

An Overview of Memory

The ability to create new memories, store them for periods of time, and recall them when they are needed allows us to learn and interact with the world around us. Consider for a moment how many times a day you rely on your memory to help you function, from remembering.

It is actually a complex process that allows us to learn and recall vast amounts of information every moment of every day. It's such a complex process that, although memory has been studied for many years, psychologists aren't entirely sure how it works. What psychologists do know is that the brain's hippocampus, thalamus, and amygdala are all involved in the complex process of memory. They also agree that the three stages involved in the memory process are **encoding**, **storage**, and **retrieval** of information.

Memory is the term given to the structures and processes involved in the storage and subsequent retrieval of information. This information takes many different forms, e.g. images, sounds or meaning.

Memory is essential to all our lives. Without a memory of the past, we cannot operate in the present or think about the future. We would not be able to remember what we did yesterday, what we have done today or what we plan to do tomorrow. Without memory, we could not learn anything.

Human Memory

The study of human memory has been a subject of science and philosophy for thousands of years and has become one of the major topics of interest within cognitive psychology. But what exactly is memory? How are memories formed? The following overview offers a brief look at what memory is, how it works, and how it is organized.

Definition of Memory

Memory refers to the processes that are used to acquire, store, retain, and later retrieve information.

According to the **Atkins-Shiffrin Theory**, memory involves three distinct but related processes: sensory memory, short-term memory and long-term memory. Together, these processes provide the avenue for environmental information to be received by the senses and either put to use, stored for later use or ignored altogether.

Most people associate memory processes exclusively with the brain, and for the most part, that is accurate. What is responsible for getting the information from the senses to the brain? That's where sensory memory becomes so important. Our senses are directly linked to our central nervous system, which is comprised of our spinal cord and brain. The process of getting information from our senses to our brain happens very quickly. In fact, it happens so quickly that we are not always consciously aware of everything that is being picked up by our senses.

There are three major processes involved in memory: **encoding**, **storage**, and **retrieval**.

Process		
1	Encoding	Code and Put Information/Memory in Mind
2	Storage	Records or Maintain Information / Memory In Mind
3	Retrieval	Recover Information / Memory From Mind

- **Encoding:** The process of acquiring information and entering it into memory.
- **Storing:** The process of maintaining information in memory over time.
- **Retrieving:** The process of recalling information stored in memory or bringing back stored memories.

## Step 1: Encoding Information

The first Step of memory is encoding. When we are exposed to information of any kind, we take the information and begin processing it in **visual**, **acoustic**, and **semantic** form. This means that we take information, either as a picture or a sound or that we give the information meaning. One way to understand encoding is to think of it as the method that you use to lay the groundwork for remembering information.

Encoding (or registration): the process of receiving, processing, and combining information. Encoding allows information from the outside world to reach our senses in the forms of chemical and physical stimuli. In this first stage we must change the information so that we may put the memory into the encoding process.

### Three Kinds of Encoding

When information comes into your sensory memory, it needs to be changed into a form that can be stored. There are three main ways in which information can be encoded /changed.

- **Visual encoding:** Information is represented as a picture.
- **Acoustic encoding:** Information is represented as sounds.
- **Semantic encoding:** Information is represented by its meaning to you.

## Step 2: Storage

The creation of a permanent record of the encoded information. Storage is the second memory stage or process in which we maintain information over periods of time.

The process of getting information out of memory. The ability to access and retrieve information from memory allows us to actually use these memories to make decisions, interact with others, and solve problems.

### Step 3: Retrieval

Retrieval (or recall, or recognition): the calling back of stored information in response to some cue for use in a process or activity. The third process is the retrieval of information that we have stored. We must locate it and return it to our consciousness. Some retrieval attempts may be effortless due to the type of information.

Retrieval is the process of recalling stored information from memory. Basically, it is getting information out of your long-term memory and returning it to your conscious mind.

### Recognition and Recall

There are two main methods of retrieving memories:

- Recognition
- Recall

#### Recognition

Recognition is the association of something with something previously experienced. It involves comparing new information with information stored in memory. The recognition process is initiated as a response to a sensory cue. When you see something, you compare it to information stored in your memory. Hence, you recognize it.

**For example**, you may go to a party and see a person you recognize from a prior experience.

#### Recall

Recall is the retrieval of information from memory without a cue. If a person asks you a question, you must search your memory to recall the answer. It involves remembering a fact, event, or other information that is not currently physically present. For example, you may have to recall the list of items you had on your shopping list.

