

# CHAPTER 6

## MEMORY

### CHAPTER OUTLINE

Memory retains the things that organisms learn. Like perception, memory is selective—some things are retained, others are not.

#### I. THE NATURE OF MEMORY

*How does information turn into memories?*

##### A. Basic Memory Processes

1. In **encoding**, information gets represented by a code that a memory system uses.
  - a) **Acoustic codes** represent information as sequences of sounds, **visual codes** represent stimuli as pictures, and **semantic codes** represent experiences by their general meanings.  
*Example:* If you read the word *pen*, an acoustic code would represent the word with its spoken sound (rhymes with *hen*), a visual code would represent the word with a visual image (a long, thin object with a point on one end), and a semantic code would represent the basic concept of a pen (a writing instrument that uses ink).
2. **Storage** is holding of information in memory over time.
3. **Retrieval** is finding information in memory and bringing it to conscious awareness.
  - a) *Recall* is to retrieve information from memory without clues or aids. Essay questions require recall.
  - b) *Recognition* is when information retrieval is aided by clues. Multiple-choice questions require recognition.

##### B. Types of Memory

1. Research suggests that there are at least three different kinds of memory.
  - a) **Episodic memory** is memory of a specific event at which you were present.  
*Example:* Your memories of experiencing your family's summer vacation in Oregon would be episodic memory.
  - b) **Semantic memory** is memory of the generalized knowledge of the world, not necessarily tied to memory of a specific event.  
*Example:* Remembering that the capital of Oregon is Salem uses semantic memory.
  - c) **Procedural memory** contains memory for how to perform certain actions. Procedural memory is usually not easily put into words.  
*Example:* Remembering how to tie your shoes or ride a bicycle uses procedural memory.
2. Many activities require all three types of memory.  
*Example:* Playing tennis uses semantic memory of the rules, procedural memory of holding the racquet and swinging, and episodic memory of your recent matches and how you performed.
  - a) Deliberate attempts to remember rely on **explicit memory**.
  - b) Recent research has also studied **implicit memory**, the unintentional recollection and influence of prior experiences. Implicit memory occurs automatically, often without awareness or explicit memory. *Priming* or unconscious improvement of performance is due to implicit memory.  
*Example:* Suppose you study a list of words (e.g., *napkin, coughing, basket*). Later, you may be better at unscrambling anagrams of those words (e.g., *aninkp, ggonicuh, ebtkas*). This implicit memory may occur even if you had no explicit

## CHAPTER 6 MEMORY CHAPTER OUTLINE

memory for the words (e.g., you may be unable to state which words were in the study list and which were not).

### C. Models of Memory

1. The **levels-of-processing** model argues that memory formation depends on how extensively information is encoded or processed.
  - a) **maintenance rehearsal**, simply repeating information over and over without necessarily thinking *about* the information, is not very effective in forming lasting memories.
  - b) **Elaborative rehearsal** involves thinking about how new material relates to already known information. This requires thinking about semantic codes, which more effectively commits the information to memory. Memory is influenced more by internal factors, such as what you think about, than external factors, such as how information is presented.
2. The **transfer-appropriate processing** view suggests that memory retrieval works best when it occurs in a manner similar to how information had been encoded. By this view, memory is best when the encoding method “transfers” well to the retrieval setting.  
*Example:* If a student is told that an upcoming test will be a multiple-choice test, then she may use particular encoding strategies that would help memory retrieval when later asked to answer multiple-choice questions. The same encoding strategies, however, might not help memory retrieval if she were later asked to write an essay.
3. According to **parallel distributed processing (PDP) models** of memory, experiences do not just affect one bit of knowledge. Rather, experiences cause diverse and general changes throughout your knowledge base.  
*Example:* Suppose you have just been introduced to digital video discs (DVDs). As you learn about DVDs, you modify associations between this and other related bits of knowledge—where DVDs are bought, how much they cost, who has a DVD player you can use, comparisons of DVDs to VCR tapes, and so on. Your memory thus stores data about DVDs through updated associations with many bits of related knowledge.
4. The **information-processing model** of memory suggests that information goes through stages of mental processing, being manipulated and transformed in specific ways unique to each stage.
  - a) In *sensory memory*, information from the senses is held very briefly, for a second or less. *Perception* takes place if information in the sensory registers is attended to, analyzed, and encoded as a meaningful pattern.
  - b) If the information is perceived, information can enter *short-term memory (STM)* storage for about eighteen seconds.
  - c) If further processed, information may enter *long-term memory (LTM)* storage, where it may remain indefinitely.
  - d) This approach emphasizes interactions between these kinds of memory. Sensory memory may merely be that part of your knowledge base (i.e., LTM) that is momentarily activated by sensory inputs, and STM may be the part of your knowledge base that is the current focus of attention.

