Chapter Preview

Memory is the persistence of learning over time. Evidence that learning persists includes three forms: recall, recognition, and relearning. Atkinson and Shiffrin have proposed an information-processing model that involves three stages: encoding, storage, and retrieval. 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 frontal lobes and hippocampus process explicit (declarative) memories, the cerebellum and basal ganglia process implicit (nondeclarative) memories, and the amygdala plays a role in emotion-related memory formation.

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.
8-1. Define memory, and describe how it is measured.

Memory is the persistence of learning over time through the storage and retrieval of information. 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.

8-2. Explain how psychologists describe the human memory system.

In some ways, our memory is like a computer’s information-processing system. Information must be encoded, stored, and retrieved. One model, connectionism, views memories as products of interconnected neural networks. Atkinson and Shiffrin’s 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. Unlike a computer, we process information simultaneously by means of parallel processing. Alan Baddeley and other memory researchers 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 with a central executive that focuses attention and pulls information from long-term memory to help make sense of new information.
8-5. **Explain how sensory memory works.**

Effortful processing begins with sensory 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. **Echoic 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.

- Exercise: Memory Capacity (p. 442)
- PsychSim 5: Short-Term Memory (p. 442)

8-6. **Describe the capacity of our short-term and working memory.**

Our short-term memory span for information just presented is very limited—a seconds-long retention of up to about seven items, depending on the information and how it is presented. Working-memory capacity varies, depending on age and other factors.

- Exercises: Chunking (p. 443); Rehearsal and the Twelve Days of Christmas (p. 443)
- Lectures: Mnemonic Devices (p. 446); The Keyword Method (p. 447); Rajan Mahadevan’s Amazing Memory (p. 448)
- Exercise/Critical Thinking Break: Verbal Information Can “Overshadow” Memory (p. 445)

8-7. **Describe the effortful processing methods that help us remember new information.**

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; in fact, it is often automatic.

To help them encode lengthy passages and speeches, ancient Greek scholars and orators also developed **mnemonics**. Many of these memory aids use vivid imagery, because we are particularly good at remembering mental pictures. 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*. In the **peg-word system**, people remember new items by using a visual code as well as an acoustic code.

When people develop expertise in an area, they often process information not only in chunks but also in **hierarchies** composed of a few broad concepts divided and subdivided into lesser concepts and facts. In this way, experts can retrieve information efficiently.

We retain information better when our encoding is distributed over time, called the **spacing effect**. One effective way to distribute practice is repeated self-testing, a phenomenon called the **testing effect**.

- Exercises: Meaning and Memory (p. 443); Visually Versus Auditorily Encoded Information (p. 444); Language Influences Picture Memory (p. 445)

8-8. **Describe the levels of processing and their effect on encoding.**

We process information at different levels, and depth of processing affects our long-term retention. **Shallow processing** encodes on a very basic level, such as a word’s letters or sound. **Deep processing** encodes semantically, based on the meaning of words. If new information is not meaningful or related to our experience, we have trouble processing it.

**Memory Storage**

- Worth Video Anthology: Living Without Memory; Clive Wearing: Living Without Memory

8-9. **Describe the capacity and duration of our long-term memories.**

Our capacity for storing information permanently is essentially unlimited. However, we do not store information as libraries store their books, in discrete, precise locations. Instead, many parts of the brain interact as we encode, store, and retrieve the information that forms our memories.
8-10. **Describe the role of the frontal lobes and hippocampus in memory storage.**

Memory requires brain networks. The network that processes and stores your explicit memories includes your frontal lobes and **hippocampus**, a limbic system structure. The hippocampus is not the permanent storehouse, but a loading dock that feeds new information to the cortex for permanent storage. People with left-hippocampus damage have trouble remembering verbal information. With right-hippocampus damage, they have trouble remembering visual designs and locations.

8-11. **Describe the role of the cerebellum and basal ganglia in our memory processing.**

Implicit memories created by classical conditioning are processed by the **cerebellum**. With a damaged cerebellum, people cannot develop certain conditioned reflexes, such as the eyeblink response. The **basal ganglia**, deep brain structures involved in motor movement, facilitate formation of our procedural memories for skills. Our implicit memory system, enabled by the cerebellum and basal ganglia, helps explain why the reactions and skills we learned during infancy reach far into our future. Yet as adults, our **conscious** memory of our first three years is blank, an experience called **infantile amnesia**.

