



## Memory

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### Memory

The word "Memory" has been derived from the Latin word 'Memoria' means to retain in mind. Memory is the storage of past experiences of an individual. Memory is that mental process that keeps different sensations, ideas, and information safe in the mind and can be recalled when the need arises. It is a memory bank in which all the information is retained and can be processed by the central unit i.e. mind.

**Woodworth:** According to Woodworth, Memory means remembering what has been learned in the past.

**Matlin:** According to Matlin (2005) "Memory is the process of maintaining information over

**Sternberg:** According to Sternberg (1999), "Memory is how we draw on our past experiences to use this information in the present."

**Hillgard:** According to Hillgard Memory expresses itself in the present reaction to the learned in the past.

**Stout:** According to Stout, Memory as an experience is a foundation for the future to proceed further.

**David G. Myers:** According to David G. Myer, memory is the storage and retrieval of information.

**Robert S. Feldman:** According to Robert S. Feldman, Memory is the capacity to record, retain, and retrieve information.

In short, we can say that Memory is the jest of our past experiences. Every incident has its prints on the mind. Whatever we see, hear, or learn in our lives, is retained in our minds. The sign of good memory is to retain past experiences and recall them as a photocopy of the original.

**Woodworth** presented the "**L-I-R**" formula to study Memory.

L means Learning

I mean Internal

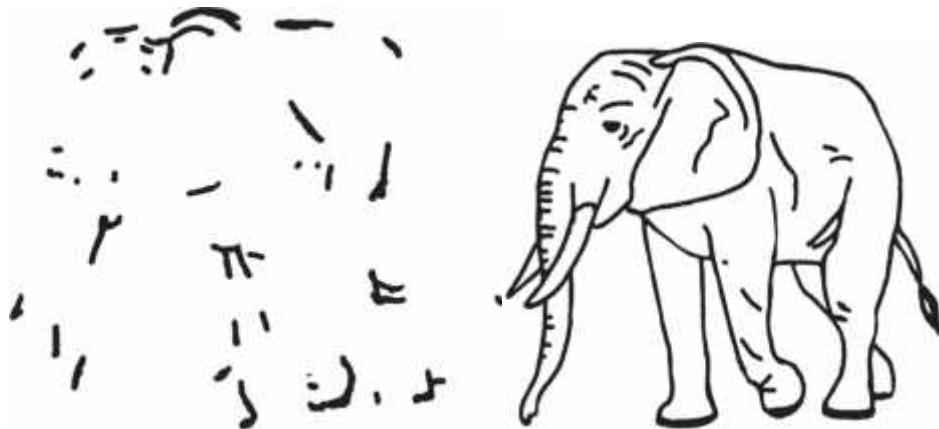
R means Remembering. (Recognition or recall)

According to this formula, Learning is the most important element of Memory. Without learning, we cannot retain anything and cannot recall it, an interval of time lies between learning and recall. So the process of memory depends upon learning and recall after a time gap or interval.

### **The Phenomena of Memory**

Memory is the persistence of learning over time. We can store and retrieve information.

Human memory can be pretty amazing. E.g. People who were shown the whole image 17 years before were more likely to identify the fragment.



