Long-Term Memory: Basic Principles

6

Some Questions We Will Consider

- What is the best way to store information in long-term memory? (196)
- How is it possible that a lifetime of experiences and accumulated knowledge can be stored in neurons? (207)
- What are some techniques we can use to help us get information out of long-term memory when we need it? (215)

Jimmy G. had been admitted to the Home for the Aged, accompanied by a transfer note that described him as "helpless, demented, confused, and disoriented." As neurologist Oliver Sacks talked with Jimmy about events of his childhood, his experiences in school, and his days in the Navy, Sacks noticed that Jimmy was talking as if he were still in the Navy, even though he had been discharged 10 years earlier. Sacks (1985) recounts the rest of his conversation with Jimmy as follows:

> "What year is this, Mr. G?" I asked, concealing my perplexity under a casual manner.
>
> "Forty-five, man. What do you mean?" He went on, "We've won the war, FDR's dead, Truman's at the helm. There are great times ahead."
>
> "And you, Jimmy, how old would you be?" Oddly, uncertainly, he hesitated a moment, as if engaged in calculation. "Why, I guess I'm nineteen, Doc. I'll be twenty next birthday." Looking at the gray-haired man before me, I had an impulse for which I have never forgiven myself—it was, or would have been, the height of cruelty had there been any possibility of Jimmy's remembering it.
>
> "Here," I said, and thrust a mirror toward him. "Look in the mirror and tell me what you see. Is that a nineteen-year-old looking out from the mirror?"
>
> He suddenly turned ashen and gripped the sides of the chair. "Jesus Christ," he whispered. "Christ, what's going on? What's happened to me? Is this a nightmare? Am I crazy? Is this a joke?"—and he became frantic, panicky.
>
> "It's okay, Jim," I said soothingly. "It's just a mistake. Nothing to worry about. Hey!" I took him to the window. "Isn't this a lovely spring day. See the kids there playing baseball?" He regained his color and started to smile, and I stole away, taking the hateful mirror with me.
>
> Two minutes later I reentered the room. Jimmy was still standing by the window, gazing with pleasure at the kids playing baseball below. He wheeled around as I opened the door, and his face assumed a cheery expression.
>
> "Hiya, Doc!" he said. "Nice morning! You want to talk to me—do I take this chair here?" There was no sign of recognition on his frank, open face.
>
> "Haven't we met before, Mr. G?" I said casually.
>
> "No, I can't say we have. Quite a beard you got there. I wouldn't forget you, Doc!"
>
> . . .
>
> "You remember telling me about your childhood, growing up in Pennsylvania, working as a radio operator in a submarine? And how your brother is engaged to a girl from California?"
>
> "Hey, you're right. But I didn't tell you that. I never met you before in my life. You must have read all about me in my chart."
>
> "Okay," I said. "I'll tell you a story. A man went to his doctor complaining of memory lapses. The doctor asked him some routine questions, and then said, 'These lapses. What about them?' 'What lapses?' the patient replied."
>
> "So that's my problem," Jimmy laughed. "I kinda thought it was. I do find myself forgetting things, once in a while things that have just happened. The past is clear, though." (Sacks, 1985, p. 14)

Jimmy G. suffers from **Korsakoff's syndrome**, a condition caused by a prolonged deficiency of vitamin B1, usually as a result of chronic alcoholism. The deficiency leads

Memory Loss in the Movies

There are countless movies that feature a character with memory loss. In some movies, a character loses his or her memory for everything in their past, including their identity, but is able to form new memories. This is what happened to Gregory Peck's character in the 1945 classic *Spellbound*, which was directed by Alfred Hitchcock. In other movies, the main character has trouble forming new memories. For example, Lenny, the fictional character played by Guy Pearce in *Memento* (2000), had a problem like Clive Wearing's and Jimmy G's, but it was apparently not as severe, because he was able to function in the outside world, although with some difficulty. To compensate for his inability to form new memories, Lenny recorded his experiences with a Polaroid camera and had key facts tattooed onto his body (Figure 6.1). Although Lenny's problem was identified in the movie as a loss of short-term memory, his short-term memory was fine, because he could remember what had just happened to him. His problem was that he couldn't form new long-term memories.

In *50 First Dates*, Drew Barrymore plays a woman who has a memory problem that occurs only in the movies—she remembers what is happening to her on a given day, but when she wakes up the next morning she can't remember anything that happened on that day. The fact that her memory "resets" every morning seems not to bother Adam Sandler, who falls in love with her, either in spite of or because of her memory problems.

The following are some other movies in which memory loss plays a crucial role: *Anastasia* (1956; Ingrid Bergman); *Dead Again* (1991; Emma Thompson); *Goundhog Day* (1993; Bill Murray); *The Long Kiss Goodnight* (1996; Geena Davis); *Who Am I?* (1998; Jackie Chan); *The Bourne Identity* (2002; Matt Damon); *Paycheck* (2003; Ben Affleck); *Eternal Sunshine of the Spotless Mind* (2004; Jim Carrey/Kate Winslet). (See Think About It on page 231 for more on memory loss in the movies.)

