal on intensity and direction of competitive anxiety. *Sport Psychologist, 12,* 40–51.

Hall, C. R., & Rodgers, W. M. (1989). Enhancing coaching effectiveness in figure skating through a mental skills training program. *Sport Psychologist, 3,* 142–154.

Hall, C. R., Rodgers, W. M., & Barr, K. A. (1990). The use of imagery by athletes in selected sports. *Sport Psychologist, 4,* 1–10.

Hanin, Y. L. (2000). Successful and poor performance and emotions. In Y. L. Hanin (Ed.), *Emotions in sport* (pp. 157–187). Champaign, IL: Human Kinetics.

Hanton, S., & Jones, G. (1999). The effects of a multi-modal intervention program on performers: Pt. II. Training the butterflies to fly in formation. *Sport Psychologist, 13,* 22–41.

Hardy, J., Gammage, K., & Hall, C. (2001). A descriptive study of athlete self-talk. *Sport Psychologist, 15,* 306–318.

Hardy, J., Hall, C. R., & Hardy, L. (2004). A note on athletes' use of self-talk. *Journal of Applied Sport Psychology, 16,* 251–257.

Hardy, L., & Callow, N. (1999). Efficacy of external and internal visual imagery perspectives for the enhancement of performance on tasks in which form is important. *Journal of Sport and Exercise Psychology, 21,* 95–112.

Hardy, L., Jones, G., & Gould, D. (1996). *Understanding psychological preparation for sport: Theory and practice of elite performers.* New York: Wiley.

Hardy, L., & Parfitt, G. (1994). The development of a model for the provision of psychological support to a national squad. *Sport Psychologist, 8,* 126–142.

Harris, D. V., & Harris, B. L. (1984). *The athlete's guide to sports psychology: Mental skills for physical people.* Champaign, IL: Human Kinetics.

Harrison, R. P., & Feltz, D. L. (1979). The professionalization of sport psychology: Legal considerations. *Journal of Sport Psychology, 1,* 182–190.

Harwood, C., Cumming, J., & Fletcher, D. (2004). Motivational profiles and psychological skills use within elite youth sport. *Journal of Applied Sport Psychology, 16,* 318–332.

Hatzigeorgiadis, A., Theodorakis, Y., & Zourbanos, N. (2004). Self-talk in the swimming pool: The effects of self-talk on thought content and performance on water-polo tasks. *Journal of Applied Sport Psychology, 16,* 138–150.

Heishman, M. F., & Bunker, L. (1989). Use of mental preparation strategies by international elite female lacrosse players from five countries. *Sport Psychologist, 3,* 14–22.

Hellstedt, J. C. (1995). Invisible players: A family systems model. In S. M. Murphy (Ed.), *Sport psychology interventions* (pp. 117–146). Champaign, IL: Human Kinetics.

Heyman, S. R. (1982). A reaction to Danish and Hale: A minority report. *Journal of Sport Psychology, 4,* 7–9.

Heyman, S. R. (1984). The development of models for sport psychology: Examining the USOC guidelines. *Journal of Sport Psychology, 6,* 125–132.

Holm, J. E., Beckwith, B. E., Ehde, D. M., & Tinius, T. P. (1996). Cognitive-behavioral interventions for improving performance in competitive athletes: A controlled treatment outcome study. *International Journal of Sport Psychology, 27,* 463–475.

Holmes, P. S., & Collins, D. J. (2001). The PETTLEP approach to motor imagery: A functional equivalence model for sport psychology. *Journal of Applied Sport Psychology, 13,* 60–83.

Holt, N. L., & Dunn, J. G. (2004). Toward a grounded theory of the psychosocial competencies and environmental conditions associated with soccer success. *Journal of Applied Sport Psychology, 16,* 199–219.

Isaac, A. R. (1992). Mental practice: Does it work in the field? *Sport Psychologist, 6,* 192–198.

Ives, J. C., Straub, W. F., & Shelley, G. A. (2002). Enhancing athletic performance using digital video in consulting. *Journal of Applied Sport Psychology, 14,* 237–245.

Jeannerod, M. (1994). The representing brain: Neural correlates of motor intention and imagery. *Behavioral and Brain Sciences, 17,* 187–202.

Johnson, J. M., Hrycaiko, D. W., Johnson, G. V., & Halas, J. M. (2004). Self-talk and female youth soccer performance. *Sport Psychologist, 18,* 44–59.

Jones, G. (1993). The role of performance profiling in cognitive-behavioral interventions in sport. *Sport Psychologist, 7,* 160–172.

Jones, G., Hanton, S., & Connaughton, D. (2002). What is this thing called mental toughness? An investigation of elite sport performers. *Journal of Applied Sport Psychology, 14,* 205–218.

Jordet, G. (2005). Perceptual training in soccer: An imagery intervention study with elite players. *Journal of Applied Sport Psychology, 17,* 140–156.

Kendall, G., Hrycaiko, D., Martin, G. L., & Kendall, T. (1990). The effects of an imagery rehearsal, relaxation, and self-talk package on basketball game performance. *Journal of Sport and Exercise Psychology, 12,* 157–166.

Kerr, G., & Goss, J. (1996). The effects of a stress management program on injuries and stress levels. *Journal of Applied Sport Psychology, 8,* 109–117.

Kerr, G., & Leith, L. (1993). Stress management and athletic performance. *Sport psychologist, 7*(3), 221–231.

Kingston, K., & Hardy, L. (1997). Effects of different types of goals on processes that support performance. *Sport Psychologist, 11,* 277–293.

Kirschenbaum, D. S., Owens, D., & O'Connor, E. A. (1998). Smart golf: Preliminary evaluation of a simple, yet comprehensive, approach to improving and scoring the mental game. *Sport Psychologist, 12,* 271–282.

Kirschenbaum, D. S., & Wittrock, D. A. (1984). Cognitive-behavioral interventions in sport: A self-regulatory perspective. In J. M. Silva & R. S. Weinberg (Eds.), *Psychological foundations of sport* (pp. 81–91). Champaign, IL: Human Kinetics.

Kitsantas, A., & Zimmerman, B. J. (2002). Comparing self-regulatory processes among novice, non-expert, and expert volleyball players: A microanalytic study. *Journal of Applied Sport Psychology, 14,* 91–105.

Korn, E. R. (1994). Mental imagery in enhancing performance: Theoretical and practice exercises. In A. A. Sheikh & E. R. Korn (Eds.), *Imagery in sport and physical performance* (pp. 201–230). Amityville, NY: Baywood.

Kornspan, A. S., & MacCracken, M. J. (2001). Psychology applied to sport in the 1940s: The work of Dorothy Hazeltine Yates. *Sport Psychologist, 15,* 342–345.

Kornspan, A. S., & MacCracken, M. J. (2002). The use of psychology in professional baseball. *Nine: A Journal of Baseball History and Culture, 11,* 36–43.

Krzyzewski, M. (2000). *Leading with the heart.* New York: Warner.

Kyllo, B., & Landers, D. (1995). Goal setting in sport and exercise: A research synthesis to resolve the controversy. *Journal of Exercise and Sport Psychology, 17,* 117–137.

Landers, D. M., Petruzzello, S. J., Salazar, W., Crews, D. L., Kubitz, K. A., Gannon, T. L., et al. (1991). The influence of electrocortical biofeedback on performance in preelite archers. *Medicine and Science in Sport and Exercise, 23,* 123–129.

Landin, D., & Hebert, E. P. (1999). The influence of self-talk on the performance of skilled female tennis players. *Journal of Applied Sport Psychology, 11,* 263–282.

Lavallee, D. (2005). The effect of a life development intervention on sports career transition adjustment. *Sport Psychologist, 19,* 193–202.

Lidor, R., & Henschen, K. P. (2003). *The psychology of team sports.* Morgantown, WV: Fitness Information Technology.

Lindsay, P., Maynard, I., & Thomas, O. (2005). Effects of hypnosis on flow states and cycling performance. *Sport Psychologist, 19,* 164–177.

Lloyd, R. J., & Trudel, P. (1999). Verbal interactions between an eminent mental training consultant and elite level athletes: A case study. *Sport Psychologist, 13,* 418–443.

Locke, E. A., & Latham, G. P. (1990). *A theory of goal setting and task performance.* Englewood Cliffs, NJ: Prentice-Hall.

Mallett, C. J., & Hanrahan, S. J. (1997). Race modeling: An effective cognitive strategy for the 100 m sprinter. *Sport Psychologist, 11,* 72–85.

Mamassis, G., & Doganis, G. (2004). The effects of a mental training program on juniors' pre-competitive anxiety, self-confidence, and tennis performance. *Journal of Applied Sport Psychology, 16,* 118–137.

Marchant, D., & Gibbs, P. (2004). Ethical considerations in treating borderline personality in sport: A case example. *Sport Psychologist, 18,* 317–323.

Marcia, J. E. (1994). Ego identity and object relations. In J. M. Masling & R. F. Bornstein (Eds.), *Empirical perspectives on object relations theory* (pp. 59–93). Washington, DC: American Psychological Association.

Martin, G. L., & Toogood, A. (1997). Cognitive and behavioral components of a seasonal psychological skills training program for competitive figure skaters. *Cognitive and Behavioral Practice, 4,* 383–404.

Martin, K. A., & Hall, C. R. (1995). Using mental imagery to enhance intrinsic motivation. *Journal of Sport and Exercise Psychology, 17,* 54–69.

Martin, K. A., Moritz, S. E., & Hall, C. R. (1999). Imagery use in sport: A literature review and applied model. *Sport Psychologist, 13,* 245–268.

Martin, S. B. (2005). High school and college athletes' attitudes toward sport psychology consulting. *Journal of Applied Sport Psychology, 17,* 127–139.

Martin, S. B., Lavallee, D., Kellmann, M., & Page, S. J. (2004). Attitudes toward sport psychology consulting of adult athletes from the United States, United Kingdom, and Germany. *International Journal of Sport and Exercise Psychology, 2,* 146–160.

Martin, S. B., Thompson, C. L., & McKnight, J. (1998). An integrative psychoeducational approach to sport psychology consulting: A case study. *International Journal of Sport Psychology, 29,* 170–186.

Maynard, I. W., & Cotton, P. C. J. (1993). An investigation of two stress-management techniques in a field setting. *Sport Psychologist, 7,* 375–387.

Maynard, I. W., Hemmings, B., & Warwick-Evans, L. (1995). The effects of a somatic intervention strategy on competitive state anxiety and performance in semiprofessional soccer players. *Sport Psychologist, 9,* 51–64.

Maynard, I. W., MacDonald, A. L., & Warwick-Evans, L. (1997). Anxiety in novice rock climbers: A further test of the matching hypothesis in a field setting. *International Journal of Sport Psychology, 28,* 67–78.

McKenzie, A., & Howe, B. L. (1997). The effect of imagery on self-efficacy for a motor skill. *International Journal of Sport Psychology, 28,* 196–210.

McPherson, S. L. (2000). Expert-novice differences in planning strategies during collegiate singles tennis competition. *Journal of Sport and Exercise Psychology, 22,* 39–62.

McPherson, S. L., & Kernodle, M. W. (2002). Tactics, the neglected attribute of expertise: Problem representations and performance skills in tennis. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 137–167). Champaign, IL: Human Kinetics.

Meyers, A. W., Whelan, J. P., & Murphy, S. M. (1996). Cognitive behavioral strategies in athletic performance enhancement. In M. Mersen, R. M. Miller, & A. S. Belack (Eds.), *Progress in behavior modification* (pp. 137–164). Pacific Grove, CA: Brooks/Cole.

Miller, A., & Donohue, B. (2003). The development and controlled evaluation of athletic mental preparation strategies in high school distance runners. *Journal of Applied Sport Psychology, 15,* 321–334.

Miller, P. S., & Kerr, G. A. (2002). Conceptualizing excellence: Past, present, and future. *Journal of Applied Sport Psychology, 14,* 140–153.

Miller, S. C., Bredemeier, B. J. L., & Shields, D. L. L. (1997). Sociomoral education through physical education with at-risk children. *Quest, 49,* 114–129.

Ming, S., & Martin, G. L. (1996). Single-subject evaluation of a self-talk package for improving figure skating performance. *Sport Psychologist, 10,* 227–238.

Moore, W. E., & Stevenson, J. R. (1994). Training for trust in sport skills. *Sport Psychologist, 8,* 1–12.

Morris, T., Alfermann, D., Lintunen, T., & Hall, H. (2003). Training and selection of sport psychologists: An international review. *International Journal of Sport and Exercise Psychology, 1,* 139–154.

Morris, T., Spittle, M., & Watt, A. P. (2005). *Imagery in sport.* Champaign, IL: Human Kinetics.

Murphy, G. M., Petitpas, A. J., & Brewer, B. W. (1996). Identity foreclosure, athletic identity, and career maturity in intercollegiate athletics. *Sport Psychologist, 10,* 239–246.

Murphy, S. (Ed.). (2005). *The sport psych handbook.* Champaign, IL: Human Kinetics.

Murphy, S. M., & Martin, K. A. (2002). The use of imagery in sport. In T. S. Horn (Ed.), *Advances in sport psychology* (2nd ed., pp. 405–439). Champaign, IL: Human Kinetics.

Newburg, D., Kimiecik, J., Durand-Bush, N., & Doell, K. (2002). The role of resonance in performance excellence and life engagement. *Journal of Applied Sport Psychology, 14,* 249–267.