### **How does Memory work?**

Psychologists think of memory as involving three processes

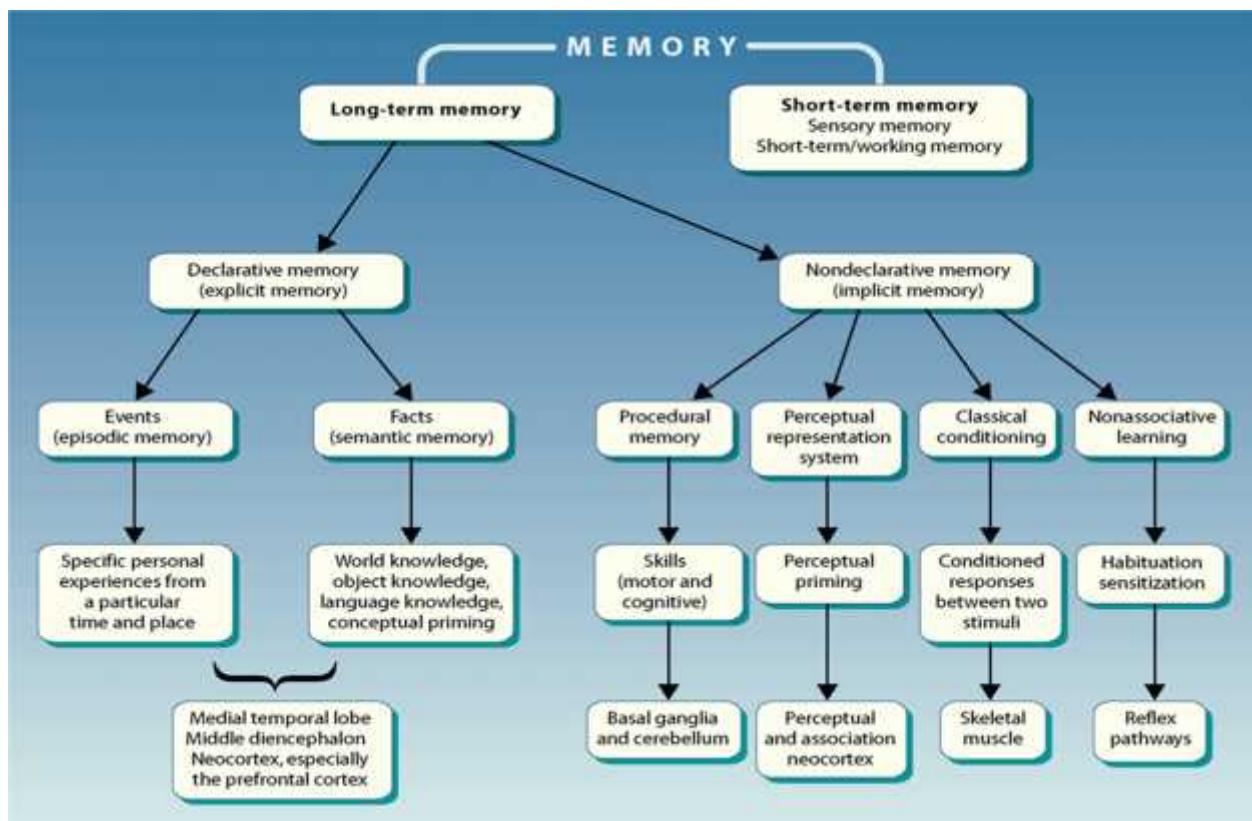
- **Encoding:** Encoding refers to the process of converting information from our sensory input into a form that can be stored in memory. This stage involves the initial processing and transformation of information. The brain receives sensory input from the environment, such as visual, auditory, or tactile stimuli, and encodes this information into neural patterns. Encoding can occur through various mechanisms, including attention, perception, and rehearsal.
- **Storage:** Storage involves the retention of encoded information over time. Once information is successfully encoded, it is stored in various memory systems. The three main types of memory systems are sensory memory, short-term memory, and long-term memory. Sensory memory, which holds brief sensory impressions, short-term memory (working memory), which holds information temporarily, and long-term memory, which stores information for longer periods.
- **Retrieval:** Retrieval is the process of accessing and recalling stored information from memory. It involves locating and activating the stored memory traces and bringing them into

conscious awareness or using them for various cognitive processes. The retrieval of information can be influenced by various factors, including cues, context, and the strength of the memory trace.

## **TYPES OF MEMORY**

There are three kinds of memory related to each other:

1. Sensory Memory
2. Short Term Memory (STM)
3. Long Term Memory (LTM)



### **1. Sensory Memory**

The immediate, initial recording of sensory information held in sensory memory. It has a large capacity, but rapid decay. The actual length of time a stimulus exists in sensory storage depends on the modality:

Iconic memory - a visual image in sensory storage - they last approximately 1/4 of a second.

Echoic memory - auditory image. These (as well as other senses) seem to last up to 3 seconds.

## **Sensory Memory to Short-term Memory**

After getting the information in the form of Iconic and Echoic Memories, data needs to be transferred to short-term memory otherwise it can be lost.

Two processes are required to get information from sensory memory to short-term memory

- Pattern recognition - when new information comes into sensory storage, we actively search through long-term memory to find a match for this new raw data.
- Attention - this is pretty obvious. The more we pay attention to a stimulus, the more likely it will continue onto the next memory store (short-term memory)

## **2. Short-term Memory**

As the name implies, short-term memory allows you to recall specific information about anything for a brief period. Short-term memory is not as fleeting as sensory memory, but it's also not as permanent as long-term memory. Short-term memory is also known as primary or active memory.

