

YOU KNOW YOU HAVE MASTERED THE MAIN TOPICS IN THIS CHAPTER IF YOU ARE ABLE TO . . .

- ∞ Introduce the study of memory including the basic processes of encoding, storage, and retrieval as well as current theories of how memory works.
- ∞ Discuss the information-processing theory of memory in detail including the concepts of sensory, short-term, and long-term memory.
- ∞ Identify the basic mechanisms and limitations in the retrieval of information including false memories.
- ∞ Describe Ebbinghaus's work on forgetting and proposed explanations for forgetting.
- ∞ Explain the biological processes thought to underlie memory and the deterioration of memory.

RAPID REVIEW

Memory can be thought of as an active system that receives information from the senses, organizes and alters it as it stores it, and then retrieves information from storage. All the current models of memory involve the three processes of **encoding, storage, and retrieval**.

Three models or theories about memory are discussed in the text. One is the **levels-of-processing model**, which proposes that how long a memory will be remembered depends on the depth to which it was processed. A second model is the **parallel distributed processing model**, which proposes that memories are created and stored across a network of neural circuits simultaneously, or in other words, in a parallel fashion. The third and currently most accepted model of memory is the **information-processing model**, which proposes that memory is divided into three components – **sensory, short term, and long term**. Sensory memory is the first stage of memory and involves information from our sensory systems. Visual sensory memory is called **iconic memory** and was studied extensively by **George Sperling** through the use of the partial report method. The capacity of iconic memory is everything that can be seen at one time and the duration is around half a second. **Eidetic imagery**, also known as photographic memory, is the ability to access visual sensory memory over a long period of time. Iconic memory is useful for allowing the visual system to view the surroundings as continuous and stable. **Echoic memory** is the memory of auditory information and has the capacity of what can be heard at any one moment and has a duration of about two seconds.

The information-processing model proposes that information moves from sensory memory to short-term memory through the process of **selective attention**. This process explains the phenomenon of the **cocktail party effect**, when you are at a party and hear your name in a conversation across the room. Another name for short-term memory is **working memory**, and some researchers propose that short-term memory consists of a central control process along with a visual “sketch pad” and auditory “recorder.” **George Miller** studied the capacity of short-term memory using the digit-span memory test and discovered that people can store an average of seven chunks of information (plus or minus two) in their short-term memory. **Chunking** is the process of reorganizing the information into meaningful units. The duration of short-term memory is between 10-30 seconds without rehearsal. **Maintenance rehearsal** describes the process of continuing to pay attention to a piece of information, such as reciting a name over and over again in your head.

Long-term memory is the third stage of memory proposed by the information-processing theory and has an essentially unlimited capacity and duration. Information may be encoded into long-term memory through **elaborative rehearsal**, a way of transferring information by making it meaningful. Long-term memories can be divided into two types, procedural and declarative. **Procedural, or nondeclarative, memories** are memories for skill and habits, in other words, memories for things people can *do*. **Declarative memories** are memories of facts, or things people can *know*. There are two types of declarative memories, semantic and episodic. **Semantic memory** is memory for the meanings of words and concepts while **episodic memory** is the memory of events or “episodes.” Procedural memories appear to be stored in the cerebellum and amygdala, while declarative memories most likely involve the

frontal and temporal lobes. Procedural memory is sometimes referred to as **implicit memory**, and declarative memory can be thought of as **explicit memory**. Explicit memories are easily verbalized, while implicit memories are nearly impossible to state in words. It is not entirely clear how the brain organizes information in long-term memory. The **semantic network model** suggests that information is stored in the brain in a connected fashion with related concepts physically close to each other.