Nicholls, A. R., Holt, N. L., & Polman, R. C. J. (2005). A phenomenological analysis of coping effectiveness in golf. *Sport Psychologist, 19,* 111–130.

Nideffer, R. M. (1981). *The ethics and practice of applied sport psychology.* Ithaca, NY: Mouvement.

Nideffer, R. M., DuFresne, P., Nesvig, D., & Selder, D. (1980). The future of applied sport psychology. *Journal of Sport Psychology, 2,* 170–174.

Nideffer, R. M., Feltz, D. L., & Salmela, J. (1982). A rebuttal to Danish and Hale: A committee report. *Journal of Sport Psychology, 4,* 3–6.

Nideffer, R. M., & Sagal, M. (2006). *Applied sport psychology: Personal growth to peak performance* (pp. 382–403). Boston: McGraw-Hill.

Norlander, T., Bergman, H., & Archer, T. (1999). Primary process in competitive archery performance: Effects of flotation REST. *Journal of Applied Sport Psychology, 11,* 194–209.

O'Connor, E. A. (2004). Which questionnaire? Assessment practices of sport psychology consultants. *Sport Psychologist, 18,* 464–468.

Ogilvie, B. C., & Tutko, T. A. (1966). *Problem athletes and how to handle them.* London: Palham.

Omodei, M. M., McClennan, J., & Whitford, P. (1998). Using a head-mounted video camera and two-stage replay to enhance orienteering performance. *International Journal of Sport Psychology, 29,* 115–131.

Orlick, T. (1980). *In pursuit of excellence.* Champaign, IL: Human Kinetics.

Orlick, T. (1986). *Psyching for sport: Mental training for athletes.* Champaign, IL: Human Kinetics.

Orlick, T. (1990). *In pursuit of excellence* (2nd ed.). Champaign, IL: Human Kinetics.

Orlick, T. (2000). *In pursuit of excellence* (3rd ed.). Champaign, IL: Human Kinetics.

Orlick, T., & Partington, J. (1987). The sport psychology consultant: Analysis of critical components as viewed by Canadian Olympic athletes. *Sport Psychologist, 1,* 4–17.

Orlick, T., & Partington, J. (1988). Mental links to excellence. *Sport Psychologist, 2,* 105–130.

Page, S. J., Sime, W., & Nordell, K. (1999). The effects of imagery on female college swimmers' perceptions of anxiety. *Sport Psychologist, 13,* 458–469.

Paivio, A. (1985). Cognitive and motivational functions of imagery in human performance. *Canadian Journal of Applied Sport Science, 10,* S22–S28.

Papacharisis, V., Goudas, M., Danish, S. J., & Theodorakis, Y. (2005). The effectiveness of teaching a life skills program in a sport context. *Journal of Applied Sport Psychology, 17,* 247–254.

Partington, J., & Orlick, T. (1987). The sport psychology consultant: Olympic coaches' views. *Sport Psychologist, 1,* 95–102.

Pates, J., Cummings, A., & Maynard, I. (2002). The effects of hypnosis on flow states and three-point shooting performance in basketball players. *Sport Psychologist, 16,* 34–47.

Pates, J., Maynard, I., & Westbury, T. (2001). An investigation into the effects of hypnosis on basketball performance. *Journal of Applied Sport Psychology, 13,* 84–102.

Pates, J., Oliver, R., & Maynard, I. (2001). The effects of hypnosis on flow states. *Journal of Applied Sport Psychology, 13,* 341–354.

Patrick, T. D., & Hrycaiko, D. W. (1998). Effects of a mental training package on an endurance performance. *Sport Psychologist, 12,* 283–299.

Perkos, S., Theodorakis, Y., & Chroni, S. (2002). Enhancing performance and skill acquisition in novice basketball players with instructional self-talk. *Sport Psychologist, 16,* 368–383.

Petitpas, A. J., Brewer, B. W., Rivera, P. M., & Van Raalte, J. L. (1994). Ethical beliefs and behaviors in applied sport psychology: The AAASP ethics survey. *Journal of Applied Sport Psychology, 6,* 135–151.

Petitpas, A. J., Cornelius, A. E., Van Raalte, J. L., & Jones, T. (2005). A framework for planning youth sport programs that foster psychosocial development. *Sport Psychologist, 19,* 63–80.

Petitpas, A. J., Van Raalte, J. L., Cornelius, A., & Presbrey, J. (2004). A life skills development program for high school students. *Journal of Primary Prevention, 24,* 325–334.

Petruzzello, S. J., Landers, D. M., & Salazar, W. (1991). Biofeedback and sport/exercise performance: Applications and limitations. *Behavior Therapy, 22,* 379–392.

Poczwardowski, A., Sherman, C. P., & Ravizza, K. (2004). Professional philosophy in the sport psychology service delivery: Building on theory and practice. *Sport Psychologist, 18,* 445–463.

Prapavessis, H., Carron, A. A., & Spink, K. S. (1996). Team building in sport. *International Journal of Sport Psychology, 27,* 269–285.

Prapavessis, H., Grove, R., McNair, P. J., & Cable, N. T. (1992). Self-regulation training, state anxiety, and sport performance: A psychophysiological case study. *Sport Psychologist, 6,* 213–229.

Privette, G., & Bundrick, C. M. (1997). Psychological processes of peak, average, and failing performance in sport. *International Journal of Sport Psychology, 28,* 323–334.

Raabe, P. B. (2001). *Philosophical counseling: Theory and practice.* Westport, CT: Praeger.

Ravizza, K. (2006). Increasing awareness for sport performance. In J. M. Williams (Ed.), *Applied sport psychology: Personal growth to peak performance* (pp. 228–239). Boston: McGraw-Hill.

Ravizza, K., & Hanson, T. (1994). *Heads-up baseball: Playing the game one pitch at a time.* Chicago: Contemporary.

Rodgers, W., Hall, C., & Buckolz, E. (1991). The effect of an imagery training program on imagery ability, imagery use, and figure skating performance. *Journal of Applied Sport Psychology, 3,* 109–125.

Rushall, B. S., Hall, M., Roux, L., Sasseville, J., & Rushall, A. C. (1988). Effects of three types of thought content instructions on skiing performance. *Sport Psychologist, 2,* 283–297.

Ryba, T. V., Stambulova, N. B., & Wrisberg, C. A. (2005). The Russian origins of sport psychology: A translation of an early work of A. C. Puni. *Journal of Applied Sport Psychology, 17,* 157–169.

Ryba, T. V., & Wright, H. K. (2005). From mental game to cultural praxis: A cultural studies model's implications for the future of sport psychology. *Quest, 57,* 192–212.

Salmela, J. H. (1984). Comparative sport psychology. In J. M. Silva & R. S. Weinberg (Eds.), *Psychological foundations of sport* (pp. 23–43). Champaign, IL: Human Kinetics.

Salmon, J., Hall, C., & Haslam, I. (1994). The use of imagery by soccer players. *Journal of Applied Sport Psychology, 6,* 116–133.

Savoy, C. (1993). A yearly mental training program for a college basketball player. *Sport Psychologist, 7,* 173–190.

Savoy, C. (1997). Two individualized mental training programs for a team sport. *International Journal of Sport Psychology, 28,* 259–270.

Seligman, M. E. P. (1998). *Learned optimism.* New York: Free Press.

Short, S. E., Bruggeman, J. M., Engel, S. G., Marback, T. L., Wang, L. J., Willadsen, A., et al. (2002). The effect of imagery function and imagery direction on self-efficacy and performance on a golf-putting task. *Sport Psychologist, 16,* 48–67.

Silva, J. M. (1989). Toward the professionalization of sport psychology. *Sport Psychologist, 3,* 265–273.

Sinclair, G. D., & Sinclair, D. A. (1994). Developing reflective performers by integrating mental management skills with the learning process. *Sport Psychologist, 8,* 13–27.

Singer, R. N. (1988). Strategies and metastrategies in learning and performing self-paced athletic skills. *Sport Psychologist, 2,* 49–68.

Singer, R. N., Cauraugh, J. H., Chen, D., Steinberg, G., Frehlich, S. G., & Wang, L. (1994). Training mental quickness in beginning/intermediate tennis players. *Sport Psychologist, 8,* 305–318.

Smith, D., & Collins, D. (2004). Mental practice, motor performance, and the late CNV. *Journal of Sport and Exercise Psychology, 26,* 412–426.

Smith, D., & Holmes, P. (2004). The effect of imagery modality on golf putting performance. *Journal of Sport and Exercise Psychology, 26,* 385–395.

Smith, D., Holmes, P., Whitemore, L., Collins, D., & Devenport, T. (2001). The effect of theoretically-based imagery scripts on hockey penalty flick performance. *Journal of Sport Behavior, 24,* 408–419.

Smith, R. E. (1989). Applied sport psychology in an age of accountability. *Journal of Applied Sport Psychology, 1,* 166–180.

Smith, R. E., & Johnson, J. (1990). An organizational empowerment approach to consultation in professional baseball. *Sport Psychologist, 4,* 347–357.

Sparkes, A. C. (1998). Athletic identity: An Achilles' heel to the survival of self. *Qualitative Health Research, 8,* 644–664.

Suedfeld, P., Collier, D. E., & Hartnett, B. D. G. (1993). Enhancing perceptual-motor accuracy through flotation REST. *Sport Psychologist, 7,* 151–159.

Suinn, R. M. (1972). Behavioral rehearsal training for ski racers. *Behavior Therapy, 3,* 519–520.

Suinn, R. M. (1977). Behavioral methods at the Winter Olympic Games. *Behavior Therapy, 8,* 519–520.

Suinn, R. M. (1984). Imagery and sports. In W. F. Straub & J. M. Williams (Eds.), *Cognitive sport psychology* (pp. 253–272). Lansing, NY: Sport Science Associates.

Suinn, R. M. (1985). The 1984 Olympics and sport psychology. *Journal of Sport Psychology, 7,* 321–329.

Suinn, R. M. (1993). Imagery. In R. N. Singer, M. Murphey, & L. K. Tennant (Eds.), *Handbook of research on sport psychology* (pp. 492–510). New York: Macmillan.

Sullivan, P. A. (1993). Communication skills training for interactive sports. *Sport Psychologist, 7,* 79–91.

Sullivan, P. A., & Nashman, H. W. (1998). Self-perceptions of the role of USOC sport psychologists in working with Olympic athletes. *Sport Psychologist, 12,* 95–103.

Tenenbaum, G. (2002). Expert athletes: An integrated approach to decision-making. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 191–218). Champaign, IL: Human Kinetics.

Tenenbaum, G., & Bar-Eli, M. (1993). Decision making in sport. In R. N. Singer, M. Murphey, & L. K. Tennant (Eds.), *Handbook on research in sport psychology* (pp. 171–192). New York: Macmillan.

Tenenbaum, G., Lidor, R., Papaioannou, A., & Samulski, D. (2003). ISSP position stand: Competencies (occupational standards, knowledge, and practice) and their accomplishments (learning specification, essential knowledge, and skills) in sport and exercise psychology. *International Journal of Sport and Exercise Psychology, 1,* 155–166.

Thelwell, R. C., & Greenlees, I. A. (2003). Developing competitive endurance performance using mental skills training. *Sport Psychologist, 17,* 318–337.

Thelwell, R. C., Weston, N., & Greenlees, I. (2005). Defining and understanding mental toughness within soccer. *Journal of Applied Sport Psychology, 17,* 326–332.

Thomas, P. R., & Fogarty, G. J. (1997). Psychological skills training in golf: The role of individual differences in cognitive preferences. *Sport Psychologist, 11,* 86–106.

Thomas, P. R., & Over, R. (1994). Psychological and psychomotor skills associated with performance in golf. *Sport Psychologist, 8,* 73–86.

Tkachuk, G., Leslie-Toogood, A., & Martin, G. L. (2003). Behavioral assessment in sport psychology. *Sport Psychologist, 17,* 104–117.

Tod, D., & Andersen, M. (2005). Success in sport psych: Effective sport psychologists. In S. Murphy (Ed.), *The sport psych handbook,* (pp. 305–314). Champaign, IL: Human Kinetics.

U.S. Olympic Committee establishes guidelines for sport psychology services. (1983). *Journal of Sport Psychology, 5,* 4–7.

Vallée, C. N., & Bloom, G. A. (2005). Building a successful university program: Key and common elements of expert coaches. *Journal of Applied Sport Psychology, 17,* 179–196.

Vealey, R. S. (1988). Future directions in psychological skills training. *Sport Psychologist, 2,* 318–336.

Vealey, R. S. (1994). Current status and prominent issues in sport psychology interventions. *Medicine and Science in Sports and Exercise, 26,* 495–502.

Vealey, R. S. (2005). *Coaching for the inner edge.* Morgantown, WV: Fitness Information Technology.

Vealey, R. S., & Garner-Holman, M. (1998). Applied sport psychology: Measurement issues. In J. L. Duda (Ed.), *Advances in sport and exercise psychology measurement* (pp. 433–446). Morgantown, WV: Fitness Information Technology.

Vealey, R. S., & Greenleaf, C. A. (2006). Seeing is believing: Understanding and using imagery in sport. In J. M. Williams (Ed.), *Applied sport psychology: Personal growth to peak performance* (5th ed., pp. 306–348). Boston: McGraw-Hill.

Vernacchia, R. A., Reardon, J. P., & Templin, D. P. (1997). Sudden death in sport: Managing the aftermath. *Sport Psychologist, 11,* 223–235.

