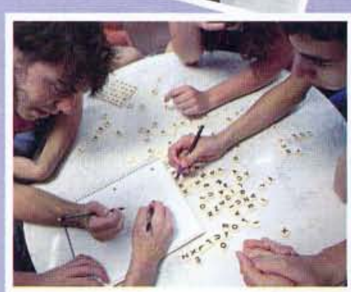
Unit VII




Cognition

Modules

31 Studying and Building Memories

32 Memory Storage and Retrieval

33 Forgetting, Memory Construction, and Memory Improvement

34 Thinking, Concepts, and Creativity

35 Solving Problems and Making Decisions

36 Thinking and Language

I revised this unit's first three modules after collaborating with Janie Wilson, Professor of Psychology at Georgia Southern University and Vice President for Programming of the Society for the Teaching of Psychology.

Throughout history, we humans have both bemoaned our foolishness and celebrated our wisdom. The poet T. S. Eliot was struck by "the hollow men . . . Headpiece filled with straw." But Shakespeare's Hamlet extolled the human species as "noble in reason! . . . infinite in faculties! . . . in apprehension how like a god!" In the preceding units, we have likewise marveled at both our abilities and our errors.

Elsewhere in this text, we study the human brain—three pounds of wet tissue the size of a small cabbage, yet containing circuitry more complex than the planet's telephone networks. We appreciate the amazing abilities of newborns. We marvel at our sensory system, translating visual stimuli into nerve impulses, distributing them for parallel processing, and reassembling them into colorful perceptions. Little wonder that our species has had the collective genius to invent the camera, the car, and the computer; to unlock the atom and crack the genetic code; to travel out to space and into our brain's depths.

Yet we have also seen that our species is kin to the other animals, influenced by the same principles that produce learning in rats and pigeons. We have noted that we not-so-wise humans are easily deceived by perceptual illusions, pseudopsychic claims, and false memories.

In this unit, we encounter further instances of these two images of the human condition—the rational and the irrational. We will ponder our memory's enormous capacity, and the ease with which our two-track mind processes information, with and without our awareness. We will consider how we use and misuse the information we receive, perceive, store, and retrieve. We will look at our gift for language and consider how and why it develops. And we will reflect on how deserving we are of our species name, *Homo sapiens*—wise human.

Module 31

Studying and Building Memories

Module Learning Objectives

- **31-1** Define *memory.*
- **31-2** Explain how psychologists describe the human memory system.
- **31-3** Distinguish between explicit and implicit memories.
- **31-4** Identify the information we process automatically.
- **31-5** Explain how sensory memory works.
- **31-6** Describe the capacity of our short-term and working memory.
- **31-7** Describe the effortful processing strategies that help us remember new information.
- **31-8** Describe the levels of processing and their effect on encoding.

Be thankful for memory. We take it for granted, except when it malfunctions. But it is our memory that accounts for time and defines our life. It is our memory that enables us to recognize family, speak our language, find our way home, and locate food and water. It is our memory that enables us to enjoy an experience and then mentally replay and enjoy it again. And it is our memory that occasionally pits us against those whose offenses we cannot forget.

AP® Exam Tip

The next three modules deal with memory. Not only is this a significant topic on the AP® exam, it is also one of the most practical topics in psychology, especially if you're a student! Some of your preconceptions about memory may be accurate and some may not. As you read, think about how you can apply what you're learning in order to be a better student.

memory the persistence of learning over time through the encoding, storage, and retrieval of information.

In large part, we are what we remember. Without memory—our storehouse of accumulated learning—there would be no savoring of past joys, no guilt or anger over painful recollections. We would instead live in an enduring present, each moment fresh. But each person would be a stranger, every language foreign, every task—dressing, eating, biking—a new challenge. You would even be a stranger to yourself, lacking that continuous sense of self that extends from your distant past to your momentary present.

Studying Memory

31-1 What is memory?

To a psychologist, **memory** is learning that has persisted over time; it is information that has been acquired, stored, and can be retrieved.

Research on memory's extremes has helped us understand how memory works. At age 92, my father suffered a small stroke that had but one peculiar effect. He was as mobile as before. His genial personality was intact. He knew us and enjoyed poring over family photo albums and reminiscing about his past. But he had lost most of his ability to lay down new memories of conversations and everyday episodes. He could not tell me what day of the week it was, or what he'd had for lunch. Told repeatedly of his brother-in-law's death, he was surprised and saddened each time he heard the news.

At the other extreme are people who would be gold medal winners in a memory Olympics. Russian journalist Shereshevskii, or S, had merely to listen while other reporters scribbled notes (Luria, 1968). You and I could parrot back a string of about 7—maybe even 9—digits. S could repeat up to 70, if they were read about 3 seconds apart in an otherwise silent room. Moreover, he could recall digits or words backward as easily as forward. His accuracy was unerring, even when recalling a list as much as 15 years later. "Yes, yes," he might recall. "This was a series you gave me once when we were in your apartment. . . . You were sitting at the table and I in the rocking chair. . . . You were wearing a gray suit. . . ."

