MEMORY

MODULE 5

MEMORY

Memory can be defined as **the process by which we encode, store, and retrieve information.**

Human memory involves more than taking information in and storing it in some mental compartment. In fact, psychologists probing the workings of memory have had to grapple with three enduring questions:

(1) How does information get into memory?

(2) How is information maintained in memory? and

(3) How is information pulled back out of memory?

These three questions correspond to the three key processes involved in memory: **encoding (getting information in), storage (maintaining it), and retrieval (getting it out).**

Encoding involves forming a memory code, or **it is the process through which information is converted into a form that can be entered into memory**. For example, when we form a memory code for a word, we might emphasize how it looks, how it sounds, or what it means. Encoding usually requires attention.

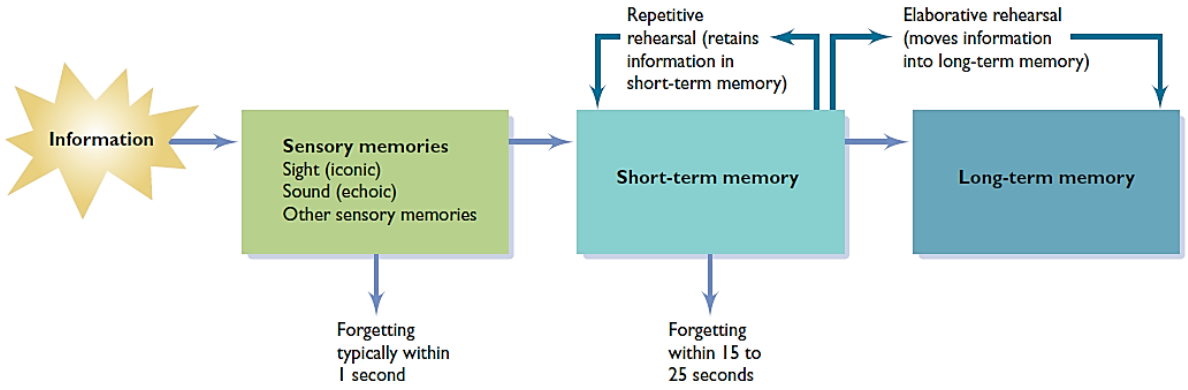
Storage involves maintaining encoded information in memory over time. Psychologists have focused much of their memory research on trying to identify just what factors help or hinder memory storage. But, as the tip-of-the-tongue phenomenon shows, information storage isn't enough to guarantee that we'll remember something. We need to be able to get information out of storage.

Retrieval involves recovering information from memory stores. In other words, **it is the process through which information stored in memory is located.** Research issues concerned with retrieval include the study of how people search memory and why some retrieval strategies are more effective than others.

5.1: THREE-SYSTEM APPROACH TO MEMORY

According to the **three-system approach to memory (**also called **information processing approach)** that dominated memory research for several decades, there are different memory storage systems or stages through which information must travel if it is to be remembered **(Atkinson & Shiffrin, 1968, 1971)**. Historically, the approach has been extremely influential in the development of our understanding of memory, and—although new theories have augmented it— it still provides a useful framework for understanding how information is recalled.

The three-system memory theory proposes the existence of the three separate memory stores. **Sensory memory** refers to the initial, momentary storage of information that lasts only an instant. Here an exact replica of the stimulus recorded by a person's sensory system is stored very briefly. In a second stage, **short-term memory** holds information for 15 to 25 seconds and stores it according to its meaning rather than as mere sensory stimulation. The third type of storage system is **long-term memory**. Information is stored in long-term memory on a relatively permanent basis, although it may be difficult to retrieve.



5.1.1: Sensory Memory

Sensory memory can be defined as a **memory system that retains representations of sensory input for brief periods of time. Sensory memory preserves information in its original sensory form for a brief time, usually only a fraction of a second.**

Actually, there are several types of sensory memories, each related to a different source of sensory information. For instance, **iconic memory** reflects information from the visual system. **Echoic memory** stores auditory information coming from the ears. In addition, there are corresponding memories for each of the other senses.

Sensory memory can store information for only a very short time. If information does not pass into short-term memory, it is lost for good. For instance, iconic memory seems to last less than a second, and echoic memory typically fades within two or three seconds. However, despite the brief duration of sensory memory, its precision is high: Sensory memory can store an almost exact replica of each stimulus to which it is exposed (Darwin, Turvey, & Crowder, 1972; Long & Beaton, 1982; Sams et al., 1993; Deouell, Parnes, & Pickard, 2006).