**For example**, when you are exposed to information through your senses, you take the information and begin processing it in visual, acoustic, and/or semantic form. This means that you take in information, either as a picture, a sound, or give the information meaning.

- If you look at a telephone number on a piece of paper, you are using visual.
- If you say the number out loud, you are acoustically encoding.
- If you notice that some of the digits sequentially represent a special date, you give that number meaning and thus semantically encoding.

## Three Types of Memory

### 1. Sensory Memory

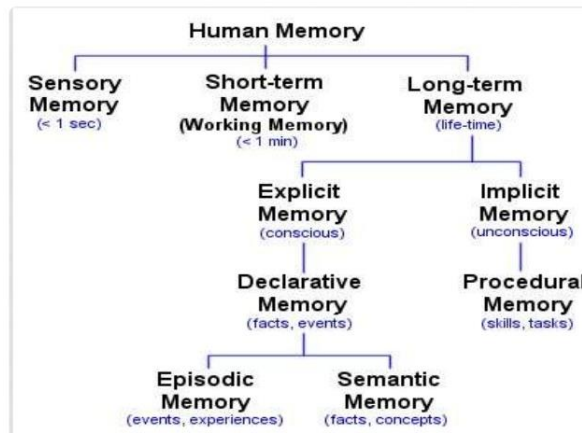
Processes information gathered through your five senses. It holds information for an extremely brief period of time (less than a second) after the original stimulus has stopped.

### 2. Short-Term Memory

Holds information you are actively thinking about. It lasts for a very brief time (less than a minute) and can only hold 7 +/- 2 pieces of information at once.

### 3. Long-Term Memory

Holds information for long periods even permanently. It seemingly can hold an unlimited amount of information.



## Sensory Memory

Sensory memory is the first stage of memory. Its purpose is to give your brain time to process the incoming information.

Sensory memory is not consciously controlled. You subconsciously and continuously gather information from the environment through your five senses. Sensory memory holds impressions of that sensory information that was received by your five senses after the original stimulus has stopped. However, it only holds it for a very brief period, generally for no longer than a second. In order for that information to be retained for longer, it has to continue onto short-term memory.

Most of the information that gets into sensory memory is forgotten. It never makes its way into the second stage of memory because it was never attended to. To get information into short-term memory, you need to attend to it – meaning consciously paying attention to it.

Sensory memory can be observed if you look at an object then close your eyes. As your eyes close, you can notice how the visual image is maintained for a fraction of a second before fading. It is your sensory memory that is holding that image.

Sensory memory also explains why the old 16mm movies shot with 16 separate frames per second appears as continuous movement rather than a series of single still pictures. A visual trace is retained in sensory memory for about a split second. But it holds it long enough to keep the image in your mind until the next still image replaces it.

### Sensory Memory subdivided into three types

- **Iconic memory** is the visual sensory memory that holds the mental representation of your visual stimuli.
- **Echoic memory** is the auditory sensory memory that holds information that you hear.
- **Haptic memory** is the tactile sensory memory that holds information from your sense of feeling.

## Short-Term Memory

Short-term memory (STM) is also known as working or active memory. It holds the information you are currently thinking about. This information will quickly be forgotten unless you make a conscious effort to retain it.

Like sensory memory, short-term memory holds information temporarily, pending further processing. However, unlike sensory memory which holds the complete image received by your senses, short-term memory only stores your interpretation of the image.

## Temporary Storage

As indicated above, information in short-term memory is not stored permanently. Information passes from sensory memory into short-term memory, where again it is held for only a short period of time. Most of the information stored in short-term memory will only be kept for approximately 20 to 45 seconds. While many of your short-term memories are quickly forgotten, paying attention to the information and processing (encoding) it allows it to continue into long-term memory. Just as sensory memory is a necessary step for short-term memory, short-term memory is a necessary step toward the next stage of retention, long-term memory.

Processing or encoding includes making judgments and assessments about meaning, relevance, and significance of that information. It also includes the mental activities needed to move selected portions of the information into long-term memory. If encoding never happens, the information never gets into long-term memory.

The reason a person forgets the name of someone to whom he or she has just been introduced to is because the name often was never encoded and transferred from short-term to long-term memory.