# CHAPTER 6

## MEMORY

### CHAPTER OUTLINE

#### II. STORING NEW MEMORIES

*What am I most likely to remember?*

##### A. Sensory Memory

**Sensory memory** holds information only long enough for it to be processed and for stimulus identification to occur. Each sense has its own **sensory register** or temporary storage place. **Selective attention**, the focusing of mental resources on only part of the stimulus field, helps control which information within sensory memory will be processed further.

##### B. Short-Term Memory and Working Memory

**Short-term memory (STM)** stores limited amounts of information for about 18 seconds. **Working memory** is the system that allows the manipulation and consideration of the information being held in STM. Working memory has at least two components: *maintenance* or holding information in STM and *manipulation* or working on that information

1. *Encoding in STM:* STM **encoding** often uses acoustic codes, even if inputs are not originally auditory. *Example:* Suppose you see and try to store a list of letters, like *S, O, T, W, L*, using STM. In remembering the items, you may wrongly recall *B* instead of *T*. This error suggests that you encoded letters based on the sound of the letters' names. Visual, semantic, and kinesthetic (physical movement) codes can also be used for information.
2. *Storage Capacity of STM:* **Immediate memory span** is the maximum number of items you can recall perfectly after one presentation. The limit seems to be seven plus or minus two items. This "magic number" refers to the number of *meaningful* groupings of information, or **chunks**.
3. *The Power of Chunking:* Learning to group items into bigger chunks of information can noticeably improve STM. Effective chunking uses what one already knows (LTM) to organize incoming STM information and provide the meaningfulness to construct chunks.
4. *Duration of STM:* Items stored in STM will remain for about eighteen seconds. Information in STM stores persists longer only as long as you keep mentally repeating the information. To prevent rehearsal from artificially prolonging STM memory in experiments, a **Brown-Peterson procedure** may be used: Subjects perform an arithmetic distractor task (e.g., count aloud from 100 going backward by threes) until a signal is given. The counting makes it difficult to rehearse.

##### C. Long-Term Memory

**Long-Term Memory (LTM)** is the memory system whose encoding and storage capabilities can produce memories that last a lifetime.

1. *Encoding in LTM:* Though some information is automatically encoded into LTM, most information is processed in the form of *semantic codes*, general, underlying meanings.
2. *Storage Capacity of LTM:* The potential capacity of LTM storage is very large and may actually be unlimited. Long-term memories, however, may be distorted—as was the case when students were asked where they were when they heard the O.J. Simpson verdict at 3 days, 15 months, and 32 months afterwards. More than 70 percent of their memories were distorted.

# CHAPTER 6

## MEMORY

### CHAPTER OUTLINE

- D. Distinguishing between Short-Term and Long-Term Memory
1. Some argue that STM and LTM are qualitatively different memory systems that should respond differently to the same manipulations. Experiments on recall support a distinction between STM and LTM.
    - a) Recalling an item from a list depends on its serial position in the list. A *serial-position curve* plots the chances of recalling an item in each position in the list.
      - (1) The **primacy effect** is the greater tendency to recall items from the beginning of a list.
      - (2) The **recency effect** is the greater tendency to recall items at the end of a list.
      - (3) Note: Using a distractor task for about 30 seconds before recalling items from the list eliminates the recency effect, but not the primacy effect. Since this distractor task erases only STM stores, the results support a distinction between STM and LTM—STM underlies the recency effect and LTM underlies the primacy effect.

