MODULE II
MEMORY AND FORGETTING

Memory: *Definition- Models of memory: The Atkinson & Shiffirin model - Types of memory: Working memory - Memory for factual information: episodic and semantic memory - Procedural memory.*

Forgetting: *Theories - interference theory-Retrieval inhibition theory-Methods to study memory: free recall and recognition-Sentence verification-Priming-Neuroimaging- Strategies to improve memory.*

Memory is defined as the ability to recall or remember information, events or skills learnt in the past. In psychology, memory is considered as a mental process which provides the basis for all cognitive processes, such as problem solving, logical thinking, imagination, and decision making.

Learning and memory are interrelated processes. The study of learning emphasizes the acquisition process while the study memory emphasizes the retention process. Retention means that the information learnt is stored and will be available on recall.

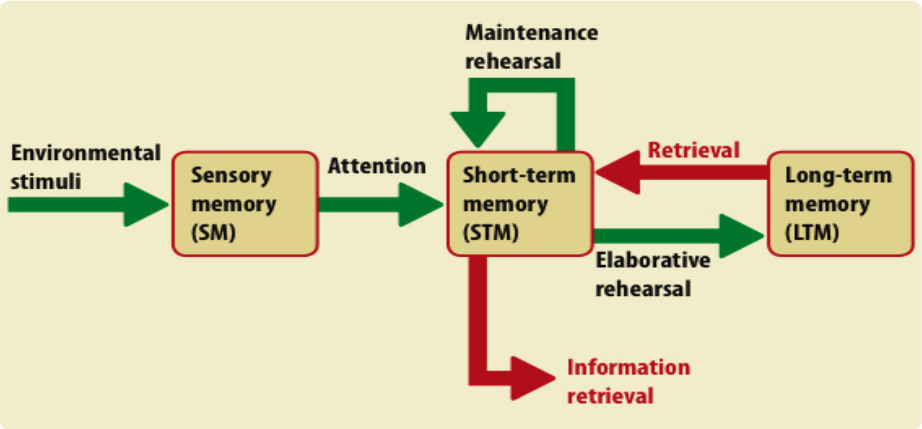
Memory consists of three separate but interrelated processes or components, i.e., encoding, storage and retrieval. *Encoding* is the first stage of memory. It is the process by which sensory information or the physical stimuli received from the environment are received and transformed into neural impulses that can be processed further or stored for later use. Encoding is also used to refer to rehearsing (practicing or repeating) the input, organizing it into groups and relating it to already stored information. *Storage* represents the second stage of memory. It refers to the retention of memorized material over a period of time. Some bits of information, which are used only once, are stored for a short period of time and then discarded. *Retrieval* is the process by which previously encoded, stored memories are brought back for current use.

The Atkinson and Shiffrin Model of Memory

According to Atkinson and Shiffrin model of memory, there are three separate components of the overall memory system, i.e., sensory memory, short-term memory (STM) and long term memory (LTM).

Atkinson and Shiffrin proposed that sensory input that reaches the receptors is stored in the sensory register or sensory memory for a brief time. If attention is paid to the input, it is transmitted to STM. The STM has a limited capacity and holds information for a brief period of time. When

information is displaced, it is forgotten. However, information can be held in STS through rehearsal. When information is rehearsed, it goes to LTM. Information in the LTM may be retained for days, months or a life time. The model is given as:

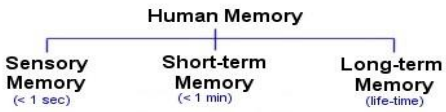


Atkinson and Shiffrin Model of Memory

There are two types of rehearsal people use, i.e., maintenance rehearsal and elaborative rehearsal. In order to maintain information in the working memory or STM, one keeps on repeating it silently. When look up a telephone number from the directory and remember it. But after making the call, we usually forget it. In elaborative rehearsal, you try to analyze the information to be remembered in terms of different association it arouses. You may also break it into chunks and reorganize.

Types of Memory

There are three different types of memory: sensory memory, short term memory and long term memory.



1. Sensory memory (Immediate Memory)

Sensory memory is the type or storage of memory that is first encountered by a stimulus. Sensory memory helps an individual to recall something a split second after having perceived it. In such type of memory, retentive time is extremely brief; ranging from a fraction to several seconds. Old sensory impressions disappear as they are erased by new information.