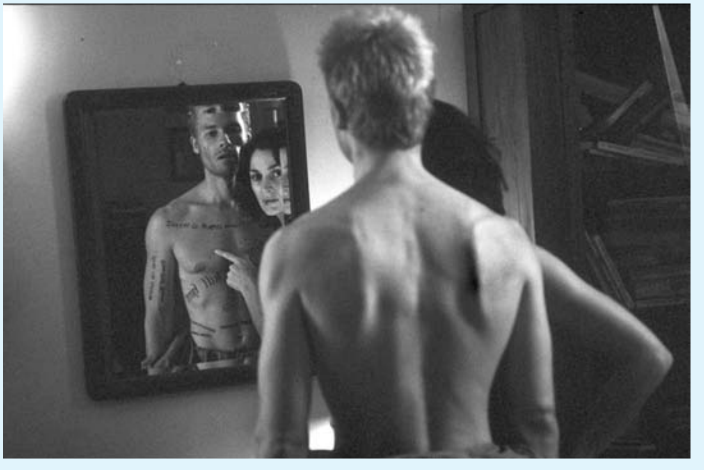


Figure 6.1 Guy Pearce's character, Lenny, from the film *Memento*. To deal with his memory problem, he had key facts he wanted to remember tattooed on his body.

to the destruction of areas in the frontal and temporal lobes, which causes severe impairments in memory. The damage to Jimmy G.'s memory makes it impossible for him to assimilate or retain new knowledge. He cannot recognize people he has just met, follow a story in a book, find his way to the corner drugstore, or solve problems that take more than a few moments to figure out. Jimmy's problem is similar to Clive Wearing's, from Chapter 5. He is unable to form new long-term memories, and his reality therefore consists of some memories from long ago plus what has happened within the last 30–60 seconds.

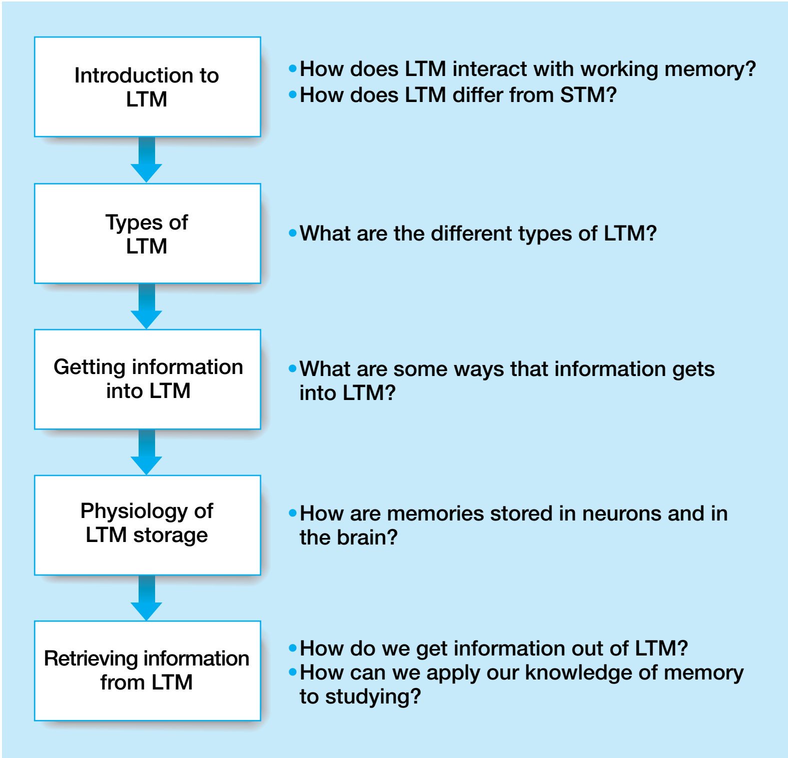


Figure 6.2 The flow diagram for this chapter.

The severe disabilities suffered by Jimmy G. and Clive Wearing illustrate the importance of being able to retain information about what has happened in the past. The purpose of this chapter is to begin looking at how long-term memory operates. We will do this by following the plan shown in Figure 6.2. First we introduce LTM by looking at how it interacts with STM/working memory, and how it differs from STM. We then describe the types of LTM, how information becomes stored in LTM, and the physiological mechanisms responsible for this storage. Finally, we will describe some of the factors involved in retrieving information from LTM. The principles introduced in this chapter lay the groundwork for the next chapter, in which we will continue our discussion of LTM by considering everyday applications of memory and why we make errors of memory.

Introduction to Long-Term Memory

One way to describe LTM is as an "archive" of information about past events in our lives and knowledge we have learned. What is particularly amazing about this storage is how it stretches from just a few moments ago to as far back as we can remember. The large time span of LTM is illustrated in Figure 6.3, which shows what a student who has just taken a seat in class might be remembering about events that occurred at various times in the past.