Research estimates that short-term memories only last for about 30 seconds. When you read a line in a book or a string of numbers that you have to recall, that's your short-term memory at work. You can keep information in your short-term memory by rehearsing the information. For example, if you need to recall a string of numbers, you might keep repeating them to yourself until you input them. However, if you are asked to recall those numbers about 10 minutes after inputting them, you'd most likely be unable to.

**Working Memory** Working memory is a type of memory that involves the immediate and small amount of information that a person actively uses as they perform cognitive tasks. While some experts view working memory as a fourth distinct type of memory, working memory can fall under the classification of short-term memory and, in many cases, is even used interchangeably.

### **Ways to extend the duration of STM**

- **Maintenance Rehearsal**
  1. The process of repeatedly verbalizing or thinking about the information.
- **Slots/Chunking**
  2. bits of information are combined into meaningful units, or chunks so that more information can be held in STM

- **Primacy and Recency**
  3. **Primacy** - when you are receiving information, the information perceived first is more likely to be remembered. This more recent information may simply get to long-term memory more easily, and thus be remembered or we may just rehearse the early information more.
  4. **Recency** - information perceived toward the end of an event is also more likely to be remembered. So, information in the "middle" seems to get pushed out and is less likely to be remembered.

- **Elaborative Rehearsal**

5. The only way to bring information into long-term memory
6. Connecting new information with previously stored, already existing associative structures.

### **3. Long-term Memory**

An unlimited capacity store that can hold information over lengthy periods. Suggested encoding modes are semantic (meaning) and visual (pictorial) in the main but can be acoustic also.

According to Feldman, the storage of information on a relatively permanent basis, although retrieval may be difficult.

Long Term Memory is called **Secondary Memory**; the rate of forgetting in Long-term memory is lesser than the short-term memory. In long-term memory, the information is made meaningful and retained in mind for a long time. As the information is stored in heaps, one has to think over and search out to select the required information to recall when the need arises. It helps in utilizing past experiences. It is the last stage of the memory process. As the sensory information is received in the first stage, it can subside after a while. The sensory information when given meanings becomes perceptible including our thinking and remembering is retained for a long time and can be recalled or recognized at any time of need. This type of memory is present in every healthy mind. It is damaged due to mental shock, trauma, or old age because the blood arteries cannot continue blood circulation in the brain nerve cells. It affects memory. The feeble-minded children also have a shortage of long-term memory as they cannot learn even with repetition and practice.

We may conclude from the explanation of all these stages of memory, that sensory memory can be changed into short-term memory with the help of repetition and attention but short-term memory can be changed into long-term memory only with the help of Abstraction which expresses the perceived information in verbal symbolic form. The rehearsal or repetition not only keeps it alive but also allows the material to be transferred into long-term memory.

## Types of Long-term Memory

There is no limit to how much our long-term memory can hold and for how long. We can further split long-term memory into two main categories: explicit and implicit long-term memory.

- **Explicit memories**, also known as **declarative memories**, include all of the memories that are available in consciousness. Explicit memory can be further divided into episodic memory (specific events) and semantic memory (knowledge about the world).
- **Implicit memory**, also known as **non-declarative memories**. Implicit memories are those that are mostly unconscious. This type of memory includes procedural memory, which involves memories of body movement and how to use objects in the environment. How to drive a car or use a computer are examples of procedural memories.

Explicit memory involves the recall of previously learned information that requires **conscious effort to receive**, while **implicit memory** is **unconscious and effortless**. Explicit memory fades in the absence of recall, while implicit memory is more robust and may last a lifetime even in the absence of further practice.

