Lecture Notes

# Chapter 5: Working Memory: Forming and Using New Memory Traces

## Learning Objectives

* Recognize how memory enters into almost every cognitive activity
* Differentiate between sensory memory and short-term memory
* Describe working memory and its components
* Contrast short-term memory and working memory
* Summarize findings from neurological studies regarding memory processes

## Outline

**I.** Setting the Stage

**A. Retrieval** is the process of calling to mind previously stored information, such as your 13th birthday party or the 9/11 attacks.

**1.** Memory enters into almost every cognitive activity.

**2.** Memory is also deeply connected to perception and attention.

**B.** To be remembered, information passes through a series of memory processes.

**1. Encoding** occurs when information is first translated into a form that other cognitive processes can use.

**2.** This form of information is called a **memory trace.**

**3.** The memory trace is held in **storage** for later retrieval.

**4.** When we cannot retrieve information, we say that **forgetting** has occurred.

**II.** Traditional Approaches to the Study of Memory

**A.** The **model of memory** assumes that information is received, processed, and stored differently for each kind of memory.

**1.** Unattended information is stored very briefly in **sensory memory.**

**2.** Attended information is held in **short-term memory (STM)** for periods of up to 20 or 30 seconds.

**3.** Information needed for longer periods of time is transferred to **long-term memory (LTM)**.

**B.** Many empirical findings support the idea of different memory systems.

**1.** The **serial position effect** is thought to be due to the operating of different memory systems.

**a)** Better recall of words at the beginning of a list (**primacy effect**) is thought to be due to greater amounts of **rehearsal** given to those words, leading them to be more likely to enter long-term memory.

**b)** Improved recall of items at the end of a list (**recency effect**) is thought to result from the use of sensory memory or short-term memory.

**2.** We believe that these memory systems are distinct because we can manipulate the testing conditions to affect one type of memory and not the other.

**a)** Presenting a list of words rapidly, to prevent adequate rehearsal, eliminates the primacy effect but not the recency effect.

**b)** Preventing the participant from reporting words right away eliminates the recency effect but not the primacy effect.

**C.** Sensory memory is closely connected to what we call perception.

**1.** Iconic memory is a rapidly fading visual image of a stimulus.

**2.** Sperling’s studies established the existence of iconic memory.

**a)** He first asked people to look at a display of 12 letters for only 50 milliseconds; people could typically report only four or five of the letters.

**b)** He then used a *partial report technique* to improve performance; he presented an auditory signal immediately after the display, telling participants to report either the top, middle, or bottom row only.

**c)** Performance improved to about 75% with the partial report technique, indicating that people could make use of a mental image of the display (an **icon)** to focus in on the correct row before the memory faded.

**d)** Delaying the tone for only 1 second, however, resulted in performance that declined back to the level of the *whole report technique.*

**e)** Later research demonstrated that the icon holds information that has not yet been categorized, and that it can be erased (*masked*) by other stimuli presented immediately after the icon.

**3.** The auditory equivalent of the visual icon is the **echo.**

**a)** Echoic memory has been studied through a “four-eared” variation of the dichotic listening task.

**b)** A partial report technique was created through using visual cues to report information from one location only.

**c)** Like icons, echos have a large capacity for information but last only a short while (although probably longer than icons and perhaps as long as 20 seconds).

**d)** As with icons, echos can be masked through presentation of another auditory stimulus—a phenomenon called the “suffix effect.”

**4.** In general, sensory memories share a number of properties.

**a)** First, sensory memories are *modality specific;* the visual sensory memory contains only visual information, and the auditory sensory memory contains only auditory information, and so forth.

**b)** Second, sensory memory capacities are relatively large.

**c)** Third, the information that can be stored appears to be relatively unprocessed, limited to physical aspects of a stimulus rather than meaning.

**D.** Short-term memory is used when you need to hold information temporarily—for example, when you need to remember a phone number long enough to dial it.

**1.** George Miller demonstrated that the **capacity** of short-term memory is about seven items, plus or minus two.

**2.** The only way to overcome this capacity limitation is by **chunking** items into larger meaningful units—for example, by combining the letters “F,” “B,” and “I” (three units) into the acronym “FBI” (one unit).

**3.** Classic research suggests that material in short-term memory is **coded** acoustically, by sound; thus, people are more likely to make short-term memory errors confusing two items that sound alike (“P” and “G”) as opposed to two items that look alike (“O” and “Q”).

