Memory

CHAPTER PREVIEW

Memory is the persistence of learning over time. One helpful model of human memory is the Atkinson-Shiffrin three-stage processing model, which describes how information is encoded, stored, and retrieved. More recent research has modified this model to incorporate the concept of working memory.

Although some types of information are encoded automatically, other types, including information involving meaning, imagery, and organization, require effort. Mnemonic devices that use imagery and that organize information into chunks aid memory. Organizing into hierarchies also helps.

Information first enters the memory through the senses. We register visual images via iconic memory and sound via echoic memory.

Although our memory for information just presented is limited to about seven items, our capacity for storing information permanently is essentially unlimited. The search for the physical basis of memory has focused on the synapses and their neurotransmitters and on brain circuits. The hippocampus processes explicit (declarative) memories; even more ancient brain regions—for example, the cerebellum—process implicit (nondeclarative) memories.

To be remembered, information that is “in there” must be retrieved with the aid of associations that serve as primers. Returning to the original context sometimes aids retrieval. While in a good or bad mood we often retrieve memories congruent with that mood. Forgetting sometimes reflects encoding failure. Without effortful processing, much of what we sense we never notice or process. Memories may also fade after storage—often rapidly at first and then leveling off. Retrieval failures may be caused by proactive or retroactive interference or even by motivated forgetting.

Memories are not stored as exact copies. Rather, they are constructed, using both stored and new information. Thus, when eyewitnesses are subtly exposed to misinformation after an event, they often believe they saw the misleading details as part of the event. Memory researchers are especially suspicious of long-repressed memories of sexual abuse that are “recovered” with the aid of a therapist or suggestive book.

Among strategies for improving memory are studying repeatedly; making material personally relevant; activating retrieval cues; using mnemonic devices; minimizing interference; getting adequate sleep; and self-testing.
CHAPTER GUIDE

- Introductory Exercise: Fact or Falsehood?
- Feature Film: Eternal Sunshine of the Spotless Mind
- Project/Exercise: Self-Defining Memories
- Video: Module 13 of Psychology: The Human Experience: What Is Memory?

The Phenomenon of Memory and Studying Memory: Information-Processing Models

- Exercises: Remembering the Seven Dwarfs; Forgetting Frequency Questionnaire
- Exercise/Project: Bias in Memory
- Lectures: The World Memory Championships; The Case of Clive Wearing
- Instructor Video Tool Kit: An Amazing Memory; Living Without Memory

1. Describe Atkinson-Shiffrin’s classic three-stage processing model of memory, and explain how the concept of working memory clarifies the processing that occurs in short-term memory.

Memory is the persistence of learning over time through the storage and retrieval of information. In some ways, our memory is like a computer’s information-processing system. Information must be encoded, stored, and retrieved. The Atkinson-Shiffrin three-stage processing model states that we first record to-be-remembered information as a fleeting sensory memory, from which it is processed into a short-term memory bin, where we encode it through rehearsal for long-term memory and later retrieval. Contemporary memory researchers note that we sometimes bypass the first two stages and process some information automatically and directly into long-term memory without conscious awareness. They also prefer the term working memory to short-term memory because it emphasizes a more active role in the second processing stage in which information is rehearsed, new stimuli are associated with existing memories, and problems are solved. The working-memory model includes the processing of incoming visual-spatial and auditory information.

Encoding: Getting Information In

- Exercises: Automatic Processing; Rehearsal and the Twelve Days of Christmas; Serial Position Effect in Recalling U.S. Presidents

2. Describe the types of information we encode automatically, and contrast effortful processing with automatic processing, giving examples of each.

To some extent, encoding occurs automatically. With little or no effort, we process an enormous amount of information about space, time, frequency, and well-learned information. For example, we can recreate a sequence of the day’s events in order to guess where we might have left a coat. Automatic processing occurs without our awareness and without interfering with our thinking about other things. Some forms of processing, such as learning to read or drive, require attention and effort when we first perform them but with practice become automatic.