5.1.2: Short-term Memory

Short-term memory can be defined as a **memory system that holds limited amounts of information for relatively short periods of time, for about 10–20 seconds.**

Because the information that is stored briefly in sensory memory consists of representations of raw sensory stimuli, it is not meaningful to us. If we are to make sense of it and possibly retain it, the information must be transferred to the next stage of memory: short-term memory. Short-term memory is the memory store in which **information first has meaning, although the maximum length of retention there is relatively short** (Hamilton & Martin, 2007).

The specific amount of information that can be held in short-term memory has been identified as **seven items, or "chunks," of information, with variations up to plus or minus two chunks.** A chunk is a meaningful grouping of stimuli that can be stored as a unit in short-term memory. According to **George Miller** (1956), a chunk can be individual letters or numbers, permitting us to hold a seven-digit phone number (such as 226-4610) in short-term memory.

5.1.3: Working Memory

Working memory can be defined as **a set of active, temporary memory stores that actively manipulate and rehearse information.**

When STM is combined with other mental processes, it acts more like a sort of "mental scratchpad," or working memory, where we do much of our thinking. That is, working memory briefly holds the information we need when we are thinking and solving problems (Holmes & Adams, 2006).

Working memory is thought to contain a central executive processor that is involved in reasoning and decision making. The central executive coordinates three distinct storage-and-rehearsal systems: the **visual store**, the **verbal store**, and the **episodic buffer**. The visual store specializes in visual and spatial information, whereas the verbal store holds and manipulates material relating to speech, words, and numbers. The episodic buffer contains information that represents episodes or events. Working memory permits us to keep information in an active state briefly so that we can do something with the information.

5.1.4: Long-term Memory

Long-term memory can be defined as a **memory system for the retention of large amounts of information over long periods of time.**

Unlike sensory memory and short-term memory, which have very brief storage durations, LTM can store information indefinitely. In fact, one point of view is that all information stored in long-term memory is stored there permanently. According to this view, forgetting occurs only because people sometimes cannot retrieve needed information from LTM.

Long-term memory as having several different components, or memory modules . Each of these modules represents a separate memory system in the brain.

5.1.4.1: Declarative Memory

Memory for factual information: names, faces, dates, and the like.

Declarative memory is memory for factual information: names, faces, dates, and facts, such as "a bike has two wheels." Declarative memory is further subdivided into semantic memory and episodic memory.

- Semantic Memory

  Memory for general knowledge and facts about the world, as well as memory for the rules of logic that are used to deduce other facts.

  Semantic memory is memory for general knowledge and facts about the world, as well as memory for the rules of logic that are used to deduce other facts. Because of semantic memory, we remember that the ZIP code for Kollam is 691001, that Mumbai is on the Arabian Sea, and that memoree is the incorrect spelling of memory . Thus, semantic memory is somewhat like a mental almanac of facts (Nyberg & Tulving, 1996; Tulving, 2002).

- Episodic Memory

  Memory for events that occur in a particular time, place, or context.

  Episodic memory is memory for events that occur in a particular time, place, or context. For example, recall of learning to ride a bike, our first competition, or arranging a surprise birthday party for our brother is based on episodic memories. Episodic memories relate to particular contexts. For example**, remembering when and how we learned that 2 x 2 = 4 would be an episodic memory; the fact itself (that 2 x 2 = 4) is a semantic memory.**

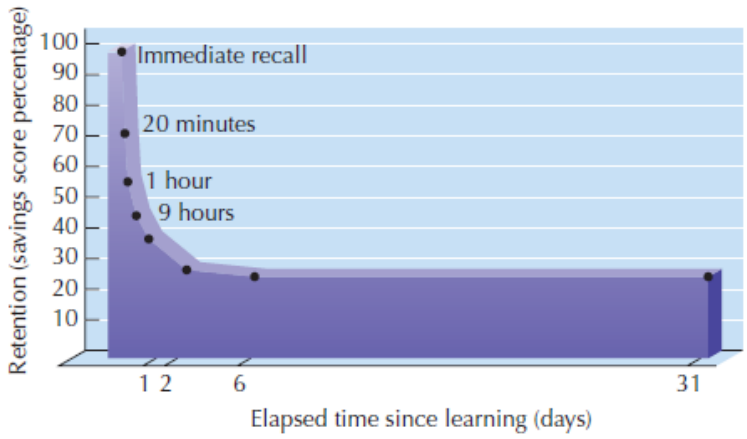
5.1.4.2: Procedural Memory

Memory for skills and habits, such as riding a bike or hitting a baseball; sometimes referred to as nondeclarative memory.