His first recollection—that he has just sat down—would be contained in his short-term/working memory because it happened within the last 30 seconds. But everything before that—from his recent memory that 5 minutes ago he was walking to class, to a memory from 10 years earlier of the elementary school he had attended in the third grade—is part of long-term memory.

Although all of these memories are contained in LTM, they aren't all the same. More-recent memories tend to be more detailed, and much of this detail and often the specific memories themselves fade with the passage of time and as other experiences accumulate. Thus, on October 1, 2006, this person would probably not remember the details of what happened while walking to class on October 1, 2005, but would remember some of the general experiences from around that time. One of the things that we will be concerned with in this chapter and the next one is why we retain some information and lose other information.

But simply considering LTM as an "archive" that retains information from the past leaves out an important function of LTM. LTM works closely with working memory to help create our ongoing experience. Consider, for example, what happens when Tony's friend Cindy says, "Jim and I saw the new James Bond movie last night" (Figure 6.4). As Tony's working memory is holding the exact wording of that statement in his mind, it is simultaneously accessing information from long-term memory, which helps him understand what Cindy is saying. Tony's ability to understand the sentence depends on retrieving, from LTM, the meanings of each of the words that make up the sentence. His

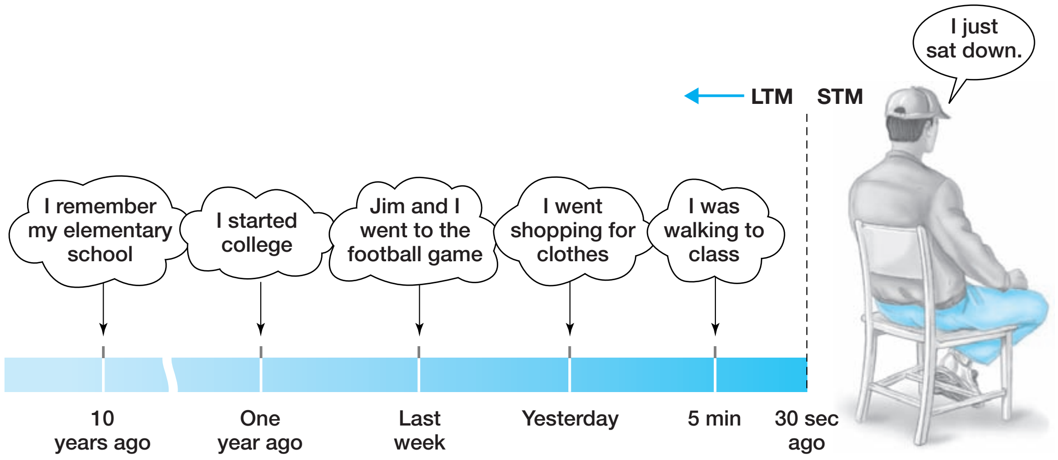
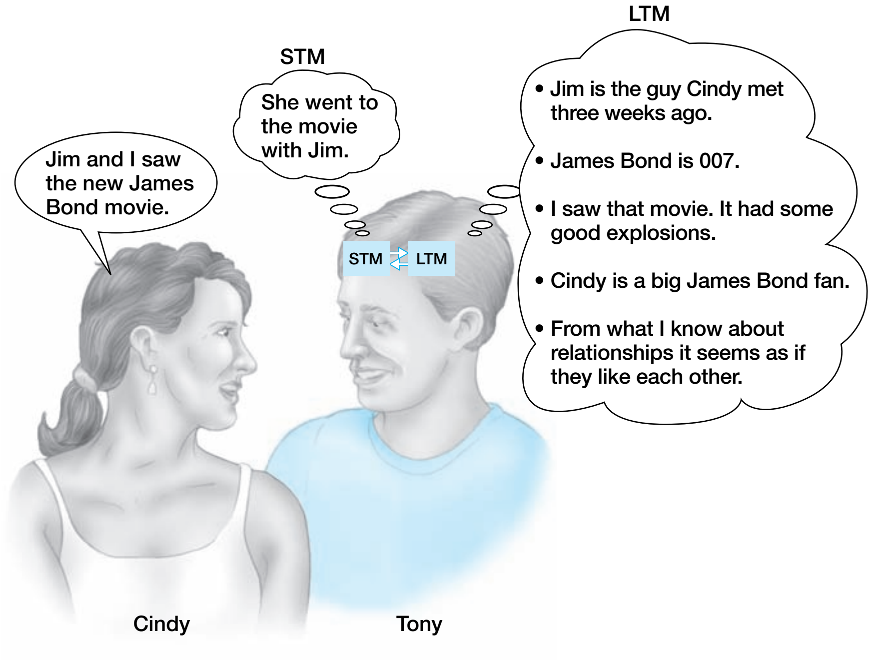


Figure 6.3 Long-term memory covers a span that stretches from about 30 seconds ago to your earliest memories. Thus, all of this student's memories, except the memory "I just sat down," would be classified as long-term memories.