Ward, D. G., Sandstedt, S. D., Cox, R. H., & Beck, N. C. (2005). Athlete-counseling competencies for U.S. psychologists working with athletes. *Sport Psychologist, 19,* 318–334.

Watt, A. P., Morris, T., & Andersen, M. B. (2004). Issues in the development of a measure of imagery ability in sport. *Journal of Mental Imagery, 28,* 149–180.

Weinberg, R., Burke, K. L., & Jackson, A. (1997). Coaches' and players' perceptions of goal-setting in junior tennis: An exploratory investigation. *Sport Psychologist, 11,* 426–439.

Weinberg, R., Burton, D., Yukelson, D., & Weigand, D. (1993). Goal setting in competitive sport: An exploratory investigation of practices of collegiate athletes. *Sport Psychologist, 7,* 275–289.

Weinberg, R., Burton, D., Yukelson, D., & Weigand, D. (2000). Perceived goal setting practices of Olympic athletes: An exploratory investigation. *Sport Psychologist, 14,* 279–295.

Weiss, M. R. (1991). Psychological skill development in children and adolescents. *Sport Psychologist, 5,* 335–354.

Weiss, M. R. (1995). Children in sport: An education model. In S. M. Murphy (Ed.), *Sport psychology interventions* (pp. 39–69). Champaign, IL: Human Kinetics.

White, A., & Hardy, L. (1998). An in depth analysis of the uses of imagery by high-level slalom canoeists and artistic gymnasts. *Sport Psychologist, 12,* 387–403.

Williams, A. M., & Grant, A. (1999). Training perceptual skill in sport. *International Journal of Sport Psychology, 30,* 194–220.

Williams, A. M., & Ward, P. (2003). Perceptual expertise: Development in sport. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 219–249). Champaign, IL: Human Kinetics.

Williams, A. M., Ward, P., & Chapman, C. (2003). Training perceptual skill in field hockey: Is there transfer from the laboratory to the field? *Research Quarterly for Exercise and Sport, 74,* 98–103.

Williams, J. M. (Ed.). (2006). *Applied sport psychology: Personal growth to peak performance* (5th ed.). Boston: McGraw-Hill.

Williams, J. M., & Straub, W. F. (2006). Sport psychology: Past, present, future. In J. M. Williams (Ed.), *Applied sport psychology: Personal growth to peak performance* (5th ed., pp. 1–14). Boston: McGraw-Hill.

Wrisberg, C. A., & Anshel, M. H. (1989). The effect of cognitive strategies on the free throw shooting performance of young athletes. *Sport Psychologist, 3,* 95–104.

Wrisberg, C. A., & Anshel, M. H. (1997). The use of positively worded performance reminders to reduce warm-up decrement in the field hockey penalty shot. *Journal of Applied Sport Psychology, 9,* 229–240.

Yates, D. H. (1943). A practical method of using set. *Journal of Applied Psychology, 27,* 512–519.

Zhang, L., Ma, Q., Orlick, T., & Zitzelsberger, L. (1992). The effect of mental-imagery training on performance enhancement with 7–10-year-old children. *Sport Psychologist, 6,* 230–241.

Zimmerman, T. S., Protinsky, H. O., & Zimmerman, C. S. (1994). Family systems consultation with an athletic team: A case study of themes. *Journal of Applied Sport Psychology, 6,* 101–115.

Zinsser, N., Bunker, L., & Williams, J. M. (2006). Cognitive techniques for building confidence and enhancing performance. In J. M. Williams (Ed.), *Applied sport psychology: Personal growth to peak performance* (5th ed., pp. 349–381). Boston: McGraw-Hill.

Zizzi, S. J., & Perna, F. M. (2002). Integrating web pages and e-mail into sport psychology consultations. *Sport Psychologist, 16,* 416–431.

CHAPTER 14

Sport Psychology: A Clinician's Perspective

ROBERT D. STAINBACK, JAMES C. MONCIER III, and ROBERT E. TAYLOR

Sport psychology consultants vary in their educational backgrounds and theoretical persuasions. They may be educated in sport science, in counseling and clinical psychology, or, more rarely, in medicine. Theoretical perspectives range from those based largely on educational models to those rooted in the principles of behavior change. The diversity among sport psychology practitioners can be regarded as a strength in that it provides numerous frameworks and methods by which one can assist those who come for help. On the other hand, this same diversity can become a source of confusion and misunderstanding to those served as well as to students and practitioners seeking to enhance their competence.

In this chapter, we give our perspectives on the field based on our backgrounds in clinical and counseling psychology. However, with the goal of maintaining diversity as a strength in the field, we also seek to provide the reader with a basis with which to integrate information from various theoretical underpinnings. To this end, information has been incorporated in the chapter spanning a variety of research traditions, including the sport sciences, psychology, and medicine. For purposes of the chapter, we use *sport psychology consultant* (or simply *consultant*) when referring to professionals, regardless of training, who provide services in sport contexts. To designate those receiving services, we use *athlete* or *client.*

The chapter begins with an invitation to reflect on the importance of developing a practice philosophy. This section is followed by discussion of the need and merits of a clinical perspective when providing sport psychology services. Topics include information about psychopathology, incidence of psychopathology in the general population and among sport participants, and prevention and treatment of psychopathology. The next section covers general assessment and screening for psychopathology, networking of referral sources, and methods for handling emotionally or cognitively based emergencies. Penultimately, we propose a conceptual paradigm or framework from which to view the sport psychology consultant's work. The final section of the chapter is devoted to a discussion of professional issues that is intended to foster an appreciation of the overlap and relatedness among sport psychology consultants regardless of their educational or theoretical backgrounds.

A PRACTICE PHILOSOPHY

We believe that successful professional practice of any type depends on practitioner awareness and understanding of the theoretical roots underlying daily decisions and actions. The work involved in acquiring a personal theoretical and practical orientation must predate situations where effective decisions and actions are necessary. One does not have the luxury to ponder various theories on crisis intervention when a client is obviously overwhelmed, in tears, and sitting in front of you asking for your help. Likewise, it is not advisable to reflect on the latest theoretical debates on performance enhancement when giving a presentation to athletes interested in how they can get better at their specific sport. The philosophical foundations are best considered and discussed with teachers and mentors during formal education and with colleagues during one's professional career. The result is a philosophy underlying interventions that evolves and is intertwined with the practitioner's development as a person and a professional.

Poczwardowski, Sherman, and Ravizza (2004) offered a conceptual framework useful for professional philosophy

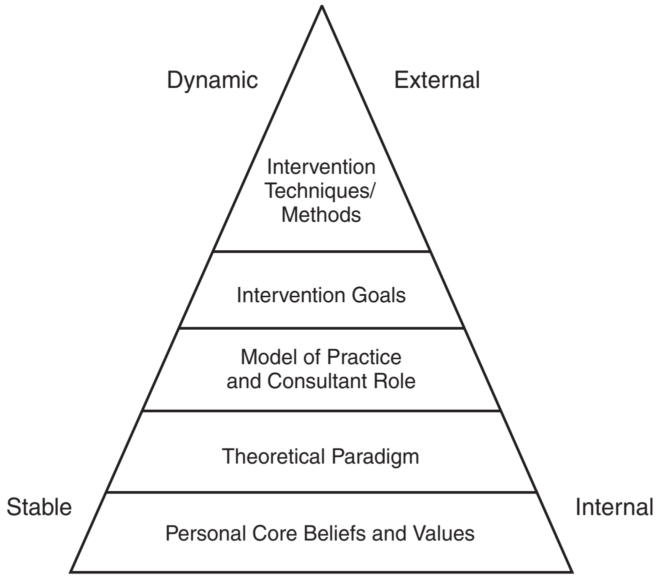


Figure 14.1 Hierarchical structure of professional philosophy. *Source:* "Professional Philosophy in the Sport Psychology Service Delivery: Building on Theory and Practice," by A. Poczwardowski, C. P. Sherman, and K. Ravizza, 2004, *Sport Psychologist, 18,* p. 450. Copyright 2004 by Human Kinetics Publishers. Reprinted with permission.

development. They present a systematic means for organizing the topic (see Figure 14.1). Their conceptualization is hierarchical in nature, with the most stable and internal component (i.e., personal core beliefs and values) providing the base for progressively more dynamic and external components moving toward the apex. The components are interdependent; however, greater influence is exerted by more fundamental levels. Although this conceptualization is in its infancy, it has potential to positively shape examination of this important topic and implications for the advancement of education, training, and practice in sport psychology. We encourage readers to reflect on their own professional philosophies related to sport psychology in the process of entertaining our thoughts about clinical issues.

THE NEED FOR A CLINICIAN'S PERSPECTIVE

Professional clinical practice can include circumstances that unexpectedly challenge the skills of the practitioner. Sport psychology is no exception. Consider the following scenarios:

- Upon arriving at the office, you receive a phone call from a despondent collegiate athlete with whom you have worked in the past. She is obviously distraught and recounts recent problems in her relationships with teammates, poor competition performances, and problems with her grades as primary concerns. She becomes tearful while talking and states, "I don't know how long I can keep going with all these terrible things happening."
- You receive a phone call from a parent who is concerned that her daughter is losing too much weight and putting too much pressure on herself in pursuing her goal to become an accomplished diver. She goes on to explain that her daughter has had a "lifelong struggle" to keep her weight under control but that she now looks "too thin."
- You sit down to a leisurely breakfast on a Sunday morning, open the local paper, turn to the sports page, and read about a collegiate football player at the university where you are on the faculty and where you provide consultation to the athletic department. The athlete was arrested the night before at a local bar for his involvement in a fight. The article goes on to explain that he has had similar problems previously and may be suspended from the team indefinitely. Upon arriving at the office the next morning, you notice two messages from your primary contact with the football team asking you to call immediately.
- You are meeting with a self-referred tennis player who has joined a professional tour after an exceptional college career. Despite all of his previous competitive success, he indicates that he is struggling with his transition to the professional ranks. He describes episodes prior to matches where he is tense, irritable, shaking, and unable to calm himself. He also indicates that he has had restless sleep for the past several weeks, ruminating about his difficulties in adjusting to the professional tour.

These scenarios could certainly be a part of the daily routine of a sport psychology consultant. The circumstances described in each scenario may be suggestive of some type of mental disorder, but this determination is dependent on further evaluation by an appropriate professional. A perusal of the mass media also suggests that athletes are not immune to mental disorders (Lapchick, 2003; Olson, 2003). Although sport psychology consultants vary in their comfort level in handling these types of difficult situations, it is imperative that all consultants be educated to deal with them either by way of direct treatment or appropriate referral.

A Working Definition of Psychopathology

A thorough discussion of psychopathology is obviously beyond the scope of this chapter. However, in this section we provide a working definition for psychopathology and related concepts. The *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-IV-TR;* American Psychiatric Association, 2000) is a rich source of information on criteria for diagnoses and differentiation among diagnoses but is limited in providing a clear indication of the distinction between abnormal and normal states of functioning (Ingram & Price, 2001). To address this limitation, Ingram and Price have offered a working definition of psychopathology that relies on practical criteria. Specifically, they broadly define psychopathology by reference to "impairment in the individual's established, or expected, roles at a given developmental period, . . . typically accompanied by reports of emotional distress" (p. 6). We believe that this is a useful definition that allows the consultant, in most situations, to draw relatively unambiguous distinctions between abnormal and normal functioning.

Other important concepts related to psychopathology discussed by Ingram and Price (2001) are *vulnerability, stress,* and *diathesis.* With respect to vulnerability, the core themes in the extant literature meriting consideration include the views that (a) vulnerability is a stable trait, whereas the actual disorder is a state that can emerge and recede episodically; (b) vulnerability is endogenous, or residing within the individual; and (c) vulnerability processes are causally related to symptoms but difficult to assess because they are latent (i.e., they are present in individuals with few or no obvious signs).

The second important concept, stress, is viewed as "the life events (major or minor) that disrupt the mechanisms maintaining the stability of an individual's physiology, emotion, and cognition" (Ingram & Price, 2001, p. 11). In the case of psychopathology, these life events are interpreted by the person as undesirable or aversive, represent a strain on adaptive capability, and interfere with physiological and psychological homeostasis. Therefore, stress is viewed as a critical variable in many models of psychopathology.

Diathesis, the third important concept discussed by Ingram and Price (2001), is conceptually related to vulnerability and refers to a predisposition to illness. Examples of biological diatheses include genetic endowment, oxygen deprivation at birth, and poor nutrition. Psychological diatheses can include chronic feelings of hopelessness and intense fear of becoming fat. Genetic, experiential, or sociocultural factors may contribute to psychological diatheses (Davison, Neale, & Kring, 2003, p. 59). Many models of psychopathology are viewed as diathesis-stress models. Psychopathology is regarded as an interactive effect of the diathesis and situational circumstances or personal events perceived by the individual as stressful. Figure 14.2 depicts the role of vulnerability and stress in understanding psychopathology where vulnerability and resilience represent opposite ends of the vulnerability continuum. Resilience, therefore, suggests resistance to disorder but not immunity.