It is generally accepted that there are many sensory memories, as there are sensory receptors such as visual, auditory, tactile, olfactory and gustatory receptors. However, researchers have concentrated on visual (iconic) and auditory (echoic) memories.

Iconic Memory

The mental representations of visual stimuli are referred to as icons. The sensory register that holds icons is labeled iconic memory. Iconic memories are acute, 'photographic memories'. However, they are very brief. The ability to retain exact mental representations of visual stimuli over long periods is referred to as eidetic imagery.

Echoic Memory

Mental representations of sounds or auditory stimuli are called echoes. The sensory register that holds echoes is referred to as echoic memory.

2. Short Term Memory (Working Memory)

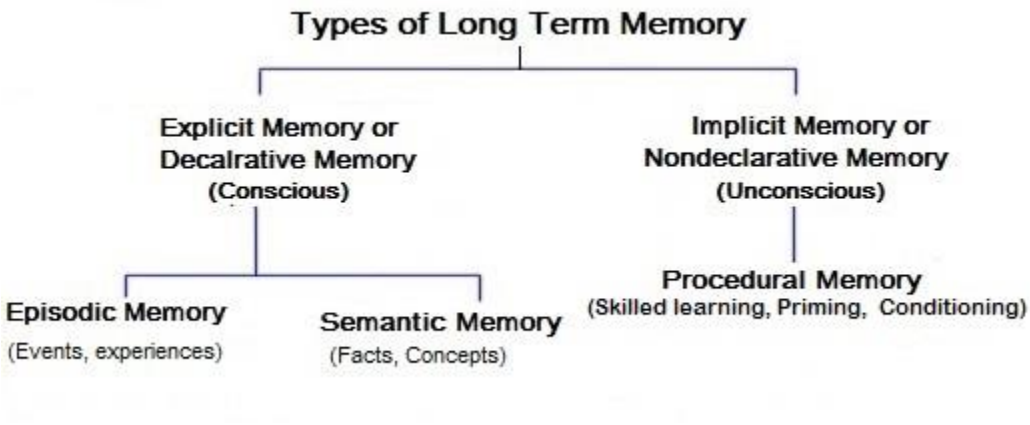
Short Term Memory (STM) is a limited capacity store that can maintain unrehearsed information for about 20 to 30 seconds. We can also maintain information in STM for longer than 30 seconds by engaging in rehearsal, the process of repetitively verbalizing or thinking about the information.

STM has limited capacity to retain or hold information for digits, letters, words, or names at a time. On the whole, it can hold seven units (chunks) of information, plus or minus two (7 ± 2). It means that the span of our STM can normally vary between 5 and 9 items. It was introduced by George Miller.

3. Long Term Memory (LTM)

In LTM, information is retained for very long period of time. Once, information is stored there, it may persist through out one's life. The storage capacity of LTM, is infinite and you can retrieve information whenever you desire.

Types of Long Term Memory



LTM can be classified into two broad categories:

1. Explicit memory or Declarative memory
2. Implicit memory or Procedural memory

Explicit or Declarative memory involves remembering specific factual information, such as names (e.g., George Washington is the first president of USA), faces, words, dates and ideas. Declarative memory can be further divided into two: *semantic* and *episodic* memory. *Semantic memory* records impersonal knowledge about the world. The names of objects, the days of the week, or months of the year, the seasons, words and language and other general facts are examples of semantic memory. Semantic memory serves as a mental dictionary or encyclopedia of basic knowledge. *Episodic memory* is an autobiographical record of personal experiences. It stores life events day after day, year after year. An accident you witnessed, your seventh birth day, the first day of college etc. are examples of episodic memories. In general, episodic memories are more easily forgotten than semantic memories. This is because new information constantly enters in episodic memory.