■ **Figure 6.4** Tony's STM, which is dealing with the present, and his LTM, which contains knowledge relevant to what is happening, work together as Cindy tells him something.

LTM also contains a great deal of additional information about movies, James Bond, and Cindy. Although Tony might not consciously think about all of this information (after all, he has to pay attention to the next thing that Cindy is going to tell him), it is all there in his LTM and adds to his understanding of what he is hearing and his interpretation of what that might mean.

LTM therefore provides both an archive that we can refer to when we want to remember events from the past, and a wealth of background information that we are constantly consulting as we use working memory to make contact with what is happening at a particular moment.

Distinctions Between LTM and STM

The interplay between what is happening in the present and information from the past, which we described in the interaction between Tony and Cindy, is based on the distinction between STM and LTM that was the centerpiece of the modal model of memory (see p. 138). Beginning in the 1960s, a great deal of research was conducted that was designed to distinguish between short-term processes (called short-term memory at the time) and long-term memory. This distinction was studied in a classic experiment by B. B. Murdoch, Jr. (1962), which is illustrated by the following demonstration:

Demonstration

Serial Position

CogLab

Serial Position

Get someone to read the stimulus list (see end of chapter, on p. 234) to you at a rate of about one word every 2 seconds. Right after the last word, write down all of the words you can remember.

You can analyze your results by noting how many words you remembered from the first five entries on the list, the middle five, and the last five. Did you remember more words from the first or last five than from the middle? Individual results vary widely, but when Murdoch did this experiment on a large number of participants and plotted the percentage recall for each word versus the word's position on the list, he obtained a function called the **serial-position curve**.

Serial-Position Curve Murdoch's serial-position curve, shown in Figure 6.5, indicates that memory is better for words at the beginning of the list and at the end of the list. Superior memory for stimuli presented at the beginning of a sequence is called the **primacy effect**. A possible explanation of the primacy effect is that participants had time to rehearse these words and transfer them to LTM. According to this idea, participants begin rehearsing the first word right after it is presented, and because no other words

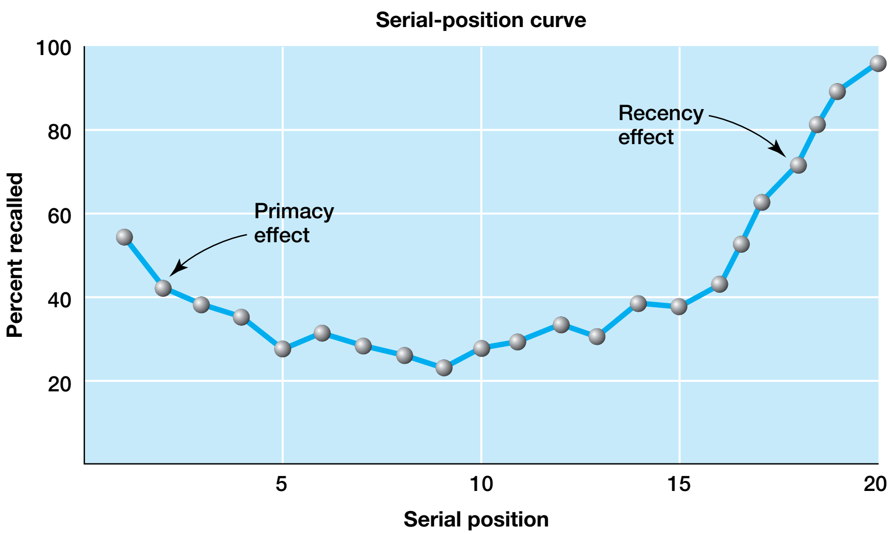


Figure 6.5 Serial-position curve (Murdoch, 1962). Notice that memory is better for words presented at the beginning of the list (primacy effect) and at the end (recency effect). (Reprinted from "The Serial Position Effect in Free Recall," by B. B. Murdoch, Jr., *Journal of Experimental Psychology, 64,* pp. 482–488. Copyright © 1962 with permission from the American Psychological Association.)

have been presented, it receives 100 percent of the person's attention. When the second word is presented, attention becomes spread over two words, and so on, so as additional words are presented less rehearsal is possible for later words.