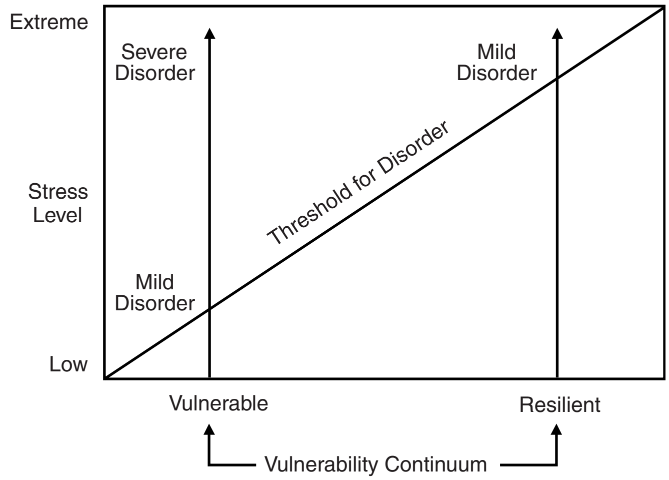


Figure 14.2 The diathesis-stress continuum. When vulnerability is at its highest level, less stress is required to activate a disorder. Adapted from *Vulnerability to Psychopathology: Risk across the Lifespan* (p. 15), by R. E. Ingram and J. M. Price, 2001, New York: Guilford Press. Copyright 2001 by the Guilford Press. Adapted with permission.

Epidemiology of Psychopathology

Mental disorders occur frequently in the United States and internationally. Recent outcomes from the U.S. National Comorbidity Survey (Kessler et al., 2005) indicated that approximately 50% of Americans will experience a mental health problem meeting the criteria for a *DSM-IV* disorder at some point in their lives. Data from the massive Global Burden of Disease Project conducted by the World Health Organization and others indicated that mental illness (including suicide) accounted for 15% of the burden of disease in established market economies (National Institute of Mental Health, n.d.).

Although epidemiological data indicate significant prevalence of mental disorders and related morbidity, there also is evidence of considerable unmet treatment needs. It has been found that the rate of help seeking by individuals with a mental disorder is low (Bourdon, Rae, Locke, Narrow, & Regier, 1992) and that there often are significant time lags between when a disorder is fully manifested and entry into treatment (Wang, Berglund, et al., 2005). Unfortunately, no treatment and poor treatment are frequent (Bijl et al., 2003; Wang, Berglund, & Kessler, 2000; Wang, Lane, et al., 2005), particularly for vulnerable groups such as the poorly educated and the underinsured.

Susceptibility to psychopathology among athletes parallels that of the general population (Calhoun, Ogilvie, Hendrickson, & Fritz, 1998; Heyman, 1986; Piersall & Hirshberg, 1955). Although a lack of empirical studies is noted (Glick & Horsfall, 2001), a recent review by Brewer and Petrie (2002) documented case studies and anecdotal reports of a variety of mental disorders in sport participants, including bipolar disorder, major depression, obsessive-compulsive disorder, and panic disorder. Nationwide surveys of clinical and counseling psychologists (Petrie & Diehl, 1995; Petrie, Diehl, & Watkins, 1995) indicate that areas of psychopathology frequently addressed in individual therapy were reported to be anxiety/stress, depressive disorders, eating disorders, and substance-related disorders. Furthermore, it has been suggested (Hays, 1999, chap. 17) that some characteristics of the sport environment, particularly at the elite level (Pipe, 2001), may place athletes at additional risk for these and other adverse health consequences. Demanding training regimens and associated performance pressures as well as the abuse of trusted relationships by coaches or others in the sport environment may be factors contributing to maladjustment. Overtraining Syndrome, characterized by a chronic decrement in sport performance along with maladaptive responses to sport- and non-sport-related stress, is one risk associated with the sport environment (Meehan, Bull, Wood, & James, 2004).

Although athletes are susceptible to a wide variety of mental disorders (see review by Brewer & Petrie, 2002), the extant sport-related literature focuses primarily on substance abuse and dependence (including anabolic steroids) and eating disorders. General information on these disorders is contained in the *DSM-IV-TR*. These topics are covered in detail in other chapters in this volume; however, because these disorders may have serious adverse health consequences, are often present with other mental disorders (comorbidity), and typically require specialized clinical treatment, we review some epidemiological information here.

Substance use in sport has a long history, is not uncommon currently, and has been reviewed extensively in an edited book by Bahrke and Yesalis (2002b). A comprehensive survey (Green, Uryasz, Petr, & Bray, 2001) of college student athletes encompassing National Collegiate Athletic Association Divisions I through III indicates that substance use is an issue to be reckoned with in this population. These investigators found that 81%, 28%, and 23% of student athletes reported use of alcohol, marijuana, and smokeless tobacco, respectively, in the past year. Although anabolic steroid use was reported at a low rate (1%) relative to other substances, 38% of steroid users reported obtaining the drug from either a team physician or another physician (Green et al., 2001, p. 55), despite professional, ethical, and legal proscriptions to providing these drugs without a legitimate medical indication. Naylor, Gardner, and Zaichkowsky (2001) in a study with adolescent athletes in Massachusetts found that 69%, 38%, and 8% of student athletes reported use of alcohol, marijuana, and smokeless tobacco, respectively, in the past year. These use rates were not significantly different from rates among students not participating in sport. However, 38% of athletes reported having violated rules designed to discourage drug use, and 13% reported having been caught doing so without penalty. These authors suggest that coaches and administrators need to assess the efficacy of drug prevention programs and their efforts to enforce rules and regulations.

Regardless of the motivation for substance use (e.g., performance enhancement, enjoyment, relaxation), it does not come without associated risks, including potential deleterious health consequences. Indeed, in a recent review of literature on alcohol use in sport, Stainback and Cohen (2002, p. 242) cited "evidence that athletes participate in more high-risk behaviors generally, including drinking-related risk behaviors, than their age peers." It has been found that intercollegiate athletes consumed significantly more alcohol per week, binge drank more frequently, and experienced more negative consequences from their substance use than college students not participating in intercollegiate sports. Male team leaders were a subgroup found to be at exceptional risk relative to other team members (Leichliter, Meilman, Presley, & Cashin, 1998). Furthermore, intercollegiate athletes appear to engage in a constellation of high-risk behaviors more frequently than their college peers. For instance, Nattiv, Puffer, and Green (1997) found athletes reported less likelihood of always using seat belts, greater quantity and frequency of alcohol use, less contraceptive use, and more involvement in physical fighting, among other high-risk behaviors. Male athletes reported greater risk taking than female athletes, and athletes in contact sports reported greater risk taking than those in noncontact sports. Athletes with one risk-taking behavior tended to report multiple risk-taking behaviors.

Research with adolescents has found that male competitive athletes are significantly more likely to initiate alcohol use than males not involved in competitive sport (Aaron et al., 1995). Adolescent athletes participating in multiple school or other organized sports have been found to drink more frequently and be more inclined toward binge drinking (defined as five or more drinks in a row during the past 30 days) than their peers with low physical activity (defined as participating in physical activity in one or two of the past 7 days) and peers who were sedentary (defined as participating in no physical activity in the past 7 days; Rainey, McKeown, Sargent, & Valois, 1996). Adolescents reporting binge drinking also have been found to be more likely to report drinking with peers, in large groups of underage persons, and away from home—situations that constitute additional risk (Mayer, Forster, Murray, & Wagenaar, 1998).

More recent findings substantiate reasons for concern about substance use in sport. In a large, nationally representative sample of American college students, Nelson and Wechsler (2003) found that significantly more sports fans drank alcohol, engaged in binge drinking (defined as drinking five or more drinks in a row for men and four or more drinks in a row for women), had a heavy drinking style (including less abstaining from alcohol, more episodes of being drunk, and more endorsement of the importance of drinking "to get drunk"), and reported alcohol-related problems than students who were not sports fans. Furthermore, the percentage of sports fans at a school was related to binge drinking rates and to secondhand effects (e.g., being assaulted, having property vandalized, having sleep or study disrupted), suggesting that the subculture surrounding sport is at the very least tolerant of binge drinking and possibly supportive of it.

College athletes have been found to have significantly higher problem gambling rates than their peers not participating in sport, and problem gambling has been associated with self-reported heavy drinking, negative consequences of alcohol use, regular tobacco and marijuana use, binge eating, and greater use of weight-control efforts in a college population (Engwall, Hunter, & Steinberg, 2004). College athletes reporting higher rates of alcohol abuse relative to their athlete peers reported more emotional symptoms, such as depression, suggesting a possible causal link between psychopathology and alcohol abuse in this population (B. E. Miller, Miller, Verhegge, Linville, & Pumariega, 2002). Finally, Stainback and Taylor (2005) briefly reviewed literature indicating that alcohol consumption is related to increased risk for a variety of health consequences, including traffic accidents, drowning, occupational injuries, and violence (either as perpetrator or victim). In particular, young men age 20 to 29 (a population in which athletes are well represented) were found to be at greatest risk for alcohol-related violence.

Anabolic steroid use has received considerable recent attention in the lay media (G. Smith, 2005). Its inappropriate use represents health risks to the individual as well as ethical and legal concerns for sport generally, and hence, the use of this class of drug is briefly reviewed here. Synthetic derivatives of testosterone have been colloquially termed "steroids." These drugs have legitimate medical uses for treatment of a variety of conditions. It is their illicit use by athletes and others for putative performance-enhancing or appearance-enhancing effects (e.g., strength and weight gain, enhanced recovery from intense workouts) that is reason for concern. Although anabolic steroids have received much research attention relative to most other performance-enhancing drugs and their effectiveness in increasing performance is well-accepted by the majority of the sport community, the extent of their effectiveness and the factors influencing these effects are not well understood (Bahrke & Yesalis, 2002a, p. 35). What is understood is that their use ranges widely and appears to have increased significantly over the past 3 decades, attributable in part to increasing use by adolescents, recreational athletes, and those not participating in sport. Indeed, as noted by Bahrke and Yesalis, "The use of anabolic steroids has cascaded down from the Olympic, professional, and college levels to the high schools and junior high schools, and there are significantly more adolescents using anabolic steroids than elite athletes" (p. 41).

While the long-term health effects of anabolic steroid use are unknown, physiological effects on the liver, serum lipids, and reproductive system are most substantiated. Definitive causal conclusions are elusive; however, it is important to understand that the deleterious psychological and behavioral effects associated with steroid use noted in the literature encompass major mood syndromes, including mania, hypomania, and depression (Pope & Katz, 1988, 1994), and psychotic symptoms (Pope & Katz, 1988). Forty-six percent of the subjects in the latter study had a positive history for substance abuse or dependence, including alcohol, cannabis, and cocaine. There is also at least one report (Brower, Blow, Beresford, & Fuelling, 1989) documenting a case description suggesting the presence of steroid dependence. In more recent research with female athletes age 18 to 65, Gruber and Pope (2000) found steroid users reporting hypomanic and depressive symptoms associated with steroid use; however, these symptoms did not meet *DSM-IV* criteria for a hypomanic or major depressive episode. Interestingly, several unusual syndromes were reported by users and nonusers among these athletes, including rigid dietary practices, nontraditional gender roles, and chronic dissatisfaction and preoccupation with physique ("muscle dysmorphia"; Gruber & Pope, 2000, p. 24). Recent research with males (Cafri et al., 2005) found that in attempting to achieve a muscular ideal, they may also resort to inappropriate dieting and steroid and other drug use. Male steroid users also have been found to be less confident about their body appearance and to display higher rates of illicit substance use, abuse, and dependence than nonusers (with use of other illicit substances typically preceding steroid use; Kanayama, Pope, Cohane, & Hudson, 2003).

Eating disorders are characterized in the *DSM-IV-TR* by severe disturbances in eating behavior. Two diagnostic categories are described: Anorexia Nervosa and Bulimia Nervosa. The reader is referred to more recent reviews (Polivy, Herman, & Boivin, 2005; Tamburrino & McGinnis, 2002) for additional, general information on these disorders.

Eating disorders among athletes have received research attention for well over a decade. In 1992, Brownell, Rodin, and Wilmore edited a book devoted to integrating, evaluating, and synthesizing information on eating and weight problems among athletes. More recently, studies have supported the notion that athletes, particularly female athletes, are a subpopulation with enhanced risk for eating disorders. In a study with a large sample of collegiate athletes, Johnson, Powers, and Dick (1999) found that approximately 13% of the sample self-reported clinically significant problems related to disturbed eating behaviors and attitudes, with females being predominantly affected. Sundgot-Borgen and Torstveit (2004) found a similar percentage of elite Norwegian athletes (13.5%) with subclinical and clinical signs of eating disorders, which was significantly higher than the percentage (4.6%) found in age-matched controls. In addition to self-report questionnaire measures, this study also included a detailed standardized clinical interview of all at-risk individuals and a representative sample of athletes and controls not classified as at risk for eating disorders. These investigators also found higher percentages of eating disordered symptoms among female (20%) than male (8%) athletes and among those competing in leanness-dependent (e.g., gymnastics) and weight-dependent (e.g., wrestling) sports than in other sports. Other studies (DeBate, Wethington, & Sargent, 2002; Hausenblas & McNally, 2004; Sanford-Martens et al., 2005) have consistently found a greater percentage of female than male athletes with behaviors symptomatic of eating disorders. Support has been inconsistent for athletes demonstrating higher rates of eating disorders than nonathletes (Sanford-Martens et al., 2005) and differences in eating disorder rates based on sport group (Hausenblas & McNally, 2004; Sanford-Martens et al., 2005). However, Sherwood, Neumark-Sztainer, Story, Beuhring, and Resnick (2002) found that among adolescent girls participating in weight-related sports, there were higher rates of substance abuse, physical and sexual abuse history, depressive symptoms, and suicide attempts in girls who demonstrated eating disorder symptoms than in those who did not.