### What is Implicit Memory?

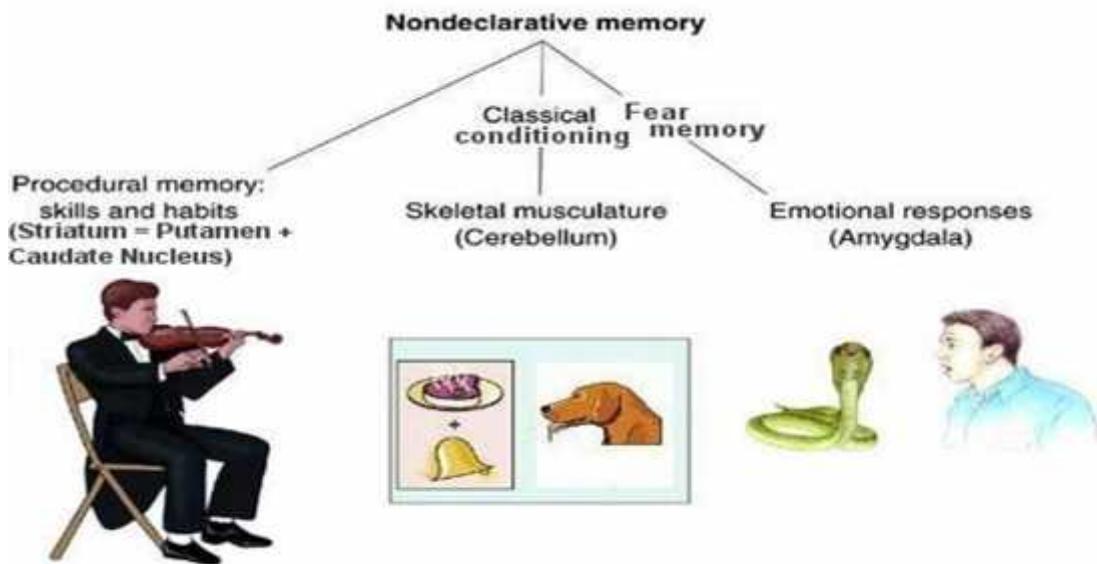
Implicit memory, also known as unconscious memory or automatic memory refers to perceptual and emotional unconscious memories which influence our behavior (Dew & Cabeza, 2011). The impact that implicit memory has on our current behavior occurs without our conscious retrieval of memories. Hence, implicit memory enables our prior experiences to improve our performance of various tasks without our conscious and explicit awareness of such experiences.

### What is Explicit Memory?

Explicit memory, also known as declarative memory, refers to memories involving personal experiences as well as factual information that we can consciously retrieve and intentionally articulate (Dew & Cabeza, 2011). Recalling information from explicit memory involves some degree of conscious effort – information is consciously brought to mind and “declared”.

### Types of Explicit Memory

- **Semantic Memory:** Semantic memory is a part of the long-term memory responsible for storing information about the world. This includes knowledge about the meaning of words, as well as general knowledge. For example, London is the capital of England. It involves conscious thought and is declarative.
- **Episodic Memory:** Autobiographical memory involves various episodes from the past gathered from our personal history based on a certain time, space, object, or person. Autobiographical memories often combine episodic and semantic memories.