Murray Glanzer and Anita Cunitz (1966) tested the idea that rehearsal of the early words might lead to better memory by presenting the list at a slower pace, so there was more time between each word and participants had more time to rehearse. Just as we would expect if the primacy effect is due to rehearsal, increasing the time between each word increased memory for the early words (see dashed curve in Figure 6.6a). (Addi-

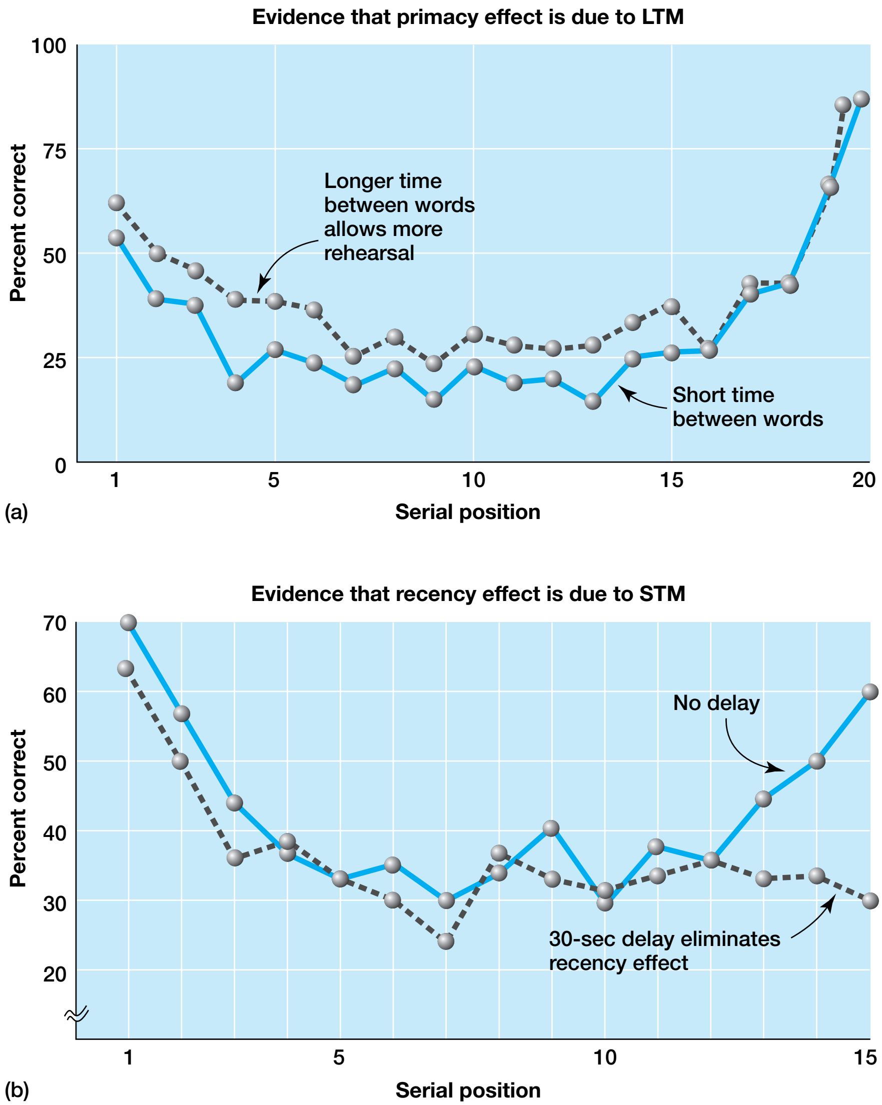


Figure 6.6 Result of Glanzer and Cunitz's (1966) experiment. (a) The solid curve is the serial position curve from Figure 6.5. The dashed curve occurred when the words were presented more slowly. (b) The serial-position curve has a normal recency effect when the memory test is immediate (solid line), but no recency effect occurs if the memory test is delayed for 30 seconds (dashed line). (Reprinted from *Journal of Verbal Learning and Verbal Behavior, 5,* M. Glanzer & A. R. Cunitz, "Two Storage Mechanisms in Free Recall," pp. 351–360, Figures 1 & 3, Copyright © 1966, with permission from Elsevier.)

Table 6.1 Primacy and Recency Effects

Effect	Why Does It Occur?	How Can It Be Changed?
Primacy Effect		
Better memory for words at the beginning of the serial-position curve.	Words are rehearsed during presentation of the list, so they get into LTM.	To increase, present the list more slowly, so there is more time for rehearsal (see Figure 6.6a).
Recency Effect		
Better memory for words at the end of the serial-position curve.	Words are still in STM.	To decrease, test after waiting 30 seconds after end of the list, so information is lost from STM (see Figure 6.6b).

tional explanations have been proposed to explain memory for the middle words. See Neath & Suprenant, 2003, for details.)

Superior memory for stimuli presented at the end of a sequence is called the **recency effect**. One possible explanation for the better memory for words at the end of the list is that the most recently presented words are still in STM. To test this idea, Glanzer and Cunitz had their participants count backward for 30 seconds right after hearing the last word of a list. This counting prevented rehearsal and allowed time for information to be lost from STM. The result was what we would predict: The delay caused by the counting eliminated the effect (dashed curve in Figure 6.6b). Glanzer and Cunitz therefore concluded that the recency effect is due to storage of recently presented items in STM (Table 6.1).

But what is the evidence that short-term/working memory and long-term memory are separate processes? After all, there could be only one process that handles memories for both recent events and later events. We will now see how neuropsychological evidence has shown that STM/working memory and LTM are, in fact, two separate processes.