Prevention of Psychopathology and Early Intervention

Sport is a pervasive and well-established institution in the United States and throughout the world. It occupies a significant portion of time for many individuals and is a potent factor in socialization. It has been estimated that only 3.7% of the U.S. population does not engage in any athletic event (as fan or participant) more than once a month. Approximately two-thirds of adolescents ages 14 to 17 are participants in sport (Miller Brewing Company, 1983). The majority of youth participate in non-school-based programs, and there has been a recent significant increase in youth sports league participation (Edmondson, 2000, p. 233).

Given the growing activity level in sport, we can assume more opportunity for positive influence on the current and future health and well-being of young people. Adolescent sport participation has been associated with self-reports of positive health behaviors, such as consumption of fruits and vegetables (Pate, Trost, Levin, & Dowda, 2000), and with a lower rate of some negative health behaviors, such as sexual risk activity and substance use (Kulig, Brener, McManus, 2003). Positive effects of regular physical activity on mental health have been documented among adults (Goodwin, 2003; Woodward, 2005).

We believe, along with others (Eppright, Sanfacon, Beck, & Bradley, 1997; Stryer, Tofler, & Lapchick, 1998), that attention must be directed toward examining how sport participation results in positive health outcomes among youth. As suggested by Danish and Nellen (1997, p. 112), "The future of our country is much more dependent on helping our youth reach their goals than it is on helping elite athletes win gold." Indeed, sport psychology is considered by Danish, Fazio, Nellen, and Owens (2002, p. 269) "to be the use of sport to enhance competence and promote development throughout the life span." Given this broad mission statement, sport psychologists are as relevant for life development as they are for athletic development. At the heart of this approach is the belief that sport is a vehicle for enhancing competence. By participating in sport, the individual learns valuable lessons transferable to other life situations. These lessons take the form of attitudes and behaviors called *life skills* that enable individuals to succeed in their living environments, including families, schools, workplaces, neighborhoods, and communities. The development and application of these life skills is seen as the lasting value of sport, rather than an end in itself. Descriptions of programs founded on this and similar philosophies are frequent in the recent literature (Curry & Maniar, 2003; Danish, 2002; Danish et al., 2002; Danish, Forneris, Hodge, & Heke, 2004; Danish & Nellen, 1997; Danish, Petipas, & Hale, 1993; Lavallee, 2005; Petitpas, Cornelius, Van Raalte, & Jones, 2005; Petitpas, Van Raalte, Cornelius, & Presbrey, 2004; C. Sherman, 2000, 2001; R. E. Smith, 1999; Unestahl, 1990).

Programs oriented toward developing life skills are a primary prevention for potential new cases of psychopathology. Secondary prevention aimed at early signs of psychopathology and use of appropriate measures for change is equally important, as well as tertiary prevention intended to arrest more advanced stages of psychopathology and decrease associated negative consequences through appropriate treatment and rehabilitation. Primary and secondary prevention are reasonable objectives for the sport psychology consultant, whereas tertiary prevention is best provided by other appropriately trained professionals (e.g., clinical psychologists, psychiatrists, social workers, mental health counselors).

Advocates of secondary prevention assume that conditions exist that predate diagnosable mental disorders and that these conditions are identifiable, thus setting the stage for potential intervention. Recent research supports this supposition. For example, persistent anhedonia and feelings of worthlessness in childhood and adolescence are prognostic of the development of depressive conditions (Wilcox & Anthony, 2004). The occurrence of problem behaviors during adolescence (e.g., smoking, alcohol use, and drug use) is associated with a high and generalized risk for developing adult psychopathology (McGue & Iacono, 2005). Other research has found reliable predictors of problematic drinking among college students (O'Connor & Colder, 2005) and of development of subsequent marijuana dependence among adolescents (Fergusson, Horwood, Lynskey, & Madden, 2003).

Unmet treatment needs and low rates of help seeking have been noted among collegiate athletes, both historically (Pierce, 1969) and currently (P. S. Howland, personal communication, May 27, 2005; S. N. Moore, personal communication, May 27, 2005). It also has been suggested that there is a tendency among athletes to deny emotional problems and stigmatize help seeking-behavior (Schwenk, 2000). Martin (2005) similarly suggested that some athlete groups (e.g., male athletes, younger athletes, and athletes socialized in sports involving physical contact) may have a stigma toward seeking sport psychology consultation.

Taken together, these findings underscore the need for secondary prevention in sport. There is growing awareness of this need as well as emerging efforts to meet it. Petrie (1993) described a disordered-eating continuum among female collegiate gymnasts: Higher levels were associated with a desire to weigh less, lower body satisfaction and self-esteem, and greater endorsement of cultural values related to women's attractiveness. Similarly, Wright, Grogan, and Hunter (2001) found that steroid users were more positive than nonusers about steroid benefits and minimized negative side effects of the drugs. These characteristics may serve as early warning signs for secondary prevention efforts. Vinci (1998) described eating disorder prevention efforts at the University of Washington in the Husky Sport Nutrition Program, a component of an overarching program that provides life skills assistance to student athletes. Iven (1998) noted the importance of preparticipation physical examinations for team physicians in establishing a sound relationship with athletes while emphasizing a thorough history, including an assessment of risk factors, family history, and personal tendencies toward substance abuse. The importance of an ongoing relationship between physician and athlete to promote early recognition and intervention with developing substance abuse problems is also highly relevant. See Stainback (1997, chap. 5) for a review of sport-related alcohol abuse and dependence prevention.

Treatment of Psychopathology

The intent here is to provide general informational sources regarding treatment, to briefly discuss referral for treatment (more is covered in the ensuing section), and to refer the reader to the regrettably infrequent descriptions of treatment in the sport context. The World Wide Web provides comprehensive resources enabling the public and professionals to obtain information on scientifically supported treatment modalities. For example, the National Guideline Clearinghouse is a comprehensive resource for evidenced-based clinical practice guidelines for physical and mental disorders (U.S. Department of Health and Human Services, n.d.). Similar resources specifically for mental disorders are provided by the American Psychological Association (APA), Division 12, Society of Clinical Psychology (n.d.), and the American Psychiatric Association (n.d.).

When considering a referral of an athlete to a mental health treatment professional, it is important to know the scope, nature, and philosophy of the professional's practice. In examining 1987 data on the distribution of patients among psychiatrists, psychologists, general medical physicians, and other health professionals, Olfson and Pincus (1996) found that psychiatrists provided significantly more visits than psychologists for schizophrenia, bipolar disorder, substance abuse, and depression, but significantly fewer visits for anxiety disorders and symptoms such as "nervousness." General medical physicians provided the most visits for adjustment disorders and substance abuse, and other professionals provided the most visits for childhood mental disorders and mental retardation. As these data are almost 20 years old and substantial changes have occurred in the delivery of and reimbursement for mental health treatment services in the intervening years, it is difficult to determine if these practice patterns exist today. However, in a recent review of the efficacy of psychological treatments, Barlow (2004, p. 873) noted that multiple surveys, across a variety of specific disorders, indicated that when given a choice, the public preferred psychological to pharmacological interventions.

Attention in the literature given to treatment of psychopathology in sport is scant; however, there are some helpful exceptions. For example, Stainback (1997) and Stainback and Taylor (2005) provided case descriptions and discussion of related issues for treatment of alcohol abuse and dependence in sport. Similarly, R. T. Sherman and Thompson (2001) discussed the unique challenges posed in the management and treatment of eating disorders among athletes. Petrie and Sherman (2000) provided a case description exemplifying the kinds of issues often encountered in working with an athlete who has an eating disorder. Articles also have been devoted to treatment of personality and mood disorders (Andersen, Denson, Brewer, & Van Raalte, 1994; Marchant & Gibbs, 2004) and head injury (Erlanger, Kutner, Barth, & Barnes, 1999; Kontos, Collins, & Russo, 2004) in athletes.

ASSESSMENT AND REFERRAL

Work with athletes often begins with a focus on performance enhancement (Van Raalte & Andersen, 2002, p. 325). An athlete also may present with issues outside of athletics, or the focus may shift from performance to personal issues as the consulting relationship progresses. Leffingwell, Weichman, Smith, Smoll, and Christensen (2001, p. 533) noted that the reasons athletes approached them for services varied as follows:

> Problems strictly related to performance enhancement compose 43% of the presenting problems. An equal number (42%) involve more personal issues, including depression, anxiety, anger management problems, substance abuse, eating disorders, and deficient life skills. Finally, 15% are initially represented by the athlete as a performance enhancement issue but later are disclosed to be personal issues that may underlie the performance problem.

As a sport psychology consultant, how does one screen effectively for the presence of mental disorders or personal issues that may impact not only performance but also an athlete's life generally? The answer to this question can be shaped by your training and background (Taylor & Schneider, 1992) but also, as noted earlier, by your professional philosophy (Poczwardowski et al., 2004).

A comprehensive, accurate assessment is a critical part of consultation. Many formal sport psychology models include assessment as part of the model (see Danish, Petitpas, & Hale, 1995; Gardner, 1995; Hellstedt, 1995; Perna, Neyer, Murphy, Oglivie, & Murphy, 1995; Whelan, Meyers, & Donovan, 1995). Assessment is used for setting up goals and strategies in preparation for intervention (Taylor & Schneider, 1992) and for evaluating the effectiveness of interventions already conducted.

One method for assessing the presence of psychopathology is a preconsultation questionnaire. Use of these questionnaires allows the athlete to communicate to the consultant a variety of concerns that can be explored further in a face-to-face meeting (B. C. Kelley, personal communication, June 14, 2005). Peterson, McCann, and Smith (1997) provide an example of such a questionnaire. A second method for assessing the presence of psychopathology is the clinical interview. Several of these have been developed for use in assessing specific psychopathologies (for examples of these, see Taylor & Schneider, 1992). Taylor and Schneider developed an intake interview format that combines sport and clinical psychology and includes questions regarding issues such as sleeping and eating habits, substance use, anxiety, and depression.

A combination of the preconsultation and clinical interview formats would be ideal in helping the consultant identify possible psychopathology. However, as Andersen (2000, p. 4) pointed out, "Probing about clinical issues may alienate some athletes." Therefore, the consultant's judgment must come into play when determining the appropriate time to introduce these issues. As rapport and trust are established between athlete and consultant, the athlete will ideally feel free to speak frankly about any troubling issues, regardless of their apparent relationship to sport. The consultant also must be alert for subtle factors that could signal the need to extend the focus beyond performance enhancement. These factors may include the length of time a problem has existed and its impact on the athlete's life, unusual emotional reactions or mood changes, and how effective more traditional performance enhancement interventions are in solving the presenting problems (Andersen, 2001). In our experience, an additional consideration is the new clinician's inclination either to overdiagnose, which often reflects inexperience and lack of confidence, or to underdiagnose as a form of denial and false self-assurance. Both serve the client poorly and can have significant negative implications.

Networking Referral Sources

The sport psychology consultant is similar to the primary health care professional in that both are likely to discover issues during their interactions with clients or patients that require referral to an alternative source for appropriate assessment and treatment. It is important for the sport psychology consultant to develop a readily available referral network of professionals who are sensitive to athletes' needs (Andersen, 2001; Van Raalte & Andersen, 2002). Consider the following: Imagine that you have completed your initial assessment and are negotiating a consultation plan with an athlete. Depending on the assessed issues, you have to decide if you are competent to provide the necessary services. Van Raalte and Andersen suggested that "competence is an issue of knowledge and skills" (p. 330). Therefore, when considering your next step, two questions should come to mind: Do I have the knowledge to provide the necessary intervention? and Do I have the skills to provide the necessary intervention? The answers to these questions can be straightforward or complex, depending on the situation.

If the answer to both questions is an unqualified no, then a referral to an appropriate professional is obviously indicated. For example, when the presenting problem is a physical illness, a referral to a primary care physician is warranted. A referral is not likely needed when the answer to both questions is an unqualified yes. An example might be a situation in which the athlete is initiating a consultation to help with establishing a precompetition routine, and you have both the requisite knowledge and skills to assist. However, in many instances, the decision may not be quite so clear-cut. An athlete with an eating disorder may require involvement of multiple professionals in addition to the sport psychology consultant. These might include a clinical psychologist, nutritionist, and sports medicine physician as well as other professionals. Andersen (2001) described concerns that should prompt the consideration of a referral, including identity and relationship issues, sexual orientation and homophobia, alcohol and substance abuse, and anger and aggression control. Questions pertaining to technical aspects of sport performance should also prompt the sport psychology consultant to refer (Brewer & Petrie, 2002).

There are other important issues surrounding a decision of whether to refer. First, consider areas you want to improve on. You may possess requisite knowledge and skills in a particular area but desire to become more proficient. Certainly, introspection is one way to assess this question, but seeking supervision, both as a way of determining your relative strengths and weaknesses as a consultant and for acquiring additional skills, is a recommended method (Van Raalte & Andersen, 2002). Supervision in general or by an expert in the relevant area may provide useful information and possibly allow you to continue working with an athlete rather than refer while expanding on your expertise. Second, consider the extent of your relationship with the athlete. Have you established trust and rapport? If so, referring the athlete when issues arise peripheral to your areas of expertise may not be the optimal or timely choice (Andersen, 2001); on the other hand, for any referral to be effective, rapport is vital. Andersen proposes another option, which is to invite a qualified professional to a session with the athlete (provided necessary confidentiality issues have been attended to) as a way of keeping the "therapeutic process going" (p. 404). This strategy may meet several needs. It may allow you to (a) learn more about the issue in question, (b) facilitate a successful referral, (c) maintain a working relationship with the athlete in the event of a referral, and (d) provide continuity of care between you and the referral source.