### Non-declarative LTM

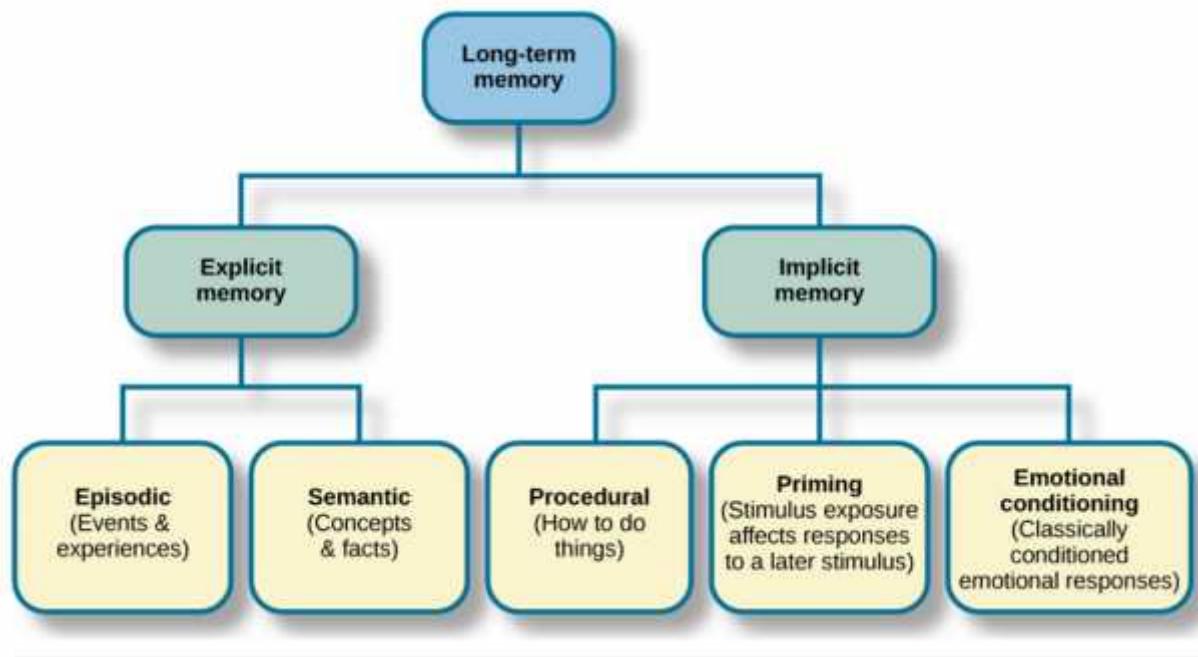


Figure: There are two components of long-term memory: explicit and implicit. Explicit memory includes episodic and semantic memory. Implicit memory includes procedural memory and things learned through conditioning.

## Models of Memory

### 1. Atkinson-Shiffrin Model

Atkinson-Shiffrin Model also known as the multi-stage Model. It consists of three different, interacting memory systems.

- **Sensory Memory**

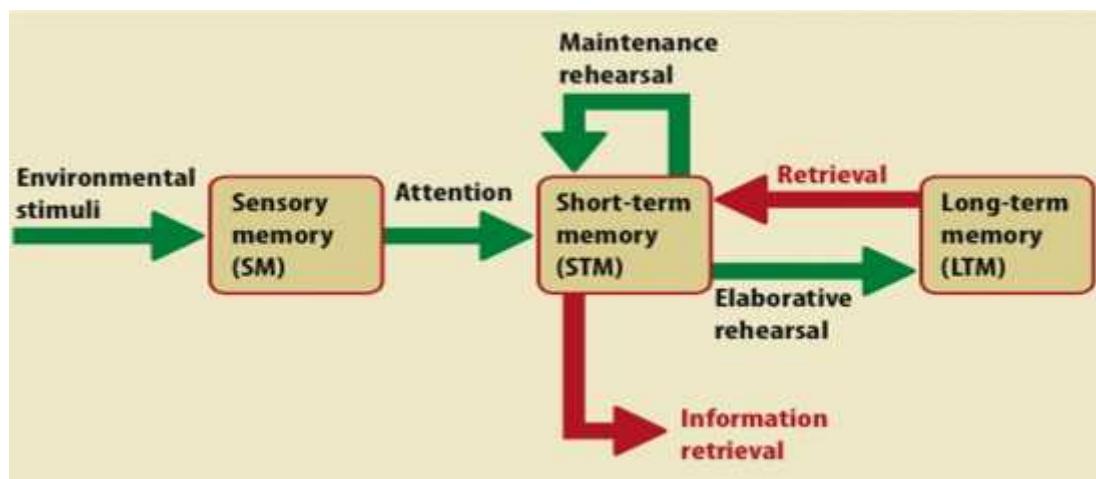
Stimuli are recorded by our senses and held briefly in sensory memory.

- **Short-term Memory**

Some of this information is processed into short-term memory and encoded through rehearsal.

- **Long-term Memory**

The information then moves into long-term memory where it can be retrieved later.