Amazing? Yes, but consider your own impressive memory. You remember countless voices, sounds, and songs; tastes, smells, and textures; faces, places, and happenings. Imagine viewing more than 2500 slides of faces and places for 10 seconds each. Later, you see 280 of these slides, paired with others you've never seen. Actual participants in this experiment recognized 90 percent of the slides they had viewed in the first round (Haber, 1970). In a follow-up experiment, people exposed to 2800 images for only 3 seconds each spotted the repeats with 82 percent accuracy (Konkle et al., 2010).

Figure 31.1
What is this? People who had, 17 years earlier, seen the complete image (in Figure 31.4 when you turn the page) were more likely to recognize this fragment, even if they had forgotten the earlier experience (Mitchell, 2006).

Or imagine yourself looking at a picture fragment, such as the one in **FIGURE 31.1.** Also imagine that you had seen the complete picture for a couple of seconds 17 years earlier. This, too, was a real experiment, and participants who had previously seen the complete drawings were more likely to identify the objects than were members of a control group (Mitchell, 2006). Moreover, the picture memory reappeared even for those who did not consciously recall participating in the long-ago experiment!

How do we accomplish such memory feats? How does our brain pluck information out of the world around us and tuck that information away for later use? How can we remember things we have not thought about for years, yet forget the name of someone we met a minute ago? How are memories stored in our brains? Why will you be likely, later in this module, to misrecall this sentence: *"The angry rioter threw the rock at the window"*? In this and the next two modules, we'll consider these fascinating questions and more, including tips on how we can improve our own memories.

Memory Models

31-2 How do psychologists describe the human memory system?

Architects make miniature house models to help clients imagine their future homes. Similarly, psychologists create memory models to help us think about how our brain forms and retrieves memories. *Information-processing models* are analogies that compare human memory to a computer's operations. Thus, to remember any event, we must

- *get information into our brain,* a process called **encoding.**
- *retain that information,* a process called **storage.**
- later *get the information back out,* a process called **retrieval.**

Like all analogies, computer models have their limits. Our memories are less literal and more fragile than a computer's. Moreover, most computers process information sequentially, even while alternating between tasks. Our dual-track brain processes many things simultaneously (some of them unconsciously) by means of **parallel processing**. As you enter the lunchroom, you simultaneously—in parallel—process information about the people you see, the sounds of voices, and the smell of the food.

To focus on this complex, simultaneous processing, one information-processing model, *connectionism,* views memories as products of interconnected neural networks. Specific memories arise from particular activation patterns within these networks. Every time you learn something new, your brain's neural connections change, forming and strengthening pathways that allow you to interact with and learn from your constantly changing environment.

To explain our memory-forming process, Richard Atkinson and Richard Shiffrin (1968) proposed another model, with three stages:

1. We first record to-be-remembered information as a fleeting **sensory memory.**
2. From there, we process information into **short-term memory,** where we encode it through *rehearsal.*
3. Finally, information moves into **long-term memory** for later retrieval.

Other psychologists have updated this model (**FIGURE 31.2**) to include important newer concepts, including *working memory* and *automatic processing*.

WORKING MEMORY

Alan Baddeley and others (Baddeley, 2001, 2002; Engle, 2002) challenged Atkinson and Shiffrin's view of short-term memory as a small, brief storage space for recent thoughts and experiences. Research shows that this stage is not just a temporary shelf for holding incoming information. It's an active desktop where your brain processes information, making sense of new input and linking it with long-term memories. Whether we hear *eye-screem* as "ice cream" or "I scream" will depend on how the context and our experience guide us in interpreting and encoding the sounds.

encoding the processing of information into the memory system—for example, by extracting meaning.

storage the process of retaining encoded information over time.

retrieval the process of getting information out of memory storage.

parallel processing the processing of many aspects of a problem simultaneously; the brain's natural mode of information processing for many functions. Contrasts with the step-by-step (serial) processing of most computers and of conscious problem solving.

sensory memory the immediate, very brief recording of sensory information in the memory system.

short-term memory activated memory that holds a few items briefly, such as the seven digits of a phone number while dialing, before the information is stored or forgotten.