The development of a referral network is an active process (Hankes, 2005). You are assembling a team of professionals who are experienced in working with athletes and who are licensed or otherwise credentialed to do so. You might include some professionals who are specifically credentialed to work in sport and some professionals who are interested in becoming more experienced in the area. Van Raalte and Andersen (2002, p. 331) make the following suggestions for developing a referral network: (a) Identify appropriate local professionals, including athletic trainers, coaches, exercise physiologists, nutritionists, physical therapists, primary care physicians, psychiatrists, and psychologists; (b) attempt to get to know these professionals; and (c) evaluate the network on an ongoing basis and make adjustments as appropriate. They also discuss "dos and don'ts" of establishing a referral network, and the reader is directed to their excellent summary for further information.

Handling Psychiatric Emergencies

Roy and Fauman (2000, p. 2040) define a psychiatric emergency as "any unusual behavior, mood, or thought, which if not rapidly attended to may result in harm to a patient or others." In essence, if an athlete with whom you are working is exhibiting behavior dramatically different from normal (either in your experience with the person, in the person's experience, or in the experience of those close to the person), you should consider the possibility that the athlete is experiencing a psychiatric emergency (e.g., suicidal or homicidal behaviors, gestures, or attempts; overwhelming anxiety or depression; confusion; paranoia; hallucinations; or agitated behavior). One does not have to look very far in the popular media to find athletes' accounts of struggling with issues such as these (see, e.g., "Olympian Holmes considered suicide," 2005). With the exceptions of suicidal or homicidal circumstances, the observation of any of these symptoms should result in the calm recommendation that the athlete be evaluated at a local psychiatric facility or medical center. It is wise to recommend that the athlete allow a trusted friend or family member to provide the transportation. If no friend or family member is available, then emergency professionals should be contacted.

In the event the athlete has disclosed suicidal thoughts, preliminary assessment is critically important. Barney and Andersen (2000, p. 147) do so with questions using the acronym PAL: "Does the person have a plan (P) for committing suicide? If a plan is present, how available (A) are the components of the plan? Finally, if carried out, how lethal (L) might the plan be?" Similar approaches have been recommended by Hirschfield (1998) and Lyon, Chase, and Farrell (2002). Though seemingly simple, this can require complex clinical judgments that can challenge even seasoned professionals. If the athlete has a plan (e.g., "I am going to get drunk and take an overdose of my pain medication") that is available (e.g., she is currently recovering from surgery and has been prescribed pain medication), that has a high chance of lethality (e.g., sufficient quantities of pain medication and alcohol can certainly be lethal), and cannot reliably and safely be transported to the emergency department, then emergency professionals should be contacted. If the answers to the questions are less definitive, the consultant will need to use professional judgment regarding how to proceed in the circumstances and with knowledge of local resources. The safety of the athlete and society as a whole is always the paramount concern. Other issues for evaluation include, but are not limited to, substance use (decreases inhibition and may potentiate the effects of medications, enhancing their lethality), previous attempts (current risk increases with the number of previous attempts), recent losses (increases current risk), the presence of depression (increases current risk), and the availability of a support network (supportive family and friends may decrease the current risk; Scully, 2001). Therapeutic choices include calling emergency professionals, setting up a "no-harm" contract (for additional information, see Zuckerman, 1997), or making a referral for more intensive care.

Assessment is also critical if the athlete reports homicidal thoughts. Homicidal ideation can be assessed in a fashion similar to that of assessing suicidal ideation (i.e., using the PAL format). The difference between the two types of assessments is the addition of the need to determine if a specific victim of the intended violence is identified by the athlete. Many states have "duty to warn" laws in place based on or derived from the landmark case *Tarasoff v. Board of Regents of the University of California* (1976). In this case, the California Supreme Court "ruled that a physician or a psychotherapist who has reason to believe that a patient may injure or kill someone must notify the potential victim, the victim's relatives or friends, or the authorities" (Kaplan, Sadock, & Grebb, 1994, p. 1174). Not all states have "duty to warn" laws. Depending on your judgment as to the seriousness and specificity of the homicidal threat, you may choose to warn the person being threatened even if "duty to warn" laws are not present. You should be aware that if "duty to warn" laws are not present, you may risk being reported to your licensing/certifying body for failure to maintain the confidentiality of the client. Examine the laws that govern your practice to determine the presence or absence of "duty to warn" laws in your jurisdiction. Other issues for evaluation include, but are not limited to, a history of violence (a positive history is the most reliable predictor of future violence) and substance use (decreases inhibition, which may make carrying out the violent threat more likely; Scully, 2001). Therapeutic choices include calling emergency professionals, notifying the intended victim if identified, or making a referral for more intensive care. Sport psychology consultants who work with children and adolescents must also be aware of the signs and symptoms and of the laws regarding the reporting of child exploitation and abuse in their jurisdiction.

PARADIGM FOR CHANGE

In a recent review of psychotherapies, Prochaska and Norcross (2003) noted the fragmentation that characterizes the field and the resulting confusion for students, practitioners, and patients prompted by an escalating number of choices of therapies (400 and growing, by recent estimates; p. 2). In an effort to reduce this fragmentation and to promote theoretical integration, these authors analyzed 16 major systems of psychotherapy, highlighting the many similarities across systems. They proposed an integrative, comprehensive model, the transtheoretical model (TTM) as "an intellectual framework for thinking and working across systems" (p. 3). This framework includes an explication of stages, processes, and levels of change. Within the TTM, it is proposed that therapeutic integration is the "differential application of the processes of change at specific stages of change according to the identified problem level" (p. 530). These authors indicated that research has been supportive of the core constructs of the TTM and suggested that the model "holds considerable promise for describing, predicting, and explaining changes in a broad range of disorders" (p. 536). Although the TTM has its origins and primary supporting data based largely in research on addictions (DiClemente, 2003; DiClemente, Schlundt, & Gemmell, 2004), the model also has been applied to preventive health behaviors, such as exercise (Adams & White, 2003; Biddle & Nigg, 2000; Landry & Solmon, 2002; Prochaska & Marcus, 1994) and dental hygiene practices (Astroth, Cross-Poline, Stach, Tilliss, & Annan, 2002), and to sport psychology consultation (Leffingwell, Rider, & Williams, 2001).

The TTM has enjoyed significant popularity among practitioners and researchers; however, its utility in understanding and promoting behavior change has been questioned. For instance, conceptual and empirical limitations have been noted, including problems with stage definition, measurement, and discreteness, among others (Sutton, 2001; Wilson & Schlam, 2004). Despite these criticisms, the model endures and continues to receive considerable attention. A specific value of the model is its focus on commonalities across therapy approaches that constitute a core of psychotherapy.

One factor discussed by Prochaska and Norcross (2003, p. 8) is the development of a strong therapeutic alliance between client and therapist. We believe this alliance is of paramount importance to the success of any helping relationship, be it in psychotherapy, sport psychology consultation, or other context. The guidelines for motivational interviewing described by W. R. Miller and Rollnick (1991, 2002) provide an excellent method to establish a therapeutic alliance that is successful in assisting the client to make desired changes. The basic tenets follow: (a) change occurs naturally and in the context of formal interventions; (b) interpersonal interactions strongly affect the likelihood that change will occur and even brief interactions can initiate change; (c) much of change occurring within treatment occurs in the first few sessions; (d) the clinician is a significant determinant of treatment outcome; (e) an empathic counseling style appears to encourage change and in its absence change may be deterred; (f) both client and counselor expectations for change in the client have powerful effects; and (g) what people say regarding change is important. Statements reflecting motivation for and commitment to change predict later behavior change. Conversely, arguments against change yield less change. Interpersonal or counseling style can significantly influence both types of statements (W. R. Miller & Rollnick, 2002, pp. 9–10).

Motivational interviewing is defined as "a client-centered, directive method for enhancing intrinsic motivation to change by exploring and resolving ambivalence" (W. R. Miller & Rollnick, 2002, p. 25). As such, it is a clinical method or style of counseling characterized by a collaborative relationship between counselor and client. In the spirit of this collaborative role, the counselor seeks to find and evoke or elicit intrinsic motivation for change in the client, all the while acknowledging and respecting the autonomy of the individual in accepting the responsibility for change (pp. 33–35). Four guiding principles that underlie motivational interviewing methods are described: (1) Express empathy through acceptance, skillful reflective listening, and respect; (2) develop discrepancy. Change is motivated by a perceived discrepancy on the client's part between current behavior and a valued goal. When motivational interviewing is done well, it is the client, not the counselor, who presents arguments for change; (3) roll with resistance. The counselor avoids arguing for change, invites but does not impose new perspectives, and views resistance as a signal to respond differently. The client is a primary resource for finding solutions; and (4) support self-efficacy. The client's belief in the possibility of change is an important motivator, and the client, not the counselor, is responsible for choosing and implementing change. The counselor's personal belief and expectations about the client's capability to change can exert a powerful effect on outcome, serving as a self-fulfilling prophesy (pp. 37–41).

In a recent meta-analysis of controlled clinical trials of adaptations of motivational interviewing (AMIs), Burke, Arkowitz, and Menchola (2003, p. 856) concluded that "AMIs were equivalent to other active treatments and superior to no-treatment or placebo controls for problems involving alcohol, drugs, and diet and exercise." Their results indicated statistical and clinical significance for the efficacy of these AMIs. The authors noted mean effect sizes comparable to those found in a compilation of meta-analyses of psychological, educational, and behavioral interventions (approximately 0.50; Lipsey & Wilson, 1993). Although AMI effect sizes are less than those reported in data from meta-analyses of psychotherapy (effect sizes ranging from 0.75 to 0.85, Wampold, 2001, as cited in Burke et al., 2003), the authors noted that AMI studies averaged under 100 minutes of treatment (two sessions), whereas most psychotherapy studies included at least eight sessions (400+ minutes) of treatment. Adaptations of motivational interviewin treatments for alcohol and drug addiction also produced client improvement rates (51%) at least equal to rates found in empirically supported treatments for depression and panic disorder. Similarly to the comparisons on effect sizes, AMI treatments demonstrated these improvement rates in an average of two sessions, compared with eight sessions of psychotherapeutic treatment (Howard, Kopta, Krause, & Orlinsky, 1986).

Results of the Burke et al. (2003) meta-analysis support the efficacy of AMIs for the problems noted earlier. Further, given the conceptual and procedural overlap between motivational interviewing and cognitive behavioral therapy (Wilson & Schlam, 2004), it is reasonable to expect that the former may be effective for applications in other areas. There is evidence that such is the case (Arkowitz & Mann, 2002). Motivational interviewing and related approaches may also have specific applications in sport. Earlier in the chapter we noted evidence of low rates of help seeking by athletes. Although reasons for this are unclear, motivational interviewing is a reasonable approach for a sport psychology consultant to take with an athlete who might benefit from counseling but is reluctant to pursue it. Stainback (1997, pp. 137–140) and Stainback and Taylor (2005) offer case examples describing the potential utility of a motivational interviewing style with athletes experiencing problems related to their alcohol use. In the latter case, the authors interject commentaries during the dialogue between counselor and athlete designed to illuminate the thoughts and intentions of the counselor during the session. Although largely connected to other theoretical backgrounds, the solution-focused approach to sport psychology as described by Hoigaard and Johansen (2004) bears a resemblance to motivational interviewing. Both approaches entail relatively brief interventions, focus on the collaborative nature of the counselor-client relationship, and emphasize that solutions ultimately are within the client. These and similar approaches appear well suited to the premiums placed on time efficiency in the sport environment and to the focus of athletes and coaches on performance improvement.

PROFESSIONAL ISSUES

At the beginning of the chapter, we discussed our belief that developing a coherent professional philosophy is an integral part of the provision of sport psychology services. We offered Poczwardowski et al.'s (2004) hierarchical model for conceptualizing this philosophy. One aspect that the model focuses on is "the consultant's beliefs and values concerning his or her potential role in, and the theoretical and practical means of, influencing . . . clients toward mutually set intervention goals" (p. 449). In essence, developing a professional philosophy defines the roles taken on by a sport psychology consultant and how these roles are approached.

Current sport psychology consultation can be truly multifaceted, as evidenced by the various roles taken and methods used by consultants as well as the numerous settings in which they provide services. McCann (2005, p. 283) aptly summarized by stating that "applied sport psychology is not easy to pigeonhole." He identified several roles taken, including team consultant and clinician and individual consultant. Interventions range from teaching athletes to use mental skills for performance enhancement, such as goal setting, relaxation, imagery, confidence building, and attention control (Williams, 2001), to applying knowledge and methods that have been traditionally the purview of psychology and related fields, such as organizational development, psychotherapy, hypnosis (Hays & Smith, 2002), and neuropsychological assessment (McCann, 2005). Finally, settings can vary tremendously, ranging from an office to considerably less traditional settings such as a locker room or a basketball court.

Sport psychology consultants come from diverse educational backgrounds, having been trained largely in sport science, counseling and clinical psychology, or medicine. In an effort to bring some cohesion to the field, the Association for the Advancement of Applied Sport Psychology (AAASP) established criteria for certification of consultants in sport psychology in the early 1990s. Zizzi, Zaichkowsky, and Perna (2002) reported that the benefits of this action are the establishment of standards of accountability and professionalism in the field, recognition and credibility for those certified, guidelines for the preparation of the professional, and an increase in the public awareness of sport and exercise psychology. The current criteria for certified consultant status require a minimum of one course in professional ethics and standards, one course in psychopathology and its assessment, and graduate coursework in counseling skills. In addition, the requirements include a minimum of three courses in sport psychology, one course in biomechanical and/or physiological bases of sport, and one course in the historical, philosophical, social, or motor behavior bases of sport (pp. 464–465). Thus, expectations are set that certified sport psychology consultants will have some common core of educational background.