Procedural memory (or nondeclarative memory) refers to memory for skills and habits, such as how to ride a bike or hit a baseball. Information about things is stored in declarative memory; information about how to do things is stored in procedural memory (Feldhusen, 2006; Brown & Robertson, 2007; Bauer, 2008). Episodic memories can be surprisingly detailed.

5.2: FORGETTING

Most forgetting tends to occur immediately after memorization. **Herman Ebbinghaus** (1885) famously tested his own memory at various intervals after learning. To be sure he would not be swayed by prior learning, he memorized nonsense syllables. These are meaningless three-letter words such as CEF, WOL, and GEX. The importance of using meaningless words is shown by the fact that VEL, FAB, and DUZ are no longer used on memory tests. People who recognize these words as detergent names find them very easy to remember. This is another reminder that relating new information to what you already know can improve memory.



By waiting various lengths of time before testing himself, Ebbinghaus plotted a curve of forgetting. This graph shows the amount of information remembered after varying lengths of time. Notice that forgetting is rapid at first and is then followed by a slow decline (Hintzman, 2005).

5.2.1: Measures of Forgetting

To study forgetting empirically, psychologists need to be able to measure it precisely. Measures of forgetting inevitably measure retention as well. Retention refers to the proportion of material retained (remembered). In studies of forgetting, the results may be reported in terms of the amount forgotten or the amount retained. In these studies, the retention interval is the length of time between the presentation of materials to be remembered and the measurement of forgetting. The three principal methods used to measure forgetting are recall, recognition, and relearning (Lockhart, 1992).

5.2.1.1: Recall

A recall measure of retention requires persons to reproduce information on their own without any cues.

5.2.1.2: Recognition

A recognition measure of retention requires subjects to select previously learned information from an array of options.

Subjects not only have cues to work with, they have the answers right in front of them. In educational testing, essay questions and fill-in-the blanks questions are recall measures of retention. Multiple-choice, true-false, and matching questions are recognition measures.

5.2.1.3: Relearning

A relearning measure of retention requires a subject to memorize information a second time to determine how much time or how many practice trials are saved by having learned it before.

Subjects' savings scores provide an estimate of their retention. Relearning measures can detect retention that is overlooked by recognition tests (Crowder & Greene, 2000).

5.2.2: Causes of Forgetting

The possible causes of forgetting are

5.2.2.1: Ineffective Encoding

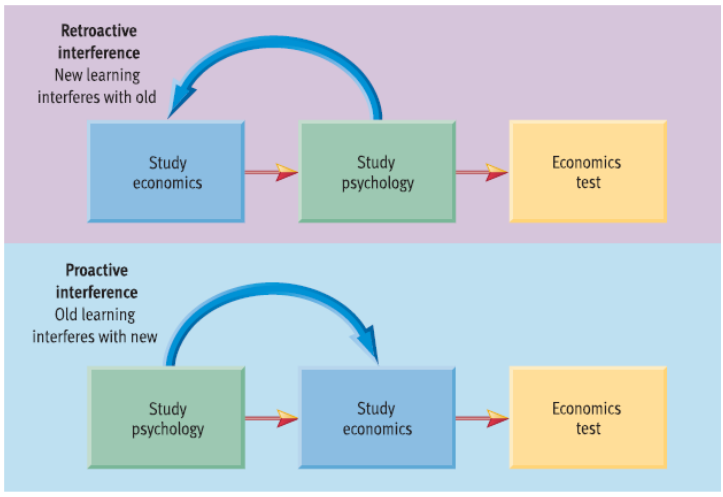
Even when memory codes are formed for new information, subsequent forgetting may be the result of ineffective or inappropriate encoding (Brown & Craik, 2000). The research on levels of processing shows that some approaches to encoding lead to more forgetting than others (Craik & Tulving, 1975).

5.2.2.2: Decay

Instead of focusing on encoding, decay theory attributes forgetting to the impermanence of memory storage. **Decay theory proposes that forgetting occurs because memory traces fade with time.** The implicit assumption is that decay occurs in the physiological mechanisms responsible for memories. According to decay theory, the mere passage of time produces forgetting. Evidence suggests that decay does contribute to the loss of information from the sensory and short-term memory stores.

5.2.2.3: Interference

Interference theory proposes that people forget information because of competition from other material.