### III. RETRIEVING MEMORIES

*How do I retrieve stored memories?*

- A. Retrieval Cues and Encoding Specificity
1. **Retrieval cues** are stimuli that help people retrieve information from LTM. Recognition is usually easier than free recall due to the additional retrieval cues.
  2. According to the **encoding specificity principle**, since long-term memories are encoded by their meanings, retrieval cues work best when they trigger the meaning of the stored information. *Example:* To recall the sentence “The man lifted the piano,” “something heavy” will be a good hint. By contrast, to recall the sentence “The man tuned the piano,” “something musical” will be a good hint. Cues work best when they are semantically related to the basic meaning used to encode the sentence.
- B. Context and State Dependence
1. In **context-dependent** memory, people remember more when they return to the same environment in which they learned information. This occurs because people tend to encode environmental features along with the learned information; these environmental features act as retrieval cues. *Example:* A witness to a hit-and-run accident may be taken back to the site of the accident to help him remember features about the runaway vehicle.
  2. Similarly, how you are feeling may be encoded during learning, so these similar states can act as retrieval cues in **state-dependent** memory. *Example:* Information encoded in a caffeine-induced state is best retrieved later in the same state.
  3. The *mood congruency effect* suggests that your emotional state facilitates processing and encoding of information that is similar in tone to that state. *Example:* If you are happy, you may pay more attention to happy incidents and encode them more effectively.
- C. Retrieval from Semantic Memory
1. *Semantic Networks:* Concepts may be represented in a *semantic memory network*—a dense network of associations between bits of information related to the concept.
    - a) Thinking of a concept activates its corresponding network, causing **spreading activation** (a sort of neural energy) to travel along the network’s paths.
      - (1) Activation will spread most along the strongest associations within the network.

## CHAPTER 6

### MEMORY

### CHAPTER OUTLINE

- (2) As activation spreads to associated units, processing and memory retrieval of those units would be facilitated.
- (3) This process gives rapid and easy access to large amounts of information related to the concept.

*Example:* If you first answer the question “Is basketball a sport?” you will then be faster in answering the question “Is basketball ever dangerous?” The first question activated your concept of basketball, which in turn spread activation to bits of information related to basketball (e.g., basketball is a sport, sports sometimes cause injuries, injuries are dangerous to health).

2. *Retrieving Incomplete Knowledge:* If concepts are represented as collections of features, then you might remember some features of a concept but still be unable to retrieve others—you are retrieving *incomplete knowledge*. In the **tip-of-the-tongue phenomenon**, when read a definition to a word, a person may not be able to recall the word itself, but can recall particular features of the word, such as how many syllables it has or its first letter.

#### IV. CONSTRUCTING MEMORIES

*How accurate are my memories?*

- A. People use what they already know to organize new facts, filling in gaps as they encode and later retrieve information. This is called *constructive memory*.

- B. Focus on Research: I Could Swear I Heard It!

Constructive memory shows how active the memory process is. Memory does not just *happen* to you—it is something you *do*. Our constructions of events may be different from what actually happened. These errors are called *false memories*.

1. *What was the researcher’s question?*  
How easy is it to create constructive memories?
2. *How did the researcher answer the question?*  
The researcher presented 16 themed lists of words and asked students to either recall the words on the list or do math problems and then recall the lists. Finally the researcher presented a new list of words and asked participants to say which had been on the earlier lists.
3. *What did the researcher find?*  
Recall was better without the distracting math problem task. The students did show constructive memory. For example, when students heard lists of words related to snow, but which did not include the word snow, they often falsely remembered having heard the word snow. Numerous trials showed similar results: students falsely remembered hearing the unrepresented theme words 55% of the time.
4. *What do the results mean?*  
Participants could not recognize which words they had heard and which they had not heard. Perhaps the theme words not on the lists were so highly associated with the words on the list that they were “pulled” at the same time during rehearsal.
5. *What do we still need to know?*  
Although studies like these show that memory is constructive, we still need to know what causes the errors and why they seem as real as memories of actual events.

## CHAPTER 6 MEMORY CHAPTER OUTLINE

### C. Constructive Memory and PDP Models

Parallel Distributed Processing (PDP) models explain that constructive memory occurs because newly learned information alters general knowledge of the world. If you confuse this generalized knowledge with the actual relevant facts, constructive memory may result. PDP networks produce *spontaneous generalizations* or conclusions about objects, events, and people. These may be inappropriate if they are created after only limited or biased experiences.

*Example:* Suppose you learn that a person whom you have never met, Don, is a basketball player. In a PDP network, basketball players you have known may have been connected to a physical feature like “tall.” Thus, the network representation of Don connects to “is a basketball player,” which in turn connects to “is tall,” even though you do not actually know if Don is tall. Later, when retrieving information about Don from this network, you may now “remember” that he is tall.

1. **Schemas** are mental representations of categories of objects, events, and people. Generalized knowledge in schemas provides a basis for making inferences about incoming information. Schemas can influence what people encode by causing them to jump to conclusions and then remember the conclusions rather than the facts.