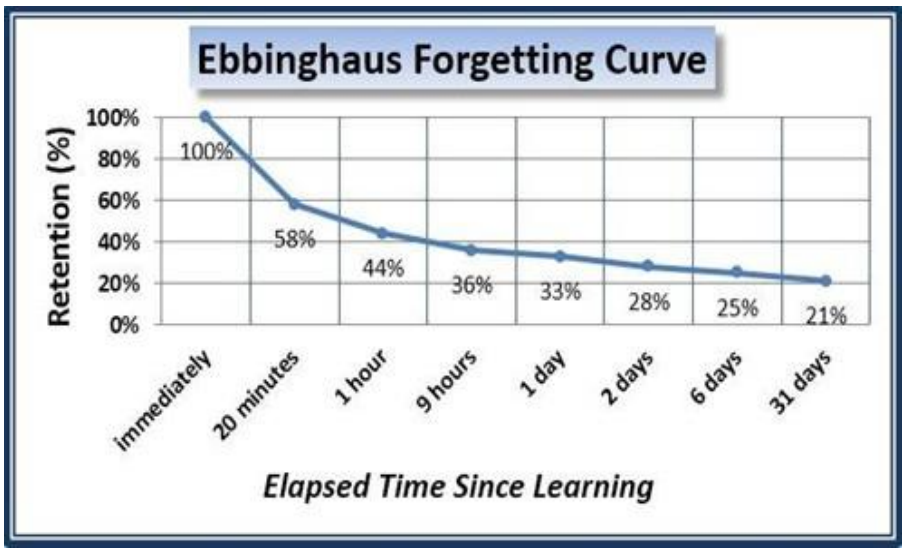
Procedural memory comes under implicit memory which includes basic conditioned responses, priming (being more likely to use a word you heard recently) and learned actions like typing, driving, solving a puzzle, riding a bicycle, writing, etc. These memories can be fully expressed only as actions. Procedural memories register in lower brain areas, especially the cerebellum.

FORGETTING

Forgetting is a failure to retain what has been acquired. In other words, forgetting is the permanent or temporary loss of the ability to recall or recognize something learned earlier.

Ebbinghaus' Curve of Forgetting

The forgetting curve is a graph that illustrates how we forget information over time. It was formulated in 1885 by Hermann Ebbinghaus, who conducted experiments on himself to understand how long the human mind retains information over time. Ebbinghaus discovered that we rapidly forget half of what we have learned in the first hour and that new material needs to be reviewed over time periodically to be stable in memory. He used himself as a test subject and started experimenting with his own capacity to recollect information. To solve this problem, he introduced nonsense syllables (A nonsense syllable is a three letter combination makes up of two consonants and a vowel. Example MEP, WIB). He studied multiples lists of these words and tested his recall of them at different time intervals varying from 20 minutes to a month to see how much he remembered. He plotted the data in a graph as shown below:



He found that about 42% of the materials he learned were forgotten in 20 minutes, 67% in one day and 72% in two days, and 79% in 31 days. Thus the forgetting was rapid at first and then slowed. The forgetting curve shows that humans tend to have their memory of newly learned knowledge in a matter of days or weeks unless they consciously review the learned material.

THEORIES OF FORGETTING

Some of the important theories of forgetting are the following:

1. Absence of adequate stimulation
2. Decay theory of passage of time
3. Interference theory
4. Obliteration of the memory trace
5. Repressive forgetting or motivated forgetting
6. Disuse theory
7. Retrieval failure theory

1. Absence of adequate stimulation

This theory states that memory may not be evident because stimuli appropriate for recall is not present. For example, something learned or experienced in childhood is recalled due to some stimulus like odor, name, etc. The theory also states that most of the recall is under the same conditions as those in which the original learning took place.

2. Decay Theory

According to this theory, forgetting takes place simply through the passage of time. With the passage of time, the normal metabolic process of the brain causes fading or decay of the memory, so that traces of material once learned gradually disintegrate and eventually disappear altogether. The theory also states that rehearsal prevents the decay process. Rehearsal is a means of keeping the material active in memory.

3. Interference Theory

According to this theory, an important cause of forgetting is the conflict among the different learning experiences to which a person is exposed. Learning in one instance interferes with recall of something learned in another instance.

There are two types of interference*: retroactive* and *proactive*. When a later experience (newer memories) interferes and disrupts recall of an earlier one, it is called retroactive interference (backward acting). When an earlier experience (older memories) interferes with recall of a later one, the condition is called proactive interference (forward acting). These two effects are also referred to as retroactive and proactive inhibition.