## Limited capacity

Short-term memory not only has a limited time, it also has a limited capacity. It is believed to only hold a few items. Research shows the number is around 7 +/- 2 items. For example, if a person is asked to listen to a series of 20 names, he or she normally retains only about seven names. Typically, it is either the first few or last few. The reason is because if you focus on the first few items, your STM becomes saturated, and you cannot concentrate on and recall the last series of items. People are able to retain more information using memory techniques such as chunking or rehearsal.

## Long-term Memory

Long-term memory (LTM) refers to the storage of information over an extended period. It is all the memories you hold for periods longer than a few seconds. The information can last in your long-term memory for hours, days, months, or even years. Although you may forget some information after you learn it, other things will stay with you forever.

Some information retained in STM is processed or encoded into long-term memory. This information is filed away in your mind and must be retrieved before it can be used. Some of the information in your LTM is easy to recall, while other memories are much more difficult to retrieve.

Unlike short-term memory, long-term memory has seemingly unlimited capacity. You may remember numerous facts and figures, as well as episodes in your life from years ago.

## Types of long-term memory

There are main two types of long term memory; **Explicit memory and Implicit memory.**

### Explicit memory

Explicit memories are those experiences that can be intentionally and consciously remembered. It is knowledge or experiences that can be consciously remembered such as facts, data, episodes, or events. Explicit memory can be further sub-categorized as either episodic or semantic memories.

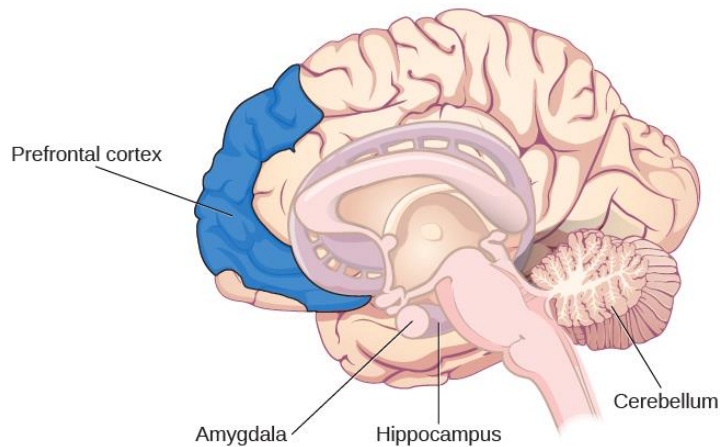
**Episodic memory** refers to the firsthand experience that you have had (e.g. episodes or events in your life). For example, you may remember your 16<sup>th</sup> birthday party or your first soccer game.

**Semantic memory** refers to knowledge of facts and concepts about the world. For example, you may remember the names of presidents or other members.

### Implicit memory

Implicit memory refers to knowledge that we cannot consciously access. It is remembering without awareness. For Example, you may remember how to ride a bike or walk, but it is difficult to explain how you do it.

## Parts of the Brain in Memory



### The Amygdala

The role of the amygdala in memory formation. The main job of the amygdala is to regulate emotions, such as fear and aggression. The amygdala plays a part in how memories are stored because storage is influenced by stress hormones.

### The Hippocampus

Hippocampus functions in memory processing the hippocampus is involved in memory, specifically normal recognition memory as well as spatial memory (when the memory tasks are like recall tests) Another job of the hippocampus is to project information to cortical regions that give memories meaning and connect them with other connected memories. It also plays a part in memory consolidation: the process of transferring new learning into long-term memory.

### Neurotransmitters

There also appear to be specific neurotransmitters involved with the process of memory, such as epinephrine, dopamine, serotonin, glutamate, and acetylcholine

- **Epinephrine**
- **Dopamine**
- **Serotonin**
- **Glutamate**
- **Acetylcholine**

### Forgetting

**Forgetting** refers to failure to either recall or retain information into present consciousness. All experiences leave traces or after-effects (images) in memory parts of the brain. Failure to retain these traces from the parts of memory is called Forgetting

### Causes of Forgetting

Everyone forgets things; like a person's name, where they left their keys, the ending to a movie, or how to do math problems. However, the reason why we forget something may differ. Have you ever felt like a piece of information has just disappeared from memory? Or have you had situations where you have no memory of a certain event? Or maybe, you know certain pieces of information exist in your mind, but you just cannot seem to retrieve it.