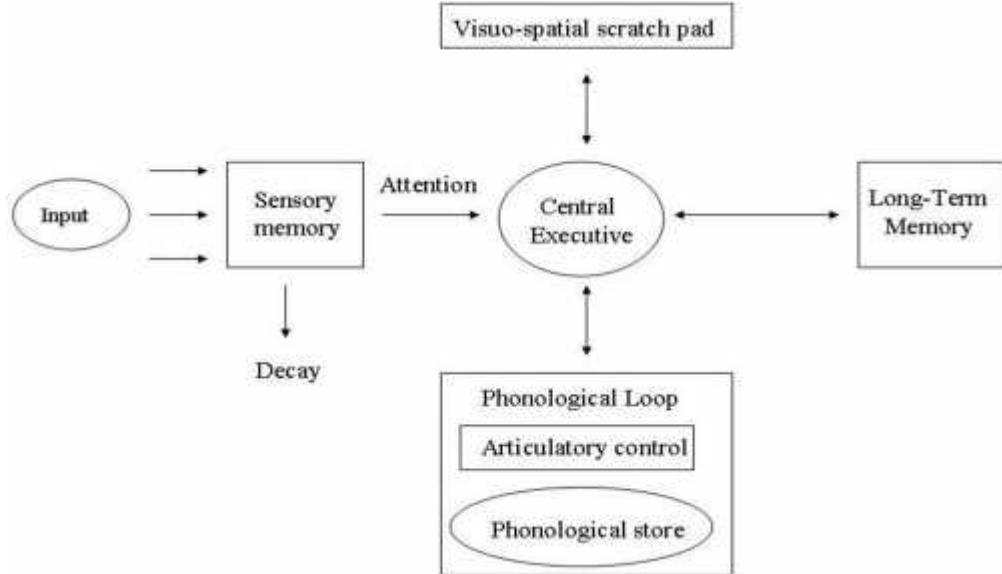


**Atkinson-Shiffrin Model**

## 2. Working Memory Model

Instead of all information going into one single store, there are different systems for different types of information. It consists of three different systems

- **Central Executive:** Drives the whole system (e.g. the boss of working memory) and allocates data to the subsystems (VSS & PL). It also deals with cognitive tasks such as mental arithmetic and problem-solving.
- **Visuo-Spatial Sketch Pad** (inner eye): Stores and processes information in a visual or spatial form. The VSS is used for navigation.
- The **phonological loop** is the part of working memory that deals with spoken and written material. It can be used to remember a phone number.



**Working Memory Model**

### 3. Level of Processing Model

A model of memory as a single system in which retention depends on how deeply information is processed

- a. With the shallowest levels of processing, a person is merely aware of the incoming sensory information
- b. Deeper processing (elaboration) takes place only when the person does something more with the information, such as forming relationships, making associations, attaching meaning to a sensory impression, or otherwise engaging in active elaboration on new material

#### Craik and Tulving Experiment:

They had participants answer yes or no to questions asked about words just before the words were flashed to them for 1/5 of a second. Participants had to process the words visually, acoustically, or semantically. The test required shallow processing for the first question, deeper processing for the second question, and still deeper processing for the third question. Later retention tests showed that the deeper the level of processing, the higher the accuracy rate of memory.



Level of processing	Type of encoding	Example of questions used to elicit appropriate encoding
<i>Shallow processing</i>	<i>Structural encoding:</i> emphasizes the physical structure of the stimulus	Is the word written in capital letters?
<i>Intermediate processing</i>	<i>Phonemic encoding:</i> emphasizes what a word sounds like	Does the word rhyme with weight?
<i>Deep processing</i>	<i>Semantic encoding:</i> emphasizes the meaning of verbal input	Would the word fit in the sentence: "He met a _____ on the street"?

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## Level of Processing Model

### Remembering

Remembering involves three kinds of memory tasks

#### Recall

- c. A measure of retention that requires a person to remember material with few or no retrieval cues, as in an essay test
- d. Trying to remember someone's name, recalling items on a shopping list, memorizing a speech or a poem word for word, and remembering
- e. May be made a little easier if cues are provided to jog memory
- f. Sometimes serial recall is required; that is, information must be recalled in a specific order
- g. Research suggests that, in free recall tasks, order associations are more resistant to distractions than meaningful associations

#### Recognition

- a. A measure of retention that requires a person to identify material as familiar, or as having been encountered before
- b. Multiple-choice, matching, and true/false questions are examples of recognition test items
- c. The main difference between recall and recognition is that a recognition task does not require you to supply the information but only to recognize it when you see it

- d. Recent brain-imaging studies have discovered that the hippocampus plays an extensive role in memory tasks involving recognition, and the degree of hippocampal activity varies with the exact nature of the task

### **Relearning**

- a. Measuring retention in terms of the percentage of time or learning trials saved in relearning material compared with the time required to learn it originally; also called the savings method
- b. Savings score
  - i. The percentage of time or learning trials saved in relearning material over the amount of time or number of learning trials required for the original learning
  - ii. College students demonstrate the relearning method each semester when they study for comprehensive final exams

### **Example of Recall:**

The process of storing information in memory is called \_\_\_\_\_.