Neuropsychological Evidence In Chapter 2 we introduced the technique of determining dissociations, which is used to draw conclusions from case studies of brain-damaged patients (see Method: Neuropsychology, p. 43). This technique has been used in memory research to differentiate between STM and LTM by identifying people with brain damage that has affected one of these functions while sparing the other. We will see that studies of patients have established a double dissociation between STM and LTM. That is, there are some patients with functioning STM who can't form new LTMs and other patients who have poor STM but functioning LTM. Taken together, these two types of patients establish a double dissociation, which indicates that STM and LTM operate independently and are served by different mechanisms.

In Chapter 5 we described Clive Wearing, the musician who lost his memory due to viral encephalitis and who has a functioning STM but is unable to form new

Table 6.2 A Double Dissociation for STM and LTM

	STM	LTM
Clive Wearing and H.M.	OK	Impaired
K.F.	Impaired	OK

LTMs. Another case of functioning STM but absent LTM is the case of H.M., who became one of the most famous cases in neuropsychology when surgeons removed his hippocampus (see Figure 5.24) in an attempt to eliminate epileptic seizures that had not responded to other treatments (Scoville & Milner, 1957).

The operation eliminated H.M.'s seizures, but unfortunately also eliminated his ability to form new LTMs. Thus, the outcome of H.M.'s case is similar to that of Clive Wearing's, except Clive Wearing's brain damage was caused by disease, and H.M.'s was caused by surgery. H.M.'s unfortunate situation occurred because in 1953 the surgeons did not realize that the hippocampus is crucial for the formation of LTMs. Once they realized the devastating effects of removing the hippocampus, H.M.'s operation was never repeated. However, H.M. has been studied for over 50 years and has taught us a great deal about memory. The property of H.M.'s memory that is important for distinguishing between STM and LTM is the demonstration that it is possible to lose the ability to form new LTMs while still retaining STM.

There are also people with the opposite problem: normal LTM but poor STM. Patient K.F.'s problem with STM was indicated by her reduced digit span—the number of digits she could remember (see p. 148; Shallice & Warrington, 1970). Whereas the typical span is between 5 and 8 digits, K.F. had a digit span of 2 and, in addition, the recency effect in her serial-position curve, which is associated with STM, was reduced. Even though K.F.'s STM was greatly impaired, she had a functioning LTM, as indicated by her ability to form and hold new memories of events in her life. (See Think About It on page 231 for more on K.F.)

Table 6.2, which indicates which aspects of memory are impaired and which are intact for Clive Wearing, H.M., and K.F., demonstrates that a double dissociation exists for STM and LTM. We can conclude, therefore, that STM and LTM are caused by different mechanisms, which can act independently.

Coding in Long-Term Memory We can also distinguish between STM and LTM by comparing the way information is coded by the two systems. In Chapter 5 we saw that auditory, visual, and semantic coding can occur for STM. LTM can also involve each of these types of coding. For example, you use visual coding in LTM when you recognize someone based on his or her appearance, auditory coding when you recognize a person based on the sound of his or her voice, and semantic coding when you remember the general gist or meaning of something that happened in the past.

Although *some* semantic coding does occur in STM, semantic coding is the *predominant* type of coding in LTM. Semantic encoding is illustrated by the kinds of errors that people make in tasks that involve LTM. For example, remembering the word "tree" as "bush" would indicate that the meaning of the word "tree" (rather than its visual appearance or the sound of saying "tree") is what was registered in LTM.

Jacqueline Sachs (1967) demonstrated the importance of meaning in LTM by having participants listen to a tape recording of a passage like the one in the following demonstration.

Demonstration

Reading a Passage

Read the following passage:

> There is an interesting story about the telescope. In Holland, a man named Lippershey was an eyeglass maker. One day his children were playing with some lenses. They discovered that things seemed very close if two lenses were held about a foot apart. Lippershey began experimenting and his "spyglass" attracted much attention. He sent a letter about it to Galileo, the great Italian scientist. Galileo at once realized the importance of the discovery and set about to build an instrument of his own.

Now cover up the passage and indicate which of the following sentences is identical to a sentence in the passage and which sentences are changed.

1. He sent a letter about it to Galileo, the great Italian scientist.
2. Galileo, the great Italian scientist, sent him a letter about it.
3. A letter about it was sent to Galileo, the great Italian scientist.
4. He sent Galileo, the great Italian scientist, a letter about it.

Which sentence did you pick? Sentence 1 is the only one that is identical to one in the passage. Many of Sachs's participants (who heard a passage about two times as long as the one you read) correctly identified (1) as being identical and knew that (2) was changed. However, a number of people identified (3) and (4) as matching one in the passage, even though the wording was different. These participants apparently remembered the sentence's meaning and not its exact wording. The finding that specific wording is forgotten but the general meaning can be remembered for a long time has been confirmed in many experiments. Semantic coding in LTM is important not only for remembering stories, but events from the past as well.