The inability to retrieve a memory is only one cause of forgetting. We may forget because the information was never in long-term memory in the first place. The way information is encoded affects the ability to remember it. If it is not coded effectively, we will likely forget the information in the future. We may also forget specific information because we confuse it with other information which we have processed. Information may also be forgotten simply because we have not thought about it in a long time.

**The main reasons for forgetting include:**

- 1. Retrieval Failure**
- 2. Ineffective Encoding**
- 3. Interference**
- 4. Decay or Fading**
- 5. Motivated Forgetting**
- 6. Physical Injury or Trauma**
- 7. Organic Causes**

### **Retrieval Failure**

The inability to retrieve a memory is one of the most common causes of forgetting. Retrieval failure is the failure to recall a memory due to missing stimuli or cues that were present at the time the memory was encoded. This theory is that a memory is temporarily forgotten simply because it cannot be retrieved, but with the proper cue that information can be brought to mind. For example, you might not remember the name of an actor in a movie, but his name might suddenly pop into your mind if you see a clip from a movie or if someone tells you the name begins with the letter “L”. The movie or the letter would be acting as a cue for remembering the actor’s name.

With retrieval failure, the information still exists in memory, but just not readily available without specific cues. A good retrieval cue will be consistent with the original encoding of the information.

### **Ineffective Encoding**

The inability to remember information may sometimes have less to do with forgetting and more to do with the fact that it never made its way into long-term memory. This type of forgetting is caused because the person did not pay attention in the first place. Encoding failure or ineffective coding may prevent information from entering long-term memory, and thus the information never being stored to be able to be retrieved at a later date. This may happen when you meet someone and later you cannot remember his or her name. This is probably because you were preoccupied when you were introduced, and the name never made it to long term memory.

**An example** of ineffective coding can also be exhibited by trying to draw the back of a dime from memory. Chances are you probably remember the shape and color, but probably could not draw a lot of the details even though you have seen hundreds of dimes over the course of your life. The reason for this is that only details necessary for distinguishing dimes from other coins were encoded into your long-term memory.

### **Interference**

Interference is another major cause of forgetting. General understanding of the subject suggests that “Information gets confused with other information in our Long-Term Memory.”

Interference occurs when information gets confused with other information in our long-term memory. The Interference theory suggests that some memories compete and interfere with other memories, and that memory loss occurs when information stored either before or after a given memory hinders the ability to remember it. Essentially, cues for different memories may be too similar so a wrong memory gets retrieved.

- **Retroactive Interference**
- **Proactive Interference**

### **Retroactive Interference**

- A mix up of previously learned information with new and similar information is called Retroactive information.

**Example:** A student studies and understands the events and causes of World-War I thoroughly. After few weeks, the student studies events and causes of World-War II.

If the student then fails to remember the events and causes of First World-War, this would be an example of Retroactive Interference.

Retroactive interference occurs when new information interferes with your ability to remember previously learned information. Basically, it occurs when information works backwards to interfere with earlier information, so previously learned information is lost because it is mixed up with new and somewhat similar information.

**Example:** If you learn the state capitals this week, new information, such as world capitals, presented to you next week could cause you to become confused about the state capitals.

Proactive Interference

- The phenomenon where the student fails to remember new information having mixed it with similar previous information is called Proactive Interference.

**Example:** Like the previous example, a student studies and understands the events and causes of World-War I in depth. After few weeks, the student studies events and causes of World-War II. If the student then fails to remember the events and causes of Second World-War, this would be an example of proactive interference.

Proactive interference is when an old memory makes it more difficult to remember new information. Current information is lost because it is mixed up with previously learned information that may be similar. For example, you could have trouble learning a new math concept because it conflicts with preconceived notions or assumptions you may have regarding a similar topic.

**Example:** If you knew the rules of rugby then started learning the rules of football, you may have trouble remembering the rules of football because they conflict with the old information (rules of rugby).

Retroactive interference	Proactive interference
Occurs when newly learned information makes people forget old information.	Occurs when old information makes people forget newly learned information.

Decay Theory (Fading)

The Decay theory suggests that when something new is learned, a memory “trace” is formed in the brain and over time the trace begins to fade and disappear, unless it is occasionally used. With this theory, if information is not occasionally retrieved, it will eventually be lost.