**4.** Research using the Brown-Peterson task has shown that, if not rehearsed, information is lost from STM in as little as 20 seconds; this length of time is referred to as the **retention duration** of STM.

**a)** In the task, participants are presented with three letters to hold in memory—for example, BKG.

**b)** They are then given a number, such as 347, and asked to count backward by threes, out loud, from that number; this prevents them from rehearsing BKG.

**c)** If asked to count backward for 3 seconds, about 80% of participants can still remember BKG.

**d)** However, if asked to count backward for 18 seconds, the percentage drops to 7%.

**e)** Without rehearsal, then, the memory trace **decays** within about 20 seconds.

**5.** Other researchers suggest that it is not decay that causes information to be lost from STM, but **interference** from new information that displaces items in STM.

**6.** When information is retrieved from STM, research suggests that the information in STM is searched in a **serial, exhaustive** manner.

**a)** Sternberg asked participants to remember a memory set of letters.

**b)** A single probe letter was then presented, and participants had to indicate whether the probe was in the memory set or not.

**c)** The size of the memory set did affect the time it took to answer, indicating a serial search (going through the memory set one item at a time).

**d)** However, participants took the same amount of time to reach a “yes” or a “no” decision, indicating that the search, once started, was exhaustive.

**7.** The nature of the information in STM, however, can affect the capacity and processing of the information.

**III.** Working Memory

**A.** Baddeley and Hitch’s studies cast doubt on the traditional concept of STM.

**1.** They asked participants to hold a series of digits in STM while also verifying the truth of sentences seen on a computer screen.

**2.** Holding one or two digits in memory did not disrupt processing of the sentence.

**3.** Even a full load of six digits in memory slowed down processing of sentences, particularly difficult ones, but participants were still able to complete the task.

**4.** Because of these results, Baddeley and Hitch argued for the existence of **working memory,** a limited capacity temporary storage system that underpins complex human thought.

**B.** Working memory is conceived as being made up of multiple components.

**1.** The **central executive** directs the flow of information, choosing what to operate on and how.

**2.** The **phonological loop** carries out rehearsal of verbal material.

**3.** The **visuospatial sketch pad** maintains visual material through visualization.

**4.** The **episodic buffer** is a temporary system that integrates information from different sources.

**C.** Working memory doesn’t just store information; it is a process that makes information available to other cognitive processes such as reasoning.

**D.** An interesting application of the working memory concept is the idea of stimulus-independent thoughts (SITs), such as daydreams.

**1.** Both auditory and visuospatial tasks can disrupt the production of SITs.

**2.** However, practiced tasks produce less interference with SITs than novel or challenging tasks.

**3.** People’s minds tend to wander naturally; it requires control from the central executive to maintain focus on a goal.

**IV.** Executive Functioning

**A.** In general, research shows that higher working memory capacity indicates that a person is better able to control his or her cognitive focus.

**1.** Antisaccade tasks require participants to resist temptation to have their attention drawn to a misleading cue; people with lower working memory capacities have more trouble with this task than people with higher WM capacity.

**2.** People with higher WM capacity have also shown higher ability to reason from premises, to make consistent decisions, to overcome effects of misleading information in an eyewitness task, and to solve problems.

**B.** In summary, there are several key differences between the conceptualizations of short-term memory and working memory.

**1.** STM can be thought of as information that is actively being processed.

**2.** WM includes these active memory traces as well as attentional processes used to maintain them.

**3.** WM has several components and is involved in a variety of forms of cognitive processing.

**V.** Neurological Studies of Memory Processes

**A.** Memories are not “stored” in one particular place in the brain.

**1.** The case study of H.M., who lost his ability to transfer new episodic memories into long-term memory after surgery, indicated the importance of the rhinal cortex in forming memories.

**2.** Findings from other brain-damaged people have implicated areas in the frontal lobe as being important for working memory.

**3.** PET scan studies show different patterns of activation for verbal working memory (primarily in the left frontal and left parietal lobes) versus spatial working memory (right parietal, temporal, and frontal lobes).

**B.** The *Hebb rule* states that if a synapse between two neurons is repeatedly activated at about the same time the postsynaptic nerve fires, the structure or chemistry of the synapse changes.

**C.** A more general mechanism, **long-term potentiation,** allows for hippocampal cells to become more sensitive to stimuli after repeated and intense electrical stimulation.

**D.** Disrupting the process of long-term potentiation (for example, through drugs) also disrupts learning and remembering.