### **Example of Recognition:**

The process of storing information in memory is called:

- a. rehearsal b. deep processing
- c. encoding d. Retrieval

## **FORGETTING**

### **Definition:**

Forgetting is to exclude useless material from the conscious. Psychologists say that forgetting is a blessing to give the way to proceed in learning and retaining useful things. So forgetting is normal whereas Amnesia, fugue, multiple personality, and depersonalization are abnormal

### **Causes / Factors of Forgetting**

The following are the causes of forgetting:-

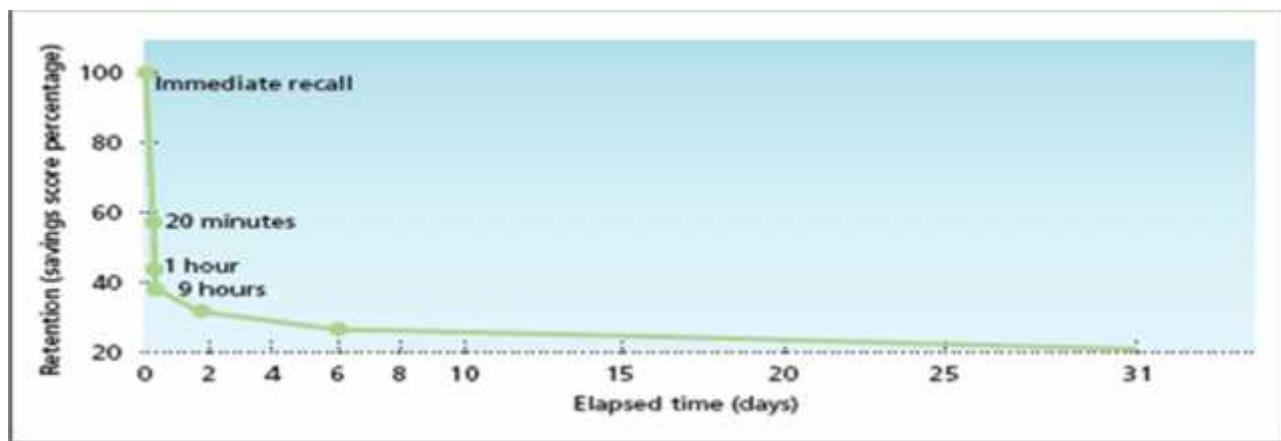
- a. Brain shock or trauma due to any head injury or carbuncle or an accident or damage to the hippocampus.
- b. Decay of brain cells due to old age.

- c. Unconscious reasons for frustration are stress, anxiety, and complexity which cause motivated forgetting. Repression is the basic defense mechanism that blocks from consciousness painful memories and anxiety arousing thoughts.
- d. Long time pause between the event experienced and the recall.
- e. Disinterest and lack of motivation cause forgetfulness.
- f. Emotions of fear, anger, and extreme grief caused by the situation of any emergency or frustration accompanied by repression lead the individual to forget painful and shameful events.
- g. Overlearning and lack of sleep also cause forgetting. E.g. the students who continuously learn their paper the night before the examination and take anti-sleeping pills to keep awake, feel nauseous, and find themselves blank and unable to recall any answer to the question.
- h. Proactive inhibition and retroactive inhibition or interference also cause forgetting.
- i. The law of disuse makes an individual inattentive to the learned lesson and causes forgetting
- j. Intoxication, drug addiction, alcohol, and opium affect active recall.

Forgetting can occur at any memory stage. As we process information, we filter, alter, or lose much of it because details of sensory memory are lessened when we give meanings to them, but are still decreased when we want to store it in our memory and after some time, the interferences, moods, and motives cause inhibition in the recall, so some items are retrieved and some are not.

### **Forgetting**

The curve of forgetting - a graph showing a distinct pattern in which forgetting is very fast within the first hour after learning a list and then tapers off gradually.



**Curve of Forgetting**

## **Forgetting due to Encoding Failure**

Failure to process information into memory.

### **a. Forgetting due to Memory Trace Theory**

Physical change in the brain that occurs when a memory is formed.

- Decay - loss of memory due to the passage of time, during which the memory trace is not used.
- Disuse - another name for decay, assuming that memories that are not used will eventually decay and disappear.