Automatic processing occurs unconsciously; effortful processing requires attention and effort. For example, our memory of names will disappear unless we rehearse them. The spacing effect is our tendency to retain information more easily if we distribute our rehearsal than if we practice in one long session. The serial position effect is our tendency to remember the last and first items in a long list (for example, a grocery list) better than the middle items. Immediately after learning, we remember the last items best (the recency effect); after a delay, we remember the first items best (the primacy effect).
3. **Compare the benefits of visual, acoustic, and semantic encoding in remembering verbal information, and describe some memory-enhancing encoding strategies.**

When processing verbal information for storage, we usually encode its meaning. For example, we associate it with what we already know or imagine. Research indicates that **semantic encoding** (of meaning) yields better memory of verbal information than **acoustic encoding** (of sound) or **visual encoding** (of an image). This research also highlights the futility of trying to remember words we do not understand and the benefits of rephrasing what we read and hear into meaningful terms.

In a variety of experiments, researchers have documented the benefits of mental **imagery**. For example, we remember concrete words that lend themselves to picture images better than we remember abstract, low-imagery words. We remember concrete nouns better than abstract nouns because, for example, we can associate both an image and a meaning with *fire* but only a meaning with *process*. Imagery is at the heart of many memory aids, or **mnemonics**. For example, in the peg-word system, people remember new items by using a visual as well as an acoustic code.

When we organize information into meaningful units, we recall it more easily. In **chunking**, we cluster information into familiar, manageable units, such as words into sentences. Chunking occurs so naturally that we often take it for granted. When people develop expertise in an area, they often process information in **hierarchies** composed of a few broad concepts divided and subdivided into lesser concepts and facts. In this way, experts can retrieve information efficiently.

**Storage: Retaining Information**

4. **Contrast two types of sensory memory, and describe the duration and capacity of working/short-term memory.**

Information first enters the memory system through the senses. **Iconic memory** is a momentary sensory memory of visual stimuli, a photographic or picture-image memory lasting for a few tenths of a second. **Echonic memory** is a momentary sensory memory of auditory stimuli. Even if attention is elsewhere, sounds and words can still be recalled within 3 or 4 seconds.

5. **Describe the capacity and duration of long-term memory, and discuss the biological changes that may underlie memory formation and storage.**

Although we know that our capacity for storing information permanently is essentially unlimited, we are not sure how and where we store it. Research has shown that memories do not reside in a single place, and the so-called **memory trace** is difficult to find.
The search for the physical basis of memory is now focused on the synapses and their neurotransmitters and on the long-term potentiation (LTP) of brain circuits. In response to increased activity in neural pathways, neural interconnections form or strengthen. Studies of the sea slug indicate that when learning occurs, the slug releases more of the neurotransmitter serotonin at certain synapses, and these synapses become more efficient at transmitting signals. In experiments, rapidly stimulating certain memory-circuit connections has increased their sensitivity for weeks to come. This LTP appears to be a neural basis for learning and remembering associations. Drugs that block LTP interfere with learning. Scientists are developing and testing drugs that enhance long-term memory. One approach is to develop drugs that enhance the production of the protein CREB. Another is to develop drugs that boost glutamate.

The naturally stimulating hormones that we produce when excited or stressed make more glucose energy available to fuel brain activity, signaling the brain that something important has happened. The amygdala, two emotion-processing clusters in the brain’s limbic system, arouses brain areas that process emotion. These emotion-triggered hormonal changes help explain our flashbulb memories of surprising, significant events. Emotionless events mean weaker memories.

6. **Distinguish between implicit and explicit memory, and identify the main brain structure associated with each.**

Studies of brain-damaged patients who suffer from amnesia reveal two types of memory. **Implicit memory** (nondeclarative memory) is retention without conscious recollection. **Explicit memory** (declarative memory) is the memory of facts and experiences that one can consciously know and "declare."

Brain scans of people recalling words and autopsies of people who had amnesia reveal that the hippocampus, a limbic system structure, plays a vital role in the gradual processing of our explicit memories into long-term memory. The hippocampus is not the permanent storehouse, but a loading dock that feeds new information to the cortex for permanent storage. Implicit memories are processed by the cerebellum. Research with rabbits in which different parts of the neural pathway were temporarily deadened during eye-blink training pinpointed implicit memory in the cerebellum at the back of the head. Our dual-memory system helps explain infantile amnesia.