4. Obliteration of the memory trace

It is assumed that certain conditions can obliterate the memory trace. One of these is electro convulsive shock. Sometimes it is used in the treatment of mental patients. In this treatment, a weak electric current is passed through the brain by means of electrodes placed on the skull and patient experiences a mild convulsion followed by unconsciousness. Such patients usually forget the trip to the hospital and the preceding the shock. An emotional shock also seems to have an effect on retention. It can upset learning and recall.

5. Repressive forgetting or motivated forgetting

Motivated forgetting refers to the process of consciously or unconsciously blocking out negative, painful or threatening memories. The work of Sigmund Freud has revealed two types of motivated forgetting: repression and suppression. Repression is the unconscious process of excluding unwanted thoughts from awareness. Conscious attempts to avoid such thoughts or actions are referred to as suppression. Repressed thoughts are not accessible to the individual except through special techniques aiding recall, suppressed thoughts are accessible but are kept in the background.

6. Disuse theory

A new version of the decay theory known as disuse theory suggests that forgetting is not the mere passage of time, but rather the repeated retrieval of similar information that leads to memory loss. You forget your former phone number because you have learned and retrieved numerous other phone numbers since last using it. This is due to the fact that old information is less likely to impair your ability to retain new information.

7. Retrieval Failure theory

The retrieval failure theory refers to one's incapacity to utilise internal or external cues (words or images that are associated with a memory and can elicit it) to retrieve previously-stored information. For example, an exam question asks you the major structures of the central nervous system. If you cannot remember the retrieval cues such as forebrain is the subcategory under brain, you will have great difficulty remembering specific structures in the forebrain. This is often exemplified by the 'tip-of-the-tongue' phenomenon. It refers to the sensation where an individual believes that they know the answer, but is unable to retrieve it from their memory store.

The systematic study of memory was started more than hundred years ago by Ebbinghaus. The methods used for studying memory are:

1. Free recall and recognition
2. Sentence verification
3. Priming
4. Neuroimaging

01. Recall and Recognition

In recall method, an individual is required to repeat what was learned previously. For example, a list of words may be read to the subject after which the subject may be asked to recall as many words as possible from the list.

There are two ways in which recall can be measured. They are ***free recall*** and ***serial recall***. Free recall is used in many studies on memory for factual information (episodic memory). In free recall, the subject is presented with some items (usually words) and later asked to recall them in any order. The more they got right, the higher the performance. But in serial recall, the subject has to recall the words in the correct position or order. When compared to free recall, serial results in greater success except during the first two trials. However, for complete tasks, such as learning a list of 15 to 20 items, the subject is more successful when he learns the material serially.

The order in which information is memorized has an effect on recall. When a list of words is given to you for reading and you will have the most difficult recalling items from the middle of the list. The greatest number of errors found for middle items of an ordered list. This is the serial position effect. The last items on a list are remembered best because they are still in STM. The first items are also remembered because they entered in an empty STM where they could be rehearsed and moved to LTM. The middle items are neither held in STM nor moved to LTM, so they are often lost.

In recognition, research participants are shown stimuli they have seen before plus another distracter item and later asked to indicate which one are old items and which one are new. The more the old item participants identify correctly, the better their memory score. For example, subjects may be asked to learn a list of 12 words. After learning the list, subjects may be asked to pick out the words learnt earlier from amongst a list of 50 words.

02. Sentence verification

Sentence verification task is generally used to study semantic memory. Here participants are shown sentences and asked to indicate whether they are true or false. The faster people respond, the better their memory for information relevant to these sentences.

03. Priming

Priming can be used to study the implicit memory in which exposure to one stimulus influences a response to another stimulus. In this procedure, research participants are first exposed to stimuli (e.g., hotel, river). Then they are shown parts of these words (e.g. hot, riv) along with the parts of other words they have not seen, and asked to complete the words. Generally, the subjects complete words, they have seen quickly. So priming is the way of finding that memory, which holds information we can't readily describe.

04. Neuro imaging

These techniques involve forming images of people's brain as they work on various tasks. If the tasks are chosen carefully we can identify which parts of the brain are involved in these aspects of memory. One commonly used procedure is PET imaging. For PET (Positron Emission Tomography) scan, technicians inject harmless radioactive substances into brain. Because brain that are busy working, use more blood. This allows researchers to see which parts are involved in various mental tasks.