The decay theory of forgetting refers to the weakening of brain cells and weakening of Memory-banks storing capacity due to the long-time hoardings of discussed memory with increasing age. According to Ebbinghaus, the learning that remains in daily use is not forgotten. As age increases, knowledge is accumulated in the shortest forms of symbolic features and can be recalled better if it is often practiced after some time. The memory traces if not repeated become dimmer and dimmer. According to Ebbinghaus, the rate of forgetting is higher in the beginning but slower afterward as recall clarifies and strengthens retention. Jenkins Dallenback also discovered that the rate of forgetting during the daytime is faster due to distractions than during sleep at night. Moreover retention power during sleep at night and after sleep in the early morning is better than midday as the mind-body function gets slower due to overload of work, boredom, and fatigue.

### **b. Forgetting due to Interference Theory**

- **Proactive interference:** memory retrieval problem that occurs when older information prevents or interferes with the retrieval of newer information.
- **Retroactive interference:** memory retrieval problem that occurs when newer information prevents or interferes with the retrieval of older information.

Interference theory of forgetting includes two types of interference i.e. proactive inhibition and retroactive inhibition. Proactive inhibition is an interference of previous memory in the current memorization and Retroactive inhibition is the interference of later learning/memory in the earlier learning/memory as shown in the figure:

### **Proactive Interference:**



### **Retroactive Interference:**



## **Memory Improvement Techniques**

Improving memory is a valuable skill that can benefit various aspects of life, such as learning, work, and daily tasks. Here are some effective memory improvement techniques:

- 1. Pay attention and be present:** Memory formation begins with paying close attention to the information you want to remember. Minimize distractions by finding a quiet environment and removing potential interruptions. Actively engage with the material, focusing your mind on the task at hand. Avoid multitasking, as it can hinder your ability to encode information effectively.
- 2. Use mnemonic techniques:** Mnemonic techniques are memory aids that help you remember information by associating it with something more memorable. There are several types of mnemonic techniques:
  - **Acronyms:** Create a word or phrase using the first letter of each item you want to remember. For example, "HOMES" represents the Great Lakes (Huron, Ontario, Michigan, Erie, Superior).
  - **Visualization:** Create vivid mental images that connect to the information. The more unusual and memorable the images, the better you will have to store them in long-term memory. For example, to remember a shopping list, imagine yourself walking through your house and encountering exaggerated versions of the items on your list in each room.
- 3. Chunking:** Chunking involves breaking down complex information into smaller, more manageable chunks. Instead of trying to remember a long string of unrelated items, group them into meaningful categories or patterns. For example, if you need to remember the number 122546385245 you can remember this number by chunking this way, 122-546-382-245.

- 4. Create associations:** Our brains excel at remembering connections between different pieces of information. When encountering new information, try to relate it to something you already know. This can be done by finding similarities, drawing analogies, or identifying shared characteristics. Creating meaningful associations helps build a network of interconnected memories, making recall easier.
- 5. Use the method of loci:** The method of loci, also known as the memory palace technique, is an ancient mnemonic strategy. It involves associating information with specific locations in a familiar environment, such as your house. To use this technique, visualize walking through your house and placing the items or concepts you want to remember at specific locations. As you mentally revisit those locations, the associations will trigger the recall of the information.
- 6. Practice retrieval:** Actively retrieving information from memory strengthens your ability to recall it in the future. Instead of passively reviewing material, engage in active recall. Test yourself through quizzes, flashcards, or summarizing the information without looking at your notes. This technique reinforces memory storage and helps identify areas that require further review.
- 7. Use spaced repetition:** Spacing out your learning sessions over time and reviewing information at increasing intervals can enhance memory retention. Instead of cramming all the information in one study session, review the material shortly after learning it, then again after a day, a week, and so on. Spaced repetition takes advantage of the spacing effect, which suggests that information is better retained when learning is distributed over time.
- 8. Get enough sleep:** Sleep plays a crucial role in memory consolidation. During sleep, the brain strengthens neural connections and transfers information from short-term memory to long-term memory. Aim for 7-8 hours of quality sleep each night to support optimal memory function.
- 9. Stay organized:** A cluttered environment can increase cognitive load and make it difficult to remember important information. Keep your physical and digital spaces organized. Use calendars, planners, or productivity apps to schedule.

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