Types of Long-Term Memory

So far, we have been discussing LTM in general. But researchers have found it useful to distinguish between different types of LTM. The most basic division of LTM is between *declarative memory* and *implicit memory*. **Declarative memory** is our conscious recollection of events we have experienced or facts we have learned. **Implicit (**or **non-declarative) memory** is memory that occurs when a past experience influences behavior, but we are not aware of the experience that is influencing the behavior (Figure 6.7).

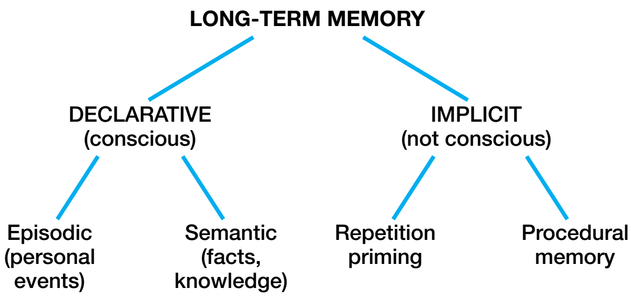


Figure 6.7 Long-term memory can be divided into declarative memory and implicit memory. We can also distinguish between two types of declarative memory, episodic and semantic. There are a number of different types of implicit memory. Two of the main types are repetition priming and procedural memory.

Declarative Memory

Most memory researchers distinguish between two types of declarative memory. **Episodic memory** is memory for personal events in our lives. For example, remembering visiting your grandfather's house when you were 10 is an example of episodic memory. **Semantic memory** involves facts and knowledge, such as knowledge about how an automobile engine works or the names of famous modern painters.

Episodic and Semantic Memory

When we say that episodic memory is memory for events and semantic memory is memory for facts, we are distinguishing between these two types of memory based on the types of *information* remembered. Endel Tulving (1985) has, however, suggested that episodic and semantic memory can also be distinguished based on the type of *experience* associated with each (also see Gardiner, 2001; Wheeler et al., 1997).

The defining property of the *experience* of episodic memory is that it involves **mental time travel**. When we are having an episodic memory we are traveling back in time to reconnect with events that happened in the past. For example, I can travel back in my mind to 1996 to remember cresting the top of a mountain near the California coast for the first time and seeing the Pacific Ocean far below, stretching into the distance. I remember sitting in the car, seeing the ocean, saying "Wow!" to my wife who was sitting next to me, and some of the emotions I was experiencing. Tulving describes this experience of episodic memory as **self-knowing** or **remembering**, with the idea that *remembering* always involves mental time travel. Note, however, that putting oneself back in a situation through mental time travel does not guarantee that the memory is accurate. As we will see in the next chapter, memories of events from our past do not always correspond to what actually happened.

In contrast to the mental time travel property of episodic memory, the experience of semantic memory involves accessing knowledge about the world that does not have to be tied to any specific personal experience. This knowledge can be things like facts, vocabulary, numbers, and concepts. When we experience semantic memory, we are not traveling

Table 6.3 Episodic and Semantic Memory

Type of Memory	Information	Characteristics	Consciousness (Tulving)
Episodic	Personally experienced events	"Mental time travel" that revisits past experiences	Self-knowing
Semantic	Facts, knowledge about the world	Knowledge, without mental time travel	Knowing

back to a specific experience in our past, but we are experiencing things we are familiar with and know about. For example, I know many facts about the Pacific Ocean—where it is located, that it is big, that if you travel west from San Francisco you end up in Japan. All of these things are semantic memories. Tulving describes the experience of semantic memory as **knowing**, with the idea that *knowing* does not involve mental time travel.

The distinctions between episodic and semantic memory are summarized in Table 6.3. We will now consider the evidence that supports the idea that episodic and semantic memories are served by different mechanisms.

The Separation of Episodic and Semantic Memories

It is possible to classify some memories as episodic and others as semantic, but is there any evidence to support the idea that there are two types of long-term memory that are served by different mechanisms? Neuropsychological research on people with different kinds of brain damage provides evidence for these differences.

Neuropsychological Evidence We first consider the case of K.C., who at the age of 30 rode his motorcycle off a freeway exit ramp and suffered severe damage to his hippocampus and surrounding structures (Rosenbaum et al., 2005). Because of this injury, K.C. lost his episodic memory—he can no longer relive any of the events of his past. He can, however, remember that certain things happened. For example, K.C. knows that his brother died—an event that occurred 2 years before the accident. He is not, however, aware of experiencing things such as hearing about the circumstances of his brother's death, where he was when he heard about it, or what happened at the funeral. K.C. also remembers facts like where the eating utensils are located in the kitchen and the difference between a strike and a spare in bowling. Thus, K.C. has lost the episodic part of his memory, but his semantic memory is largely intact.