The Decay Theory explains the loss of memories from sensory and short-term memory, but not from long term memory. When information fades from working and short-term memory, it disappears because the space was needed for other incoming information. However, loss of long-term memories does not seem to depend on how much time has gone by since the information was learned. Most theorists believe that once information has been transferred to long-term memory it is stored there permanently. The theorists believe that the memory is always there, but the mental path to get to the memory has decayed. For example, people might easily remember their first day of high school, but completely forget the last movie they saw. This may be because of the strong links (emotion, visual, etc.) the person has to the memory. This is why people who see a horrific accident, have a hard time forgetting it.

With the Decay theory, when information fades from long-term memory, what really fades is the link to that information, not the information itself. The information is there, but we just cannot find it. It is like a path in the woods that leads to a cabin; the more you use the path, the easily it is to find the cabin. However, if you do not use the path for several years, the path will eventually fade. The cabin will still exist, but will be harder to find because the path that leads there has faded.

Fading

Disuse of information causes memory traces to slowly eradicate with time, and this process is called **Fading**. Fading occurs rapidly from the Short-term memory. Information in working memory fades away, as new incoming information is stored in the Short-Term Memory.

Fading can be prevented by encoding the information as meaningfully as possible, by frequently retrieving it, and by using effective memory strategies.

Motivated Forgetting

The Motivated Forgetting theory suggests people forget because they push unpleasant thoughts and feelings deep into their unconscious. People may actively work to forget memories, especially those of traumatic or disturbing events or experiences.

The process of purposefully blocking or repressing memory information is termed as motivated forgetting. The term is derived from **Freudian Psychotherapy** that refers to **Repression**. Basically, it means trying to avoid remembering or recalling any information deliberately.

**Example:** An abused child may not be able to recall the events in details having suppressed them.

Suppression or Repression of memory is not always a result of an emotional trauma. For instance, a student who hates her French teacher might not remember her French lessons. This is mainly because she has avoided contact with the subject matter

**The two basic forms of motivated forgetting are:**

**Suppression:** a conscious form of forgetting.

**Repression:** an unconscious form of forgetting.

**Causes of Forgetting** aren't limited to just these and there are various other factors that affect memory. Memory disorders like Amnesia also cause **Forgetting**. Two major types of Amnesia are:

- **Psychological Amnesia:** Disturbances in the process of encoding, storage, and retrieval causes psychological amnesia.
- **Biological Amnesia:** Abnormal functioning of brain results in biological amnesia, which might be caused by any internal problem such as uneven blood flow, drugs, diseases, blow to the head, and other damages to brain.

### **Physical Injury or Trauma**

- **Anterograde amnesia** is the inability to remember events that occur after an injury or traumatic event.
- **Retrograde amnesia** is the inability to remember events that occurred before an injury or traumatic event.

### **Organic Causes**

Forgetting that occurs through physiological damage to the brain is referred to as organic causes of forgetting. These theories encompass the loss of information already retained in long term memory or the inability to encode new information. This is typically caused by the gradual slowing down of the central nervous system due to aging. Examples include Alzheimer's, Amnesia, and Dementia.

### **Factors that Influence Memory Process in Humans**

These Factors can be Influence Memory Process in Humans are as follows:

1. **Ability to retain**
2. **Good health**
3. **Age of the learner**
4. **Maturity**
5. **Will to remember**
6. **Intelligence**
7. **Interest**
8. **Over learning**
9. **Speed of learning**
10. **Meaningfulness of the material**
11. **Sleep or rest.**

Memory as stated already, is a process which includes learning, retention and remembering.

As such all the three processes are important for good memory.

They include the processes to **improve retention, remembering** and also **overcoming forgetting**.

#### **Ability to retain:**

This depends upon good memory traces left in the brain by past experiences.

#### **Good health:**

A person with good health can retain the learnt material better than a person with poor health.

#### **Age of the learner:**

Youngsters can remember better than the aged.

#### **Maturity:**

Very young children cannot retain and remember complex material.

#### **Will to remember:**

Willingness to remember helps for better retention.

#### **Intelligence:**

More intelligent person will have better memory than a dull person,

#### **Interest:**

If a person has more interest, he will learn and retain better.

#### **Over learning:**

Experiments have proved that over learning will lead to better memory.

#### **Speed of learning:**

Quicker learning leads to better retention,

#### **Meaningfulness of the material:**

Meaningful materials remain in our memory for longer period than for nonsense material,

#### **Sleep or rest:**

Sleep or rest immediately after learning strengthens connections in the brain and helps for clear memory.