STRATEGIES TO IMPROVE MEMORY

The study and use of memory techniques is called mnemonics.

01. **Concentration:** One of the basic ways to improve memory is concentration.

02. **Structure and Organize information:** retention tends to be greater when information is well structured and organized. Try grouping similar concepts and terms together, or make an outline of your notes and textbook. Taking the time to organize material which you wish to remember can improve retrieval. For example, outlining the contents of a chapter in a text book can help to show how various concepts are related to each other.

03. **Engage in adequate rehearsal:** retention improves with increased rehearsal. Rehearsal helps to transfer information into long term memory. Review what you've learned the same day you learn it, and at intervals thereafter. This "spaced rehearsal" is more effective than cramming, especially for retaining what you've learned.

04. **Schedule distributed practice:** retention tends to be greater after distributed practice than after massed practice.

05. **Minimize interference:** memorizing one course can interfere with the retention of information for another course. Review of materials as close to exam time will help you to avoid memory loss due to interference.

06. **Engage in deep processing:** if you want to remember what you read, you have to wrestle fully with its meaning. If we spent less time on rote repetition and devoted more effort to analyzing the meaning of their reading assignments, memorizing will become easier.

07. **Enrich encoding with visual imagery:** memory can be enhanced by the use of visual imagery. It involves creating mental pictures of things which are not physically present. Visual images create a second memory code and that two codes are better than one of enhancing recall.

08. **Focus your attention on the materials you are studying:** Attention is one of the major components of memory. In order for information to move from short-term memory into long-term memory, you need to actively attend to this information. Try to study in a place free of distractions such as television, music, and other diversions.

09. **Relate new information to things you already know:** When you are studying unfamiliar material, take the time to think about how this information relates to things that you already know. By establishing relationships between new ideas and previously existing memories, you can dramatically increase the likelihood of recalling the recently learned information.

10. **Visualize concepts to improve memory and recall:** Many people benefit greatly from visualizing the information they study. Pay attention to the photographs, charts, and other graphics in your textbooks. If you do not have visual cues to help, try creating your own. Draw charts or figures in the margins of your notes or use highlighters or pens in different colors to group related ideas in your written study materials.

11. **Teach new concepts to another person:** Educators and psychologists have also discovered that having students actually *teach* new concepts to others enhances understanding and recall. You can use this approach in your own studies by teaching new concepts and information to a friend or study partner.

12. **Pay extra attention to difficult information:** When you come across an especially difficult concept, devote some extra time to memorizing the information.

13. **Involve as many senses as possible.** Try to relate information to colors, textures, smells, and tastes. The physical act of rewriting information can help imprint it onto your brain. Even if you're a visual learner, read out loud what you want to remember. If you can recite it rhythmically, even better.

14. **Use Mnemonic Devices :** Mnemonics are clues of any kind that help us remember something, usually by helping us associate the information we want to remember with a visual image, a sentence, or a word. Mnemonic devices such as ***acrostics, acronyms, chunking and narrative methods*** are helpful to improve memory.

    Acrostics are phrases (or poems) in which the first letter of each word (or line) functions as a cue to help you recall information to be remembered. For example, the sentence "Every good boy does fine" to memorize the lines of the treble clef, representing the notes E, G, B, D, and F. *Acronym* is a word formed out of the first letters of a series of words. Students memorizing the order of colors in the light spectrum often store the name "Roy G. Biv" to remember red, orange, yellow, green, blue, indigo, and violet. *Chunking* breaks a long list of numbers or other types of information into smaller, more manageable chunks. Remembering a 10-digit phone number by breaking it down into three sets of numbers: 555-867-5309 (as opposed to 5558675309).

    Narrative methods are used to remember a list of words by creating a story that includes the words in the appropriate order. Another verbal mnemonic that people often rely on rhymes.

15. **Stop Multitasking:** Multitasking is now shorthand for the human attempt to do simultaneously as many things as possible, as quickly as possible. Ultimately, multitasking may actually slow you down, make you prone to errors as well as make you forgetful.

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