A person whose brain damage resulted in symptoms opposite to those experienced by K.C. is an Italian woman who was in normal health until she suffered an attack of encephalitis at the age of 44 (DeRenzi et al., 1987). The first signs of a problem were headaches and a fever, which were later followed by hallucinations lasting for 5 days. When she returned home after a 6-week stay in the hospital, she had difficulty recog-

Table 6.4 Dissociations of Episodic and Semantic Memory

	Semantic	Episodic
K.C.	OK	Poor
Italian woman	Poor	OK

nizing familiar people; she had trouble shopping because she couldn't remember the meaning of words on the shopping list or where things were in the store; and she could no longer recognize famous people or recall facts such as the identity of Beethoven or the fact that Italy was involved in World War II. All of these are semantic memories.

Despite this severe impairment of memory for semantic information, the woman's episodic memory for events in her life was preserved. She could remember what she had done during the day and things that had happened weeks or months before. Table 6.4 summarizes the two cases we have described. These cases, taken together, demonstrate a double dissociation between episodic and semantic memory, which supports the idea that memory for these two different types of information probably involves different mechanisms.

Although the double dissociation shown in Table 6.4 supports the idea of separate mechanisms for semantic and episodic memory, not all researchers agree that a double dissociation has been demonstrated, and so research continues on how brain damage affects LTM. (See Squire & Zola-Morgan, 1998, and Tulving & Markowitsch, 1998, for further discussion of this evidence.) There is, however, evidence from brain imaging experiments that retrieving episodic and semantic memories activates different areas of the brain.

Brain Imaging Evidence Evidence for separate mechanisms has also been provided by the results of brain imaging experiments. Brian Levine and coworkers (2004) had participants keep diaries of audiotaped descriptions of everyday events (example: "It was the last night of our Salsa dance class. . . . People were dancing all different styles of Salsa. . . ."), and facts drawn from their world knowledge ("By 1947, there were 5,000 Japanese Canadians living in Toronto").

When the participants later listened to these descriptions while in an MRI scanner, the everyday experiences elicited retrieval of episodic memories, and the facts elicited retrieval of semantic memories. The results were complicated, because many brain areas were involved, but the overall conclusion of this study was that retrieving episodic and semantic memories causes overlapping but different patterns of brain activity. Other research comparing brain activity during episodic and semantic retrieval has also found differences between the areas activated by episodic and semantic memory (Cabeza & Nyberg, 2000; Duzel et al., 1999; Nyberg et al., 1996).

Connections Between Episodic and Semantic Memories

The distinctions between episodic and semantic memories have been extremely useful for understanding memory mechanisms. But although we can distinguish between episodic and semantic memory, we can also show that there are connections between them.

Episodic Memories Can Be Lost, Leaving Only Semantic First consider how we acquire the knowledge that makes up our semantic memories. Sitting in the sixth grade, you learn about how the U.S. government works. Then in the seventh grade you look back and remember what was going on in class as you were learning about U.S. government. Placing yourself back in the class and remembering what was happening is episodic memory. Later, in college, you still remember the information you learned in the sixth grade and may even know that you learned about U.S. government in the sixth grade. However, if you have lost the episodic component of this memory and can no longer remember the specific day you were sitting there in class, you are experiencing a semantic memory. This example illustrates that the knowledge that makes up semantic memories is initially attained through a personal experience that could be the basis of an episodic memory, but that memory for this experience often fades, leaving only semantic memory.

This kind of "morphing" from episodic to semantic memory can also occur for personal experiences. For example, consider graduating from high school. This is an important event in many people's lives, and one that they may remember for many years. It is likely that many of the readers of this book can clearly place themselves at their high school graduation. Memory for many of the details of this event may, however, fade over the years, until many years later, not enough of the details remain to achieve the mental time travel required for episodic memory. Nonetheless, semantic memory remains, if the person knows the year they graduated, the high school they graduated from, and other facts associated with their graduation.

Semantic Memory Can Be Enhanced If Associated With Episodic Memory Semantic memories that have personal significance, which are called **personal semantic memories**, are easier to remember than semantic memories that are not personally significant. For example, knowledge about the facts associated with your high school graduation would be personal semantic memories because your high school graduation has personal significance for you. Robyn Westmacott and Morris Moscovitch (2003) showed that participants have better recall for names of public figures such as actors, singers, and politicians whom they associated with personal experiences. For example, you would be more likely to recall the name of a popular singer in a memory test if you had attended one of his or her concerts than if you had just read about the singer in magazines.

Semantic Memory Can Influence Our Experience by Influencing Attention Consider this situation: Steven and Seth are watching a football game. The quarterback takes the snap, is rushed hard, and flips the ball over the oncoming linemen for a completion. Later, Seth remembers the details of the play, which was a pass over the left side, but the play doesn't stand out for Stephen. Seth remembers the play because his semantic memory, which contains knowledge about football, caused him to direct his attention to what various players were doing as the play unfolded. Thus, Seth's semantic memory helped direct his attention, so he formed memories about specific plays, but Stephen just remembered that there were running plays and passing plays (Figure 6.8).