8-12. **Discuss how emotions affect our memory processing.**

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.

8-13. **Explain how changes at the synapse level affect our memory processing.**

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** onto certain neurons, and these cells 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.

**Retrieval: Getting Information Out**

**8-14. Describe how external cues, internal emotions, and order of appearance influence memory retrieval.**

As noted earlier, **recall**, **recognition**, and **relearning** speed are three ways that psychologists measure retention of memories. Additional rehearsal (**overlearning**) of verbal information increases retention. Tests of recognition and relearning reveal that we remember more than we recall.
Memories are held in storage by a web of associations. Retrieval cues enable you to follow the path to the memory. For example, 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.

Putting yourself back in the context where you experienced something can prime your memory retrieval. Closely related to context-dependent memory is state-dependent memory, the tendency to recall information best in the same 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.

Another memory-retrieval quirk is the serial position effect, 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).

Forgetting

- Exercise: Encoding Failure (p. 454)
- Lectures: A. J.: A Case Study in Total Recall (p. 453); Using the Arts to Cope With Alzheimer’s Disease (p. 453); Change Blindness (p. 454)
- Exercise/Critical Thinking Break: “Blindness”: Neuroscience, Magic, Attention, and Memory (p. 453)

8.15. Explain why we forget.

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. There are two types of forgetting: anterograde amnesia involves the inability to form new memories, whereas retrograde amnesia is the inability to recall the past.

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.

- Exercise: Rehearsal Prevents Decay in Working Memory (p. 454)

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.

- Exercises: The Tip-of-the-Tongue Phenomenon and Capital Cities (p. 456); Repression or Inadequate Retrieval Cues? (p. 457)
- Lecture: Suppressed Memory (p. 458)
- Project: A Forgetting Journal (p. 455)
- Project/Exercise: Earliest Recollections (p. 456)
- PsychSim 5: Forgetting (p. 457)

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 Errors

- Lectures: Misremembering the Causes of Behavior (p. 460); The Misinformation Effect (p. 460)
- Exercises: Creating a False Memory (p. 461); Eyewitness Testimony—What Have We Learned? (p. 462); Eyewitness Recall (p. 462)
- Exercise/Critical Thinking Break: Beliefs About Eyewitness Memory (p. 462)
- Project: Constructive Memory (p. 459)
- PsychSim 5: Trusting Your Memory (p. 461)
- Worth Video Anthology: Creating False Memories: A Laboratory Study

8-16. **Explain how misinformation, imagination, and source amnesia influence our memory construction, and describe how we decide whether a memory is real or false.**

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**.

- Lectures: Source Amnesia (p. 464); The Déjà Vu Illusion (p. 465)
- Exercise: Déjà Vu in the Classroom (p. 464)

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. 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**.

- Lectures: True Photos and False Memories (p. 465); False Memories Surrounding the Iraq War (p. 466)

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: Multiple Interviews and Children’s Eyewitness Recall (p. 467); Repressed Memories of Abuse (p. 467); The Misinformation Effect and False Confessions (p. 468)
- Exercise/Critical Thinking Break: Scientifically Informed Public Policy (p. 466)
- Worth Video Anthology: Repression: Reality or Myth?

8-17. **Describe the reliability of young children’s eyewitness descriptions, and discuss why reports of repressed and recovered memories are so hotly debated.**

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 (p. 469)

8-18. *Describe how you can use memory research findings to do better in this and other courses.*

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 re-creating 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.
Fact or Falsehood?

T F 1. Memory storage is never automatic; it always takes effort.
T F 2. The day after you are introduced to a number of new co-workers, you will more easily recall the names of those you met first.
T F 3. Memory aids (e.g., those that use imagery and devices for organization) are no more useful than simple rehearsal of information.
T F 4. Only a few people have any type of photographic memory.
T F 5. Although our capacity for storing information is large, we are still limited in the number of permanent memories we can form.
T F 6. We store information in memory as libraries store their books, that is, in discrete, precise locations.
T F 7. When people learn something while intoxicated, they recall it best when they are again intoxicated.
T F 8. The hour before sleep is a good time to commit information to memory.
T F 9. Repeatedly imagining a nonexistent event can lead us to believe it actually happened.
T F 10. Children typically will repress any memory of having seen one of their parents being murdered.