This expectation is important when one considers the alternative. For example, Sanchez, Godin, and De Zanet (2005, p. 81) surveyed French-speaking sport psychology service providers in Belgium (a country without sport psychology certification) as a case study and found that "degree-holding psychologists and people without any credentials coexist." These authors called for cooperative efforts between sport governing bodies and political authorities in Europe to develop the professional practice of sport psychology.

Given the variety of roles, methods, and settings that characterize the practice of sport psychology, a professional with a "hybrid" (Cogan, 1998; Hays, 1995) background in both psychology and sport science would appear most advantageously prepared. Support for such an approach comes from several sources. In his interview with Nicki Moore, PhD, about her responsibilities at the University of Oklahoma as assistant director of athletic academic affairs for psychological services, Hankes (2005) highlighted the need for a variety of skills when working in a collegiate athletic department. Eyal (2001, p. 170) noted that to be successful, the consultant must be stylistically flexible in working within the rules of the world of sports. Leffingwell, Wiechman, et al. (2001) described a clinical doctoral training program that provided services to the school's athletic department, including consultation with coaches, team interventions, performance enhancement with individual athletes, mental health and leadership consultation, and program evaluation. In return, participating graduate students received applied training, financial support, and research opportunities. Career summaries of the graduate students who participated in these training opportunities indicated their contribution to sport psychology research and practice.

Ethical Issues

Whelan, Meyers, and Elkins (2002) noted that the development of an ethics code is one way for a profession to regulate itself. It is also a way of protecting the public from misuse of the knowledge unique to the profession. Both the International Society of Sport Psychology (n.d.) and AAASP have developed codes of ethics for sport psychology. The latter is based in great part on the 1992 version of the American Psychological Association's Code of Ethics (AAASP, 1998, as cited in Sachs, Burke, & Schrader, 2001). In reporting the results of a Web-based survey of AAASP members' ethical beliefs and behaviors, Etzel, Watson, and Zizzi (2004, p. 248) indicated that consultants certified by AAASP were more likely than noncertified consultants "to have practiced without supervision or peer consultation, to have been sexually attracted to clients and to have allowed out-of-town clients to reside in their home while services were being provided." The authors conceded that, though these behaviors are not necessarily unethical, they are potentially risky and could lead to ethical problems. The authors theorized that the certified consultants included in the study may have felt they had the experience to judge each particular situation instead of rigidly adhering to the ethical standards, or may not be as familiar with the current ethical principles as they could be. The results may also reflect that the certified consultants were more honest, self-aware, and sensitive to boundary concerns. Nonetheless, each applicant for certified consultant status indicates acknowledgment of the need to adhere to the AAASP Ethics Code by signing the application.

The divergent backgrounds of sport psychology consultants pose challenges to ethical code adherence. Those professionals trained in areas outside of psychology may not view the practice situations in which they find themselves as particularly ethically complex. Also, they may view the work they do as not within the purview of psychology and thus not subject to the ethical constraints of psychology. Conversely, those from psychology backgrounds are probably not familiar with the nuances of sport psychology practice and lack experience in applying their ethical standards outside of a traditional psychology practice. With the development of an AAASP Ethics Code comes the need for professional dialogue to explore its ramifications. Moore (2003, p. 602) noted, "Ethical limitations and considerations . . . have been discussed in the sport psychology literature . . . , yet these potential ethical concerns have not been fully assessed and discussed as they pertain to the Ethics Code developed by the APA (2002)." Whelan et al. (2002, p. 520) noted that sport psychology consultants often encounter ethical situations that are both difficult and controversial in the field. Several of these areas of concern have been identified in the sport psychology literature and are discussed next. These include the potential negative health effects of competitive athletics, confidentiality, use of informed consent, balancing multiple roles, and maintaining professional boundaries.

The mental health benefits of exercise are well-documented in the general population (for reviews of this topic, see Hays, 1995; Woodward, 2005); however, some (Lavallee, 2005; Pipe, 2001) have pointed out the potential personal costs of the pursuit of performance excellence, particularly at the elite level of sport. One area receiving recent attention in the literature is overtraining, which can present with symptoms similar to clinical depression and can have a serious negative impact on an athlete's career (e.g., Meehan et al., 2004; Schwenk, 2000). As Pipe (2001, p. S193) stated:

> It is essential that all involved in the development and training of athletes understand the degree to which sport participation may pose problems to an athlete's physical, emotional and social well-being. Involvement in sport may lead to injury and illness as well as a variety of behavioural and psychological issues.

It is incumbent upon all sport service providers to remember that the health and well-being of the athlete is their paramount goal. However, it is equally important to recognize that concerns for the well-being of the athlete may conflict with the wishes of the athlete and other interested parties (e.g., coaches, organizational agents, family members).

Confidentiality is a critical part of the practitioner-client relationship. If an athlete independently initiates a consulting relationship and pays for it, most practitioners understand that the athlete determines who has access to confidential information, with exceptions being dictated by state or federal law for those licensed to practice. However, if the practitioner is approached and paid by a third party, perhaps a coach or a representative of a team, who then determines access to information? An additional issue involves the conducting of assessments. How and to whom are results presented? Another issue may occur while traveling with a team. For example, the sport psychology consultant is approached by an athlete with preperformance anxiety issues and there is no office in which to meet. How do you keep the ensuing discussion confidential?

Informed consent includes "all information necessary for a client to make an educated, informed decision about the likely benefits and risks of the specific intervention to be used and the development of a professional working relationship with the therapist/consultant" (Moore, 2003, p. 603). For clarity, it is preferable that the client receives this information in writing, be given ample opportunity to ask questions, and be asked to sign the document indicating understanding and acceptance. Harris (2002) recommends that informed consent include the nature of the practice, treatment plan and options, the purpose of meetings and sessions, fees, billing practices, insurance reimbursement, practitioner availability, treatment record policy, confidentiality and its limitations, and the treatment of minors, including the minor's rights to informed consent. The Codes of Ethics of both AAASP and APA require the use of appropriate informed consent. However, given the small amount of formal discussion in the sport psychology literature regarding this issue, Moore concluded that there may be sport psychology consultants practicing without conducting preconsultation informed consent. If true, this practice can lead to both ethical and legal problems.

Multiple roles when working with an organization (such as a team or school) are often unavoidable (Gardner, 2001; McCann, 2000; Moore, 2003) and can become problematic, especially when the roles conflict (Canter, Bennett, Jones, & Nagy, 1994, as cited in Moore, 2003). Examples of potential role conflicts include being the team psychologist while also being asked to give input to management regarding player termination, providing services to two athletes who are currently competing for the same position, and acting in the apparent best interests of the individual athlete when these interests potentially conflict with the team's success.

Many ethical concerns can be avoided by maintaining professional boundaries. A boundary in this case is defined by Gutheil and Simon (2002, p. 585) "as the 'edge' of appropriate or professional behavior, transgression of which involves the therapist stepping out of the clinical role." The interested reader is referred to work by Gutheil and his colleagues (Gutheil, 2005; Gutheil & Simon, 2002; Norris, Gutheil, & Strasburger, 2003) for additional discussion regarding the issue of professional boundaries. It is important for the sport psychology consultant to be alert to feelings of overidentification (Andersen, Van Raalte, & Brewer, 2001), to conflicting roles, and to the presence of multiple relationships as clues to the possible blurring of professional boundaries. Andersen et al. noted these warning signs:

> (a) feeling more vibrant in the athlete's presence, (b) prolonged emotional reactions to the athlete's wins and losses, (c) pleasurably anticipating athlete sessions more than usual, (d) finding excuses for more athlete contact, and (e) breaching confidentiality with colleagues (e.g., name dropping one's client to a colleague). (p. 17)

Establishing clear expectations for the consultation before beginning is a reasonable initial strategy to prevent boundaries from being crossed (Andersen et al., 2001; Gardner, 2001; Moore, 2003). Mutual expectations can be spelled out with written and verbal informed consent. Consulting relationships with peers are also effective ways to receive counsel on managing professional boundaries and resolving difficult ethical issues. The consultant may also find it appropriate to engage in supervision regardless of how long he or she has been consulting, especially when learning new skills or facing new professional situations.

Moore (2003) recommended that sport psychology consultants have a thorough understanding of the Ethics Codes of both APA and AAASP so as to practice more ethically, morally, and competently. We would like to add that thinking about the ethical issues unique to sport psychology consultation and the possible options for their successful resolution before being confronted with them will also assist the professional in managing difficult ethical situations. These suggestions emphasize the importance of risk management in the practice of sport psychology consultation. Risk management incorporates spending time anticipating problems prior to their occurrence and acting to prevent their occurrence as much as possible. The reader is referred to the general psychology literature (e.g., Doverspike, 1999) or to available workshops (e.g., Harris, 2002, 2003) for more information regarding risk management.

Consultant Self-Awareness

One way that a sport psychology consultant can think about the concerns just discussed and stay informed of ethical issues is by being ethically self-aware (Moore, 2003). For this purpose, Moore included the "Ethical Self-Awareness Checklist for Sport Psychologists" in her article (pp. 608–610). This checklist is comprised of a series of questions that can be answered by yes, no, or N/A, such as "Am I thoroughly aware of APA's Code of Ethics and how it pertains to my work?" and "Do I have professional liability insurance?" More important, it includes a section of questions to use when faced with an ethical dilemma, such as "Have I consulted with a colleague or another professional in the field?" and "If applicable, have I contacted a lawyer regarding this issue?"

An alternative or complement to Moore's (2003) approach is to develop a reflective practice, as advocated by Anderson, Knowles, and Gilbourne (2004). They defined reflective practice as "adopting an approach to practice that requires practitioners to be open and questioning. The process also stresses the importance of making space and time to retrospectively examine practice in detail" (p. 192). The authors offered several uses for reflective practice: focusing on the technical aspects of practice, exploring personal meaning in a situation, questioning the consultant's own values in a situation, and looking at issues outside of the consultant that impact the practice of sport psychology (p. 192). They reviewed many ways of becoming a reflective practitioner; these included journaling, supervision, and the use of structured questions practitioners may ask themselves that encourage consideration of "the consequences of their actions and whether alternative action may have been more appropriate" (p. 194).

Van Raalte and Andersen (2002) suggested that self-assessment may have limited utility for the improvement of consultant self-awareness. They argued instead that supervision is the best way to understand one's limitations as a consultant. It is also a good way to clarify the integrity of boundaries, to maintain adherence to ethical standards, and to generally improve the supervisee's comfort in the consulting role. Sport psychology consultants who have established practices may not require supervision; however, they may benefit from peer consultation. Although Van Raalte and Andersen argue that self-assessment is inferior to supervision or consultation for enhancing self-awareness, the use of strategies such as those presented by Anderson et al. (2004) and Moore (2003) are excellent starting points for either supervision or consultation.

CONCLUSION

We have endeavored to present a clinician's perspective on the practice of sport psychology. The field is characterized by diversity in consultant educational background and theoretical roots, highlighting the importance of philosophical clarity to personal and professional development. We endorse the model described by Poczwardowski et al. (2004) as a guide for philosophy development.

The need and merits of a clinical perspective when providing sport psychology services were emphasized. Sport psychology practice scenarios involving athletes with potential mental disorders, a working definition of psychopathology, and a model depicting relationships among vulnerability, stress, and mental disorder were offered. Diathesis-stress models suggest that as stress increases, so does the incidence and severity of mental disorders. These models have particular heuristic value for the sport psychology consultant because stress is an unavoidable component of the sport environment. We recommend that sport psychology consultants familiarize themselves with these models and related literature to better understand the incidence and nature of mental disorders in sport.

Incidents of mental disorders in the general population and in sport are frequent and result in significant disability relative to most other health problems. Particular attention in the sport literature has been paid to substance abuse and eating disorders; however, these disorders demonstrate significant comorbidity with other mental disorders. Low rates of help seeking and high incidence of insufficient treatment place great importance on effective prevention and treatment efforts. Primary, secondary, and tertiary efforts are needed, with sport psychology consultants potentially playing a major role in the first two and typically referring the last for appropriate treatment elsewhere.

Accurate and timely assessment is critical to determine how to proceed with interventions and whether or not a referral is indicated. Establishing a readily available referral network of professionals is critical, as are basic competencies in handling psychiatric emergencies. These skills are important components of the foundation of effective practice. Therefore, sufficient time and energy should be spent in their development.

The TTM and motivational interviewing provide useful conceptualizations for sport psychology consulting. The former is an integrative structure from which to view change in a variety of behaviors, and the latter is a clinical method for enhancing client intrinsic motivation. We recommend both as potential sources of valuable information relevant to sport psychology practice development.

Current sport psychology consultation is multifaceted, requiring the consultant to take on a variety of roles in numerous settings using a variety of methods. The diversity of practitioners and practice activities poses challenges to ethical code development and adherence. Several areas of concern have been cited in the literature and reviewed here. Anticipating consultation problems ahead of time can help the sport psychology consultant better manage them when they occur. Developing self-awareness as well as actively seeking supervision or peer consultation when appropriate are suggested as reasonable alternatives to establish and maintain an ethical practice.