Retrieval describes the process of pulling memories out of long-term memory. A **retrieval cue** is a stimulus that aids in the process of remembering. When the environment in which you learned an item serves as a retrieval cue, it is referred to as **encoding specificity**. If an emotional state serves as a retrieval cue, it is called **state-dependent learning**. Information can be retrieved through the process of **recall**, such as filling in the blanks, or **recognition**, such as multiple choice questions in which the correct answer only needs to be “recognized.” Not all information can be recalled equally well. The **serial position effect** describes the finding that information at the beginning and end of a list is more likely to be remembered than the information in the middle. The **primacy effect** proposes that the information at the beginning of the list is remembered due to rehearsal, while the **recency effect** proposes that the information at the end of the list is remembered due to the fact that it is still in short-term memory. Recognition is usually a much easier task than recall since the retrieval cue is the actual piece of information you are trying to remember, yet retrieval errors are still made when using recognition. A **false positive** occurs when someone recognizes a piece of information as a memory even though it did not happen. For example, a witness says they saw broken glass at the scene of an accident, when there was no glass broken in the accident. **Elizabeth Loftus** has spent over 30 years investigating the reliability of eyewitness memories and has found that what people see and hear about an event after the fact can affect the accuracy of their memories for that event. **Automatic encoding** is a term used to describe the memory process when we aren’t actively paying attention to the information. A **flashbulb memory** is a specific type of automatic encoding that occurs when an unexpected and often emotional event occurs. Flashbulb memories typically contain a great deal of information including many details but might not be as accurate as they appear.

The retrieval of memories is a much more **constructive process** than most people assume. Several factors affect the accuracy of information retrieval. One factor is the **misinformation effect** in which false information presented after an event influences the memory of that event. When suggestions from others create inaccurate or false memories, this is referred to as the **false memory syndrome**. The false memory syndrome has frequently been observed while people are under hypnosis. Research by Loftus has suggested that in order for an individual to interpret a false event as a true memory, the event must seem plausible and the individual should be given information that supports the belief that the event could have happened to them personally. **Hindsight bias** is the tendency of people to falsely believe that they would have been able to accurately predict a result.

Herman Ebbinghaus was one of the first scientists to systematically study the process of forgetting. Using lists of **nonsense syllables**, he discovered that most forgetting occurs in the initial hour after the material is learned. He presented his findings in a visual graph called the **curve of forgetting**. There are at least four different causes for forgetting. **Encoding failure** occurs when the information does not make it past the initial encoding process and never really becomes a memory. Another possible cause of forgetting is the **decay** (or **disuse**) of the **memory trace** in short-term memory or the disuse of the information in long-term memory. The final two causes of forgetting discussed in the textbook have to do with interference. **Proactive interference** occurs when information from the past disrupts newly learned information. **Retroactive interference** occurs when the newly learned information interferes with the memories of the information from the past. Ebbinghaus found he could greatly improve memory if he spaced out his study sessions, a technique called **distributed practice**, as opposed to “cramming” or trying to learn all the information the night before the exam.

It is still unclear exactly how memories are physically stored in the brain. The concept of the physical change that takes place in the brain when memories are formed is called the **engram**, and scientists continue their search for the engram. In general, there is strong evidence to suggest that long-term procedural memories are stored in the cerebellum, while long-term declarative memories are stored in the frontal and temporal lobes. Storage of short-term memories has been associated with the prefrontal cortex

and the temporal lobe. The process of physically storing a memory in your brain is called **consolidation** and could consist of a number of changes including an increase in receptor sites, increased sensitivity at the synapse, changes on the dendrites, or changes in proteins in the neuron. The hippocampus has been found to play an important role in the formation of new memories. This fact was mainly discovered by observing patients with damage to the hippocampus and noting their inability to form any new memories. A man named **H.M.** is the most famous of these patients. H.M.'s hippocampi were removed during a surgical procedure to reduce the severity of his epileptic seizures. After the surgery, H.M. could not form any new declarative memories. H.M. could, however, still form new procedural memories. **Amnesia** is a disorder which is characterized by severe memory loss, such as that of H.M.'s and can take one of two forms. **Retrograde amnesia** is an inability to retrieve memories from the past, while **anterograde amnesia** is an inability to form any new memories. An inability to remember events from the first few years of life has been described as **infantile amnesia** and may be due to the implicit, or nonverbal, nature of those memories.

Alzheimer's disease is one type of dementia that is associated with severe memory loss. Currently there is no cure for Alzheimer's disease but researchers are working hard to find one. Several possibilities include drugs that block the breakdown of acetylcholine, chemicals within the ginkgo biloba herb, drugs that stimulate nerve growth, and statins or drugs that lower cholesterol.