## V. LINKAGES: MEMORY AND PERCEPTION IN THE COURTROOM

A. A number of factors shape the ability of eyewitnesses to recall information during their courtroom testimony.

1. Witnesses can only remember what they attend to and what they perceive. There are limits to how accurately witnesses can recall information.
2. New information, including a lawyer’s questions, can alter a witness’s memory.  
*Example:* Witnesses who were asked “How fast were the cars going when they *smashed into* each other?” later estimated that they saw the cars traveling at a higher speed than did subjects who had been asked “How fast were the cars going when they *hit* each other?”
3. Objects or events not witnessed but mentioned after the fact may be incorporated into memories. This *misinformation effect* can occur for a number of reasons.
  - a) New information may make it harder to retrieve the original memory.
  - b) New information may be integrated into the original memory.
  - c) If a respected person says an object was there or an event occurred, witnesses might believe this must be true.

B. Jurors tend to judge a witness as believable based on how the witness presents evidence, not just on what the witness says.

1. Jurors are more likely to believe witnesses who give very detailed accounts, even if those accounts are inaccurate.
2. Jurors are more likely to believe witnesses who are very confident, but research suggests that, on average, more confident witnesses are not more accurate.
  - a) Inflated confidence may stem from repeated exposure and recall of misinformation.

C. Eyewitness identification of criminals is more accurate when mug shots are viewed one at a time or when witnesses are told that the perpetrator might not be included in the lineup.

# CHAPTER 6

## MEMORY

### CHAPTER OUTLINE

#### VI. FORGETTING

*What causes me to forget things?*

##### A. How Do We Forget?

1. Hermann Ebbinghaus began the systematic study of forgetting with nonsense syllables, (e.g., GAN, DOF). Using such stimuli eliminates associations between pre-existing and new material.
  - a) He measured forgetting with the **method of savings**, which recorded the difference between the number of repetitions needed to learn a list of syllables and the number of repetitions needed to relearn it after some time period.
    - (1) Ebbinghaus found that most forgetting occurred in the first hour.
  - b) Ebbinghaus's research produced two important discoveries.
    - (1) The shape of the forgetting curve for nonsense syllables is similar to that for all other stimuli.
    - (2) Savings in LTM can be very long—information is often retained for decades.

##### B. Why Do We Forget?

1. Forgetting by **decay** occurs when unused memory representations slowly fade over time.
2. **Interference** causes “forgetting” when one piece of information impairs either the encoding or retrieval of another piece of information.
  - a) *Displacement* is a kind of interference in which one piece of information “pushes” another piece of information out of memory storage.
  - b) Interference during memory retrieval can occur in one of two ways.
    - (1) **Retroactive interference** occurs when learning new information interferes with the retrieval of older information. *Example:* Your study of Excel computer program procedures during second semester can interfere with your recall of Access computer program procedures learned in the first semester.
    - (2) **Proactive interference** occurs when old information interferes with learning or remembering new learning. *Example:* If you get a new locker combination at the gym, you may be confused when you try to remember it—remembering the old combination instead or combining portions of both the old and the new!
3. Forgetting in STM is mainly due to decay or displacement.
4. Forgetting in LTM is largely due to interference during memory retrieval. This suggests that memories may sometimes persist in LTM stores even when you cannot retrieve them.

##### C. *Thinking Critically:* Can Traumatic Memories Be Repressed, Then Recovered?

Some people have claimed to repress memory for a traumatic experience, only to recall the memory sometimes decades later.

1. *What am I being asked to believe or accept?*  
Memory of a shocking or traumatic experience can be repressed for decades and then accurately recalled later.
2. *Is there evidence available to support the claim?*  
Evidence that support these claims includes the following. (1) Several studies do show that mental processing can occur without direct awareness. (2) Implicit memory research shows that our behavior can be influenced by information of which we are unaware. (3) It may be that repressed memories are recalled only because the right retrieval cues are

## CHAPTER 6 MEMORY CHAPTER OUTLINE

finally provided. (4) Some research has shown that *motivated forgetting* does occur, in which people are more likely to forget unpleasant rather than pleasant events. (5) People who recall once-repressed memories report very high confidence in their recollections.

3. *Can that evidence be interpreted another way?*  
Repression of childhood abuse may well occur, but the fact that this is possible does not necessarily mean that every claimed recovered memory is genuine. False memories, in which people recall events that did not occur, can be just as vivid as real, accurate memories and people can be just as confident in them. In a number of studies, people have recalled as real events that never occurred but were imagined or made up in response to questions. Thus, even well intentioned psychotherapists may unwittingly encourage clients to “recover” false memories.
4. *What evidence would help to evaluate the alternatives?*  
Using physical evidence and other objective data will help to verify the accuracy of claimed recovered memories and the kinds of people and events most likely to be associated with them. Other clues may come from the study of *flashbulb memories*, memories of experiences in such intense detail that their recollections feel almost perceptual, “as if it happened yesterday.” Also useful would be research about how repression might occur.
5. *What conclusions are most reasonable?*  
There is little doubt that people sometimes do forget unpleasant events and then later have the capacity to recall those events. However, the fact that this is possible does not mean that it has occurred for any single given case. Indeed, there is also evidence that people can construct and distort memories without realizing they are doing so. Thus, any single case of claimed recovered memory should be approached cautiously, neither uncritically accepted nor uncritically rejected.