Interference is assumed to be greatest when intervening material is most similar to the test material. Decreasing the similarity should reduce interference and cause less forgetting. There are two kinds of interference: **retroactive and proactive** (Jacoby, Hessels, & Bopp, 2001). **Retroactive**

interference occurs when new information impairs the retention of previously learned information. Retroactive interference occurs between the original learning and the retest on that learning, during the retention interval. In contrast, **proactive interference occurs when previously learned information interferes with the retention of new information.** Proactive interference is rooted in learning that comes before exposure to the test material.

5.2.2.4: Retrieval Failure

People often remember things that they were unable to recall at an earlier time. This phenomenon may be obvious only during struggles with the tip-of-the tongue phenomenon, but it happens frequently. In fact, a great deal of forgetting may be due to breakdowns in the process of retrieval.

5.2.2.5: Motivated Forgetting

Sigmund Freud (1901) came up with an entirely different explanation for retrieval failures. Freud asserted that people often keep embarrassing, unpleasant, or painful memories buried in their unconscious.

The tendency to forget things one doesn't want to think about is called motivated forgetting, or to use Freud's terminology, repression. In Freudian theory, **repression refers to keeping distressing thoughts and feelings buried in the unconscious.**

5.3: MEMORY DYSFUNCTIONS

5.3.1: Alzheimer's Disease

These memory problems are symptomatic of Alzheimer's disease, an illness characterized in part by severe memory problems.

In the beginning, Alzheimer's symptoms appear as simple forgetfulness of things such as appointments and birthdays. As the disease progresses, memory loss becomes more profound, and even the simplest tasks—such as using a telephone—are forgotten. Ultimately, victims may lose their ability to speak or comprehend language, and physical deterioration sets in, leading to death.

The causes of Alzheimer's disease are not fully understood. Increasing evidence suggests that Alzheimer's results from an inherited susceptibility to a defect in the production of the protein beta amyloid, which is necessary for the maintenance of nerve cell connections. When the synthesis of beta amyloid goes awry, large clumps of cells form, triggering infl ammation and the deterioration of nerve cells in the brain (Selkoe, 2002; Detoledo-Morrell, Stoub, & Wang, 2007; Horínek, Varjassyová, & Hort, 2007; Selkoe, 2008)

5.3.2: Amnesia

Amnesia is characterized by **memory loss that occurs without other mental difficulties.**

Mainly, there are two types of amnesia, retrograde and anterograde amnesia.

5.3.2.1: Retrograde Amnesia

Amnesia in which memory is lost for occurrences prior to a certain event.

In retrograde amnesia, memory is lost for occurrences prior to a certain event. Usually, lost memories gradually reappear, although full restoration may take as long as several years. In certain cases, some memories are lost forever. But even in cases of severe memory loss, the loss is generally selective.

5.3.2.2: Anterograde Amnesia

Amnesia in which memory is lost for events that follow an injury.

In anterograde amnesia loss of memory occurs for events that follow an injury. Information cannot be transferred from short-term to long-term memory, resulting in the inability to remember anything other than what was in long-term storage before the accident (Gilboa, Winocur, & Rosenbaum, 2006).

5.4: THE PHYSIOLOGY OF MEMORY

The search for the **engram**, the term for the physical memory trace that corresponds to a memory, has proved to be a major puzzle to psychologists and other neuroscientists interested in memory. Using advanced brain scanning procedures in their efforts to determine the neuroscientific basis of memory formation, investigators have learned that certain areas and structures of the brain specialize in different types of memory related activities.

The **hippocampus,** a part of the brain's limbic system, plays a central role in the consolidation of memories. Located within the brain's medial temporal lobes just behind the eyes, the hippocampus aids in the initial encoding of information, acting as a kind of neurological e-mail system. That information is subsequently passed along to the **cerebral cortex** of the brain, where it is actually stored (Govindarajan, Kelleher, & Tonegawa, 2006; J. Peters et al., 2007; Lavenex & Lavenex, 2009).

The **amygdala,** another part of the limbic system, also plays an important role in memory. The amygdala is especially involved with memories involving emotion. For example, if we are frightened by a large Doberman, we are likely to remember the event vividly—an outcome related to the functioning of the amygdala. Encountering the Doberman or any large dog in the future is likely to reactivate the amygdala and bring back the unpleasant memory (Hamann, 2001; Buchanan & Adolphs, 2004; Talmi et al., 2008).

Evidence on long-term potentiation also supports the idea that memory traces consist of specifi c neural circuits. **Long-term potentiation (LTP) is a long-lasting increase in neural excitability at synapses along a specific neural pathway**.

5.5: REFERENCES

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