Between-Subject Designs and Within-Subjects Designs

Between-Subject Designs

Any independent variable must have a minimum of two levels, and experiment will compare condition A with condition B. Those who participate in the study might be placed in level A, level B, or both. If they receive either A or B but not both, the design is a **between-subject designs**; so named because the comparison of condition A and B will be a contrast between two different groups of individuals. On the other hand, if each participant receives both level A and B, we could say that both levels exist within each individual; hence, this design is called a **within-subject design** (or, sometimes, a **repeated measures design**).

Major advantage of a between-subjects design is that each subject enters the study fresh, and native with respect to the procedures to be tested. The prime disadvantage is that large number of people may need to be recruited, tested, and debriefed during the course of the experiment. Hence, the researcher invests a great deal of energy in this type of design. Another disadvantage of between-subjects designs is that differences between the conditions could be due to the independent variables, but they might also be due to the differences between the two groups.

To deal with this potential confound, deliberate steps must be taken to create **equivalent groups**. There are two common techniques for creating equivalent groups in a between-subjects experiment. One approach is to use **random assignment**. A second strategy is to use **matching**.

Within-Subjects Designs

One practical advantage of this design should be obvious- fewer people need to be recruited. If you have a study comparing two conditions and you want to test 20 people in condition 1, you will need to recruit 40 people for a between-subjects study, but only 20 for a within-subjects study.

Another advantage of within-subjects designs is that they eliminate the equivalent groups problem that occurs with between-subjects designs.

Sequence / Order Effect

In a within-subjects design, a major problem is that once a participant has completed the first part of a study, the experience or altered circumstances could influence performance in later parts of the study. The problem is referred to as a **sequence or order effect.**

An **order effect** occurs when the absolute order of conditions influences the results such as later performance is often better than early performance because of practice. Order effects are related

to the order that treatments are given but not due to the treatment itself. For example, scores can decrease over time due to fatigue, or increase due to learning.

A **sequence effect** occurs when the relative order of conditions influences the results such as receiving the context condition prior to the no-context condition. It is also known as differential transfer.

Some particular sequence might produce effects that are different from those of other sequences, what could be called a **carryover effect.** Carry-over effect occurs when participating in a prior condition influences participation in the current condition. It can be avoided by allowing sufficient time between treatments.

Controlling Sequence Effects

Counterbalancing Techniques

The typical way to control sequence effects in a within-subjects designs is to use more than one sequence, a strategy known as **counterbalancing**. Counterbalancing techniques determine the order of presentation of the conditions in a repeated measures design. They attempt to control (not eliminate) order effects.

There are various methods to reduce order threats in repeated measures designs. These methods include randomization, allowing time between treatments, and counterbalancing the order of treatments among others.

Residual Effect/ Carry over Effect:

The effect which a treatment has during its period of application (its **direct effect**) may persist into the following period(s). If the effect persists only into the immediately following period the effect is called the **first-order residual effect** or residual effect. If the effect lasts into the following two periods it is said to be second-order residual effect.

Circular Balanced Design: A design is called circular balanced if each treatment immediately precedes every other treatment (excluding itself) an equal number of times.

Circular Strongly Balanced Design: A design is called circular strongly balanced if each treatment precedes every other treatment (including itself) an equal number of times.

Second-Order Circular Balanced Design: A design is called second-order circular balanced if each treatment precedes (one period apart) every other treatment (excluding itself) an equal number of times.

Second-Order Circular Strongly Balanced Design: A design is called second-order circular strongly balanced if each treatment precedes (one period apart) every other treatment (including itself) an equal number of times.

Repeated Measures Designs

In comparative experiments involving human or animal subjects, it is very appealing to assign a sequence of treatments to each subject. Subjects are randomly divided into n sequence groups and each group is assigned a sequence of p treatments. Each member of the group receives each of the p treatments in order and each treatment is administered for the same length of time. This type of experiment is known as a cross-over trial or repeated measurements design (RMD). The choice of RMD must be made in a way that the treatments can be efficiently compared after allowing for the residual effects. The dependency or correlation among responses measured in the same individual is the defining feature of a repeated measurement design. Areas where repeated measurement designs are widely used include medicine, pharmacology, animal science and psychology. In repeated measures designs scores for one group, tested in two or more conditions, are compared.

Steps involves in Repeated Measures Designs

Step 1: A sample of subjects is selected from the population.
Step 2: Subjects all receive the same treatments (usually called "conditions").
Step 3: Scores from the Tx conditions are collected.
Step 4: Scores are analyzed using appropriated "repeated measures" stats tests.
Note: A within-groups design has more than one score per person.

We use blocks in designed experiments to minimize bias and variance of the error. In repeated measures designs, the subjects are their own controls because the model assesses how a subject responds to all of the treatments.

When to Use Repeated Measures ANOVA

If any repeated factor is present, then repeated measures ANOVA should be used. This approach is used for several reasons.

- First, some research hypotheses require repeated measures. Longitudinal research, for example, measures each sample member at each of several ages. In this case, age would be a repeated factor.
- Second, in cases where there is a great deal of variation between sample members, error variance estimates from standard ANOVAs are large. Repeated measures of each sample member provides a way of accounting for this variance, thus reducing error variance.
- Third, when sample members are difficult to recruit, repeated measures designs are economical because each member is measured under all conditions.