### VII. BIOLOGICAL BASES OF MEMORY

*How does my brain change when I store a memory?*

- A. The Biochemistry of Memory
  1. Changes in the brain’s synapses may provide the physical basis of a new memory.
    - a) New synapses may be formed and the number of *spines* on dendrites may be increased.
    - b) Communication at *existing* synapses may be altered through sensitization called *long-term potentiation*.
  2. In the hippocampus, memory-dependent changes especially occur in synapses involving the neurotransmitter *glutamate*.
  3. The neurotransmitter *acetylcholine* plays a prominent role in memory. Neurons using acetylcholine are among those especially damaged in Alzheimer’s disease.
- B. Brain Structures and Memory  
Memory involves both specialized regions for various types of memory and widespread areas for storage.
  1. *The Impact of Brain Damage:*
    - a) Damage to the hippocampus, nearby parts of the cerebral cortex, and the thalamus often results in **anterograde amnesia**, loss of memory for events occurring after the injury.

## CHAPTER 6 MEMORY CHAPTER OUTLINE

- (1) Anterograde amnesia patients cannot form new episodic memories, but they can develop and use implicit procedural memories. *Example:* Such a person would get better at playing tennis after practicing daily, despite his never being able to recall if he had played the game before.
  - (2) Since hippocampal damage does not impair working memory, formation of new procedural memories, or retrieval of already stored memories, these functions must rely on other brain regions.
  - b) **Retrograde amnesia** is the loss of memory for events *prior* to some brain injury.
    - (1) Often the memories lost in retrograde amnesia are gradually recovered.
    - (2) The oldest memories are recovered first, then memories closer to the injury. Often, however, the last few seconds before the injury are not recalled. The events of those last seconds before the injury were probably encoded into STM but transfer to LTM was interrupted by the trauma.

*Note:* Both retrograde and anterograde amnesias are due to organic causes—brain damage. The type of amnesia in repressed memories is psychological. There is no apparent organic damage.
2. *Multiple Storage Areas:* Certain brain areas store specific aspects of each remembered event, but many brain systems are involved in recalling the entire event.

### VIII. IMPROVING YOUR MEMORY

*How can I remember more information?*

#### A. Mnemonics

1. **Mnemonics** are strategies for placing information into an organized context in order to remember it.
  - a) In the *method of loci*, or the method of places, first imagine a set of familiar geographic locations, and then imagine walking through a location and placing each item to be remembered in one of these locations.
  - b) All mnemonics rely on using information already in LTM, which then gives a context in which to remember the new material.

#### B. Guidelines for More Effective Studying

1. Memory for textbook information is best when people create an overall context for learning (e.g., an outline) beforehand rather than just reading and rereading.
2. *Distributed* practice, studying in a number of shorter sessions, leads to much better memory retention than *massed practice*, cramming in one long session.

*Example:* Studying one hour a day for five straight days is better than studying five hours in one day.
3. *Reading a Textbook*
  - a) Successful students tend to monitor their understanding as they read, reread difficult sections, and periodically stop to review what they have learned.
  - b) Two specific guidelines for reading a textbook are:
    - (1) Understand what you are reading before moving on.
    - (2) The *PQ4R method*, one of the most successful strategies for remembering textbook material, consists of six activities:
      - (a) *Preview:* Skim a chapter to get a general idea of the topics and their organization.

## CHAPTER 6 MEMORY CHAPTER OUTLINE

- (b) Question:* Ask yourself questions about what content will be covered and what information you want to extract from each section.
  - (c) Read:* Think about the material as you read it.
  - (d) Reflect:* Create examples of concepts and consider links to what you already know.
  - (e) Recite:* After each section, recite the major points.
  - (f) Review:* Review and summarize the chapter after reading it.
- 4. *Lecture notes*
  - a)* More notes are not always better. Actively think about what is being said.
  - b)* Summarize the major ideas using relatively few words.
  - c)* Review notes as soon as possible after a lecture to fill in gaps and decipher scribbles. Remember most material is forgotten in the first hour after learning.
  - d)* Study from notes later as you would if they were a textbook chapter.