**Retrieval: Getting Information Out**

- Project: Perm astore
- Project/Exercise: Retrieval Cues
- Exercise: Expertise and Retrieval Rate
- Video: Video Clip 24 of Digital Media Archive: Psychology, 1st ed.: Aging and Memory
- ActivePsych: Digital Media Archive, 2nd ed.: A Journey into Memory

7. **Contrast the recall, recognition, and relearning measures of memory, and explain how retrieval cues help us access stored memories.**

**Recall** is a measure of memory in which the person must retrieve information learned earlier, as on a fill-in-the-blank test. **Recognition** is a measure in which a person need only identify items previously learned, as on a multiple-choice test. **Relearning** is a memory measure that assesses the
amount of time saved when relearning previously learned information. Tests of recognition and relearning reveal that we remember more than we recall.

We can think of a memory as held in storage by a web of associations. Retrieval cues are bits of related information we encode while encoding a target piece of information. They become part of the web. To retrieve a specific memory, we need to identify one of the strands that leads to it, a process called priming. Activating retrieval cues within our web of associations aids memory. Such activation may occur without our awareness.

Exercise: Déjà Vu in the Classroom; The Pollyanna Principle; Word-Pleasantness Experiment
Lecture: The Déjà Vu Illusion
Video: Video Clip 24 of Digital Media Archive: Psychology, 1st ed.: Aging and Memory

8. Describe the impact of environmental contexts and internal emotional states on retrieval.

Retrieval is sometimes aided by returning to the original context in which we experienced an event or encoded a thought. It can flood our memories with retrieval cues that lead to the target memory. Sometimes, being in a context similar to one we’ve been in before may trick us into subconsciously retrieving an earlier experience. The result is a feeling that we are reliving something that we have experienced before—a phenomenon known as déjà vu.

State-dependent memory is the tendency to recall information best in the same emotional state as when the information was learned. Memories are somewhat mood-congruent. While in a good or bad mood, we often retrieve memories consistent with that mood. For example, research suggests that currently depressed people recall their parents as rejecting, punitive, and guilt-promoting, whereas formerly depressed people describe their parents much as do those who have never suffered depression. Moods also prime us to interpret others’ behavior in ways consistent with our emotions.

Forgetting

Exercise: Encoding Failure
Lectures: A. J.: A Case Study in Total Recall; Change Blindness
Instructor Video Tool Kit: Retrieval: A Journey into Memory

9. Explain why we should value our ability to forget, and discuss the roles of encoding failure and storage decay in the process of forgetting.

The capacity to forget useless or out-of-date information is helpful. Because of his inability to forget, the Russian memory whiz known as S found it more difficult than others to think abstractly—to generalize, to organize, to evaluate. Without an ability to forget we would be overwhelmed by out-of-date and irrelevant information. As noted by Daniel Schacter, our memories fail us through forgetting (absent-mindedness, transience, and blocking), through distortion (misattribution, suggestibility, and bias), and through intrusion (persistence of unwanted memories).

One explanation for forgetting is that we fail to encode information for entry into our memory system. Without effortful processing, much of what we sense we never notice or process. For example, most people in the United States have looked at thousands of pennies. However, when tested on specific features, they have difficulty recognizing the real thing.

Memories may fade after storage. From his research on learning and retention, Ebbinghaus found that forgetting occurs rapidly at first, then levels off. This principle became known as the forgetting curve. Storage decay may reflect a gradual fading of the physical memory trace. Another possible explanation is that we simply can’t retrieve the information.

Exercise: The Tip-of-the-Tongue Phenomenon and Capital Cities; Repression or Inadequate Retrieval Cues?
Lecture: Suppressed Memory
Project: A Forgetting Journal
Project/Exercise: Earliest Recollections
PsychSim 5: Forgetting
10. Explain what is meant by retrieval failure, and discuss the effects of interference and motivated forgetting on retrieval.