REFERENCES

Aaron, D. J., Dearwater, S. R., Anderson, R., Olsen, T., Kriska, A. M., & LaPorte, R. E. (1995). Physical activity and the initiation of high-risk health behaviors in adolescents. *Medicine and Science in Sports and Exercise, 27,* 1639–1645.

Adams, J., & White, M. (2003). Are activity promotion interventions based on the transtheoretical model effective? A critical review [Electronic version]. *British Journal of Sports Medicine, 37,* 106–114.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC: Author.

American Psychiatric Association. (n.d.). *Practice guidelines.* Retrieved January 20, 2005, from http://www.psych.org/psych_pract/treatg/pg/prac_guide.cfm.

American Psychological Association, Division 12, Society of Clinical Psychology. (n.d.). *A guide to beneficial psychotherapy.* Retrieved January 20, 2006, from http://www.apa.org/divisions/div12/rev_est/index.html.

American Psychological Association. (2002). Ethical principles of psychologists and code of conduct. *American Psychologist, 57,* 1060–1073.

Andersen, M. B. (2000). Beginnings: Intakes and the initiation of relationships. In M. B. Andersen (Ed.), *Doing sport psychology* (pp. 3–16). Champaign, IL: Human Kinetics.

Andersen, M. B. (2001). When to refer athletes for counseling or psychotherapy. In J. M. Williams (Ed.), *Applied sport psychology: Personal growth to peak performance* (4th ed., pp. 401–415). Mountain View, CA: Mayfield.

Andersen, M. B., Denson, E. L., Brewer, B. W., & Van Raalte, J. L. (1994). Disorders of personality and mood in athletes: Recognition and referral. *Journal of Applied Sport Psychology, 6,* 168–184.

Andersen, M. B., Van Raalte, J. L., & Brewer, B. W. (2001). Sport psychology service delivery: Staying ethical while keeping loose. *Professional Psychology: Research and Practice, 32,* 12–18.

Anderson, A. G., Knowles, Z., & Gilbourne, D. (2004). Reflective practice for sport psychologists: Concepts, models, practical implications, and thoughts on dissemination. *Sport Psychologist, 18,* 188–203.

Arkowitz, H., & Mann, B. J. (2002). A cognitive-behavioral assimilative integration. In F. W. Kaslow (Series Ed.) & J. W. Lebow (Vol. Ed.), *Comprehensive handbook of psychotherapy: Vol. 4. Integrative and eclectic therapies* (pp. 317–337). Hoboken, NJ: Wiley.

Astroth, D. B., Cross-Poline, G. N., Stach, D. J., Tilliss, T. S., & Annan, S. D. (2002). The transtheoretical model: An approach to behavioral change [Electronic version]. *Journal of Dental Hygiene, 76,* 286–295.

Bahrke, M. S., & Yesalis, C. E. (2002a). Anabolic-androgenic steroids. In M. S. Bahrke & C. E. Yesalis (Eds.), *Performance-enhancing substances in sport and exercise* (pp. 33–46). Champaign, IL: Human Kinetics.

Bahrke, M. S., & Yesalis, C. E. (Eds.). (2002b). *Performance-enhancing substances in sport and exercise.* Champaign, IL: Human Kinetics.

Barlow, D. H. (2004). Psychological treatments. *American Psychologist, 59,* 869–878.

Barney, S. T., & Andersen, M. B. (2000). Looking for help, grieving love lost: The case of C. In M. B. Andersen (Ed.), *Doing sport psychology* (pp. 139–150). Champaign, IL: Human Kinetics.

Biddle, S. J. H., & Nigg, C. R. (2000). Theories of exercise behavior. *International Journal of Sport Psychology, 31,* 290–304.

Bijl, R. V., de Graaf, R., Hiripi, E., Kessler, R. C., Kohn, R., Offord, D. R., et al. (2003). The prevalence of treated and untreated mental disorders in five countries. *Health Affect, 22,* 122–133.

Bourdon, K. H., Rae, D. S., Locke, B. Z., Narrow, W. E., & Regier, D. A. (1992). Estimating the prevalence of mental disorders in U.S. adults from the Epidemiologic Catchment Area Survey. *Public Health Report, 107,* 663–668.

Brewer, B. W., & Petrie, T. A. (2002). Psychopathology in sport and exercise. In J. L. Van Raalte & B. W. Brewer (Eds.), *Exploring sport and exercise psychology* (2nd ed., pp. 307–323). Washington, DC: American Psychological Association.

Brower, K. J., Blow, F. C., Beresford, T. P., & Fuelling, C. (1989). Anabolic-androgenic steroid dependence. *Journal of Clinical Psychiatry, 50*(1), 31–33.

Brownell, K. D., Rodin, J., & Wilmore, J. H. (Eds.). (1992). *Eating, body weight, and performance in athletes: Disorders of modern society.* Philadelphia: Lea & Febiger. Abstract retrieved April 13, 2005, from PsychINFO database. (Accession number 1992-97163-000)

Burke, B. L., Arkowitz, H., & Menchola, M. (2003). The efficacy of motivational interviewing: A meta-analysis of controlled clinical trials. *Journal of Consulting and Clinical Psychology, 71,* 843–861.

Cafri, G., Thompson, J. K., Ricciardelli, L., McCabe, M., Smolak, L., & Yesalis, C. (2005). Pursuit of the muscular ideal: Physical and psychological consequences and putative risk factors. *Clinical Psychology Review, 25,* 215–239.

Calhoun, J. W., Ogilvie, B. C., Hendrickson, T. P., & Fritz, G. K. (1998). The psychiatric consultant in professional team sports. *Child and Adolescent Psychiatric Clinics of North America, 7,* 791–802.

Cogan, K. D. (1998). Putting the "clinical" into sport psychology consulting. In E. M. Stern (Series Ed.) & K. F. Hays (Vol. Ed.), *Integrating exercise, sports, movement, and mind: Therapeutic unity* (pp. 131–143). Binghamton, NY: Hayworth Press.

Curry, L. A., & Maniar, S. D. (2003). Academic course combining psychological skills training and life skills education for university students and student-athletes. *Journal of Applied Sport Psychology, 15,* 270–277.

Danish, S. J. (2002). Teaching life skills through sport. In M. Gatz, M. A. Messner, & S. J. Ball-Rokeach (Eds.), *Paradoxes of youth and sport* (pp. 49–60). Albany, NY: State University of New York Press.

Danish, S. J., Fazio, R. J., Nellen, V. C., & Owens, S. S. (2002). Teaching life skills through sport: Community-based programs to enhance adolescent development. In J. L. Van Raalte & B. W. Brewer (Eds.), *Exploring sport and exercise psychology* (2nd ed., pp. 269–288). Washington, DC: American Psychological Association.

Danish, S. J., Forneris, T., Hodge, K., & Heke, I. (2004). Enhancing youth development through sport. *World Leisure Journal (Okanagan Falls, BC), 46,* 38–49. Abstract retrieved April 6, 2005, from EBSCOhost research databases.

Danish, S. J., & Nellen, V. C. (1997). New roles for sport psychologists: Teaching life skills through sport to at-risk youth. *Quest, 49,* 100–113.

Danish, S. J., Petitpas, A. J., & Hale, B. D. (1993). Life development intervention for athletes: Life skills through sports. *Counseling Psychologist, 21,* 352–385.

Danish, S. J., Petitpas, A. J., & Hale, B. D. (1995). Psychological interventions: A life development model. In S. M. Murphy (Ed.), *Sport psychology interventions* (pp. 19–38). Champaign, IL: Human Kinetics.

Davison, G. C., Neale, J. M., & Kring, A. M. (2003). *Abnormal psychology* (9th ed.). Hoboken, NJ: Wiley.

DeBate, R., Wethington, H., & Sargent, R. (2002). Sub-clinical eating disorder characteristics among male and female triathletes. *Eating and Weight Disorders, 7,* 210–220.

DiClemente, C. C. (2003). *Addiction and change: How addictions develop and addicted people recover.* New York: Guilford Press.

DiClemente, C. C., Schlundt, D., & Gemmell, L. (2004). Readiness and stages of change in addiction treatment. *American Journal on Addictions, 13,* 103–119.

Doverspike, W. F. (1999). *Ethical risk management: Guidelines for practice.* Sarasota, FL: Professional Resource Press.

Edmondson, K. (2000). Issues in after-school youth development programming. In S. J. Danish & T. P. Gullotta (Eds.), *Developing competent youth and strong communities through after-school programming* (pp. 217–237). Washington, DC: CWLA Press.

Engwall, D., Hunter, R., & Steinberg, M. (2004). Gambling and other risk behaviors on university campuses. *Journal of American College Health, 52,* 245–255.

Eppright, T. D., Sanfacon, J. A., Beck, N. C., & Bradley, J. S. (1997). Sport psychiatry in childhood and adolescence: An overview. *Child Psychiatry and Human Development, 28*(2), 71–88.

Erlanger, D. M., Kutner, K. C., Barth, J. T., & Barnes, R. (1999). Neuropsychology of sports-related head injury: Dementia pugilistica to post concussion syndrome. *Clinical Neuropsychologist, 13,* 193–209.

Etzel, E. F., Watson, J. C., II., & Zizzi, S. (2004). A Web-based survey of AAASP members' ethical beliefs and behaviors in the new millennium. *Journal of Applied Sport Psychology, 16,* 236–250.

Eyal, N. (2001). Reflections on sport psychology practice: A clinical perspective. In G. Tenenbaum (Ed.), *The practice of sport psychology* (pp. 169–196). Morgantown, WV: Fitness Information Technology.

Fergusson, D. M., Horwood, L. J., Lynskey, M. T., & Madden, P. A. F. (2003). Early reactions to cannabis predict later dependence. *Archives of General Psychiatry, 60,* 1033–1039.

Gardner, F. L. (1995). The coach and the team psychologist: An integrated organizational model. In S. M. Murphy (Ed.), *Sport psychology interventions* (pp. 147–175). Champaign, IL: Human Kinetics.

Gardner, F. L. (2001). Applied sport psychology in professional sports: The team psychologist. *Professional Psychology: Research and Practice, 32,* 34–39.

Glick, I. D., & Horsfall, J. L. (2001). Psychiatric conditions in sports: Diagnosis, treatment, and quality of life. *Physician and Sportsmedicine, 29.* Retrieved June 7, 2005, from http://www.physsportsmed.com/issues/2001/08_01/glick.htm.

Goodwin, R. D. (2003). Association between physical activity and mental disorders among adults in the United States. *Preventive Medicine, 36,* 698–703.

Green, G. A., Uryasz, F. D., Petr, T. A., & Bray, C. D. (2001). NCAA study of substance use and abuse habits of college student-athletes. *Clinical Journal of Sport Medicine, 11,* 51–56.

Gruber, A. J., & Pope, H. G. (2000). Psychiatric and medical effects of anabolic-androgenic steroid use in women. *Psychotherapy and Psychosomatics, 69,* 19–26.

Gutheil, T. G. (2005). Boundary issues and personality disorders. *Journal of Psychiatric Practice, 11,* 88–96.

Gutheil, T. G., & Simon, R. I. (2002). Non-sexual boundary crossings and boundary violations: The ethical dimension. *Psychiatric Clinics of North America, 25,* 585–592.

Hankes, D. (2005). 10 burning questions with Nicki Moore, PhD. *Association for the Advancement of Applied Sport Psychology Newsletter, 20*(1), 5–7.

Harris, E. A. (2002, October). *Legal and ethical risks and risk management in professional psychological practice: Sequence I. General risk management strategies.* Symposium conducted for the Alabama Psychological Association, Birmingham.

Harris, E. A. (2003, October). *Legal and ethical risks and risk management in professional psychological practice: Sequence II. Risk management in specific high risk areas.* Symposium conducted for the Alabama Psychological Association, Birmingham.

Hausenblas, H. A., & McNally, K. D. (2004). Eating disorder prevalence and symptoms for track and field athletes and nonathletes. *Journal of Applied Sport Psychology, 16,* 274–286.

Hays, K. F. (1995). Putting sport psychology into (your) practice. *Professional Psychology: Research and Practice, 26,* 33–40.

Hays, K. F. (1999). *Working it out: Using exercise in psychotherapy.* Washington, DC: American Psychological Association.

Hays, K. F., & Smith, R. J. (2002). Incorporating sport and exercise psychology into clinical practice. In J. L. Van Raalte & B. W. Brewer (Eds.), *Exploring sport and exercise psychology* (2nd ed., pp. 479–502). Washington, DC: American Psychological Association.

Hellstedt, J. C. (1995). Invisible players: A family systems model. In S. M. Murphy (Ed.), *Sport psychology interventions* (pp. 117–146). Champaign, IL: Human Kinetics.

Heyman, S. R. (1986). Psychological problem patterns found with athletes. *Clinical Psychologist, 39*(3), 68–71.

Hirschfield, R. M. (1998). Clinical experience: The suicidal patient. *Hospital Practice, 33*(10), 119–138.

Hoigaard, R., & Johansen, B. T. (2004). The solution-focused approach in sport psychology. *Sport Psychologist, 18,* 218–228.

Howard, K. I., Kopta, S. M., Krause, M. S., & Orlinsky, D. E. (1986). The dose-effect relationship in psychotherapy. *American Psychologist, 41,* 159–164.

Ingram, R. E., & Price, J. M. (2001). The role of vulnerability in understanding psychopathology. In R. E. Ingram & J. M. Price (Eds.), *Vulnerability to psychopathology: Risk across the lifespan* (pp. 3–19). New York: Guilford Press.