Retrieval failure can occur if we have too few cues to summon information from long-term memory. It may also happen when old and new information compete for retrieval. In proactive interference, something we learned in the past interferes with our ability to recall something we have recently learned. In retroactive interference, something we have recently learned interferes with something we learned in the past.

With his concept of repression, Sigmund Freud proposed that our memories are self-censoring. To protect our self-concepts and to minimize anxiety, we may block from consciousness painful memories. In Freud's view, this motivated forgetting submerges memories but leaves them available for later retrieval under the right conditions. Increasing numbers of memory researchers think repression rarely, if ever, occurs. More typically, we have trouble forgetting traumatic experiences.

Memory Construction

- Lectures: Misremembering the Causes of Behavior; The Misinformation Effect; True Photos and False Memories; False Memories Surrounding the Iraq War; Source Amnesia
- Exercises: Eyewitness Testimony—What Have We Learned?; Eyewitness Recall; Creating a False Memory
- Project: Constructive Memory
- PsychSim 5: Trusting Your Memory
- Video: Segment 17 of the Scientific American Frontiers Series, 2nd ed.: True or False?
- Instructor Video Tool Kit: Creating False Memories: A Laboratory Study

11. Explain how misinformation, imagination, and source amnesia can distort our memory of an event, and discuss why it is difficult to distinguish between true and false memories.

Memories are not stored as exact copies, and they certainly are not retrieved as such. Rather, we construct our memories, using both stored and new information. In many experiments around the world, people have witnessed an event, received or not received misleading information about it, and then taken a memory test. The repeated result is a misinformation effect: After exposure to subtle misinformation, many people misremember. Asking leading questions can plant false memories. As people recount an experience, they fill in their memory gaps with plausible guesses. Other vivid retellings may also implant false memories. Even repeatedly imagining and rehearsing nonexistent events can create false memories, called imagination inflation.

Our memory for the source of an event is particularly frail. In source amnesia, we attribute to the wrong source an event that we have experienced, heard about, read about, or imagined. Thus, we may recognize someone but have no idea where we have seen the person. Or we imagine or dream an event and later are uncertain whether it actually happened.

Because memory involves reconstruction as well as reproduction, we are unable to tell whether a memory is real by how real it feels. False memories created by suggested misinformation and misattributed sources may feel as real as true memories and may be very persistent. Just as perceptual illusions may seem like real perceptions, false memories may feel like real memories.

- Lectures: Repressed Memories of Abuse; The Misinformation Effect and False Confessions
- Exercise: The Heartland Forgiveness Scale (HFS)
- Instructor Video Tool Kit: Repression: Reality or Myth?

12. Discuss whether young children's eyewitness reports are reliable and the controversy over reports of repressed and recovered memories.

Preschool children are particularly sensitive to suggestion, and their recollections of sexual abuse may be prone to error. When researchers have used suggestive interviewing techniques, they have found that most preschoolers and many older children can be induced to report false events. However, even young children can accurately recall events if a neutral person asks about their
experiences in neutral words they can understand and uses less suggestive, more effective techniques.

Innocent people have been falsely convicted of abuse that never happened, and true abusers have used the controversy over recovered memories to avoid punishment. Forgetting of isolated past events, both negative and positive, is an ordinary part of life. Cued by a remark or an experience, we may later recover a memory. Controversy, however, focuses on whether the unconscious mind forcibly represses painful experiences and whether they can be retrieved by therapist-aided techniques. Memories “recovered” under hypnosis or drugs are especially unreliable, as are memories of things happening before age 3. Traumatic experiences are usually vividly remembered, not banished into an active but inaccessible unconscious.

**Improving Memory**

- **Lecture: Making Doctors’ Instructions More Memorable**

13. *Explain how an understanding of memory can contribute to effective study techniques.*

   The psychology of memory suggests several effective study strategies. These include studying repeatedly by using spaced practice; making new material personally meaningful by relating it to what is already known; mentally recreating the contexts and moods in which the original learning occurred in order to activate retrieval cues; using mnemonic devices; minimizing interference, for example, by studying just before sleeping; sleeping more; and testing your own knowledge both to rehearse it and to determine what must still be learned.