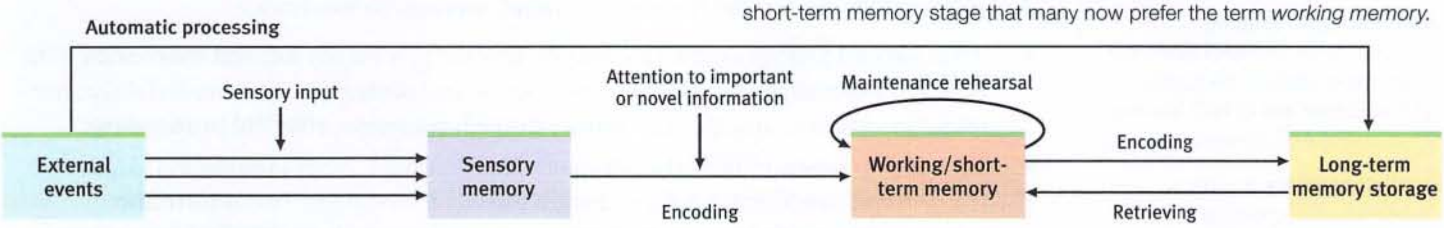
long-term memory the relatively permanent and limitless storehouse of the memory system. Includes knowledge, skills, and experiences.

AP® Exam Tip

You will see several versions of Figure 31.2 as you work your way through Modules 31, 32, and 33. Pay attention! This model may look confusing now, but will make more and more sense as its components are described in more detail.

Figure 31.2

A modified three-stage processing model of memory Atkinson and Shiffrin's classic three-step model helps us to think about how memories are processed, but today's researchers recognize other ways long-term memories form. For example, some information slips into long-term memory via a "back door," without our consciously attending to it (*automatic processing*). And so much active processing occurs in the short-term memory stage that many now prefer the term *working memory.*



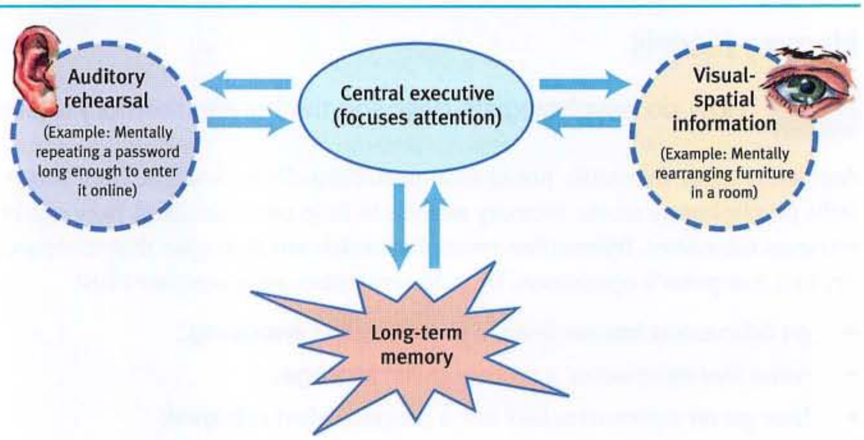


Figure 31.3
Working memory Alan Baddeley's (2002) model of working memory, simplified here, includes *visual* and *auditory rehearsal* of new information. A hypothetical *central executive* (manager) focuses attention and pulls information from long-term memory to help make sense of new information.

To emphasize the active processing that takes place in this middle stage, psychologists use the term **working memory.** Right now, you are using your working memory to link the information you're reading with your previously stored information (Cowan, 2010; Kail & Hall, 2001).

The pages you are reading may enter working memory through vision. You might also repeat the information using auditory rehearsal. As you integrate these memory inputs with your existing long-term memory, your attention is focused. Baddeley (2002) suggested a *central executive* handles this focused processing (**FIGURE 31.3**).

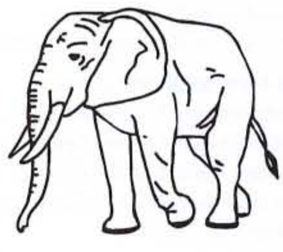


Figure 31.4
Now you know People who had seen this complete image were, 17 years later, more likely to recognize the fragment in Figure 31.1.

Without focused attention, information often fades. In one experiment, people read and typed new information they would later need, such as "An ostrich's eye is bigger than its brain." If they knew the information would be available online, they invested less energy in remembering, and they remembered the trivia less well (Sparrow et al., 2011). Sometimes Google replaces rehearsal.

Before You Move On

► **ASK YOURSELF**

How have you used the three parts of your memory system (encoding, storage, and retrieval) in learning something new today?

► **TEST YOURSELF**

Memory includes (in alphabetical order) long-term memory, sensory memory, and working/short-term memory. What's the correct order of these three memory stages?

Answers to the Test Yourself questions can be found in Appendix E at the end of the book.

working memory a newer understanding of short-term memory that focuses on conscious, active processing of incoming auditory and visual-spatial information, and of information retrieved from long-term memory.

explicit memory memory of facts and experiences that one can consciously know and "declare." (Also called *declarative memory.*)

effortful processing encoding that requires attention and conscious effort.

automatic processing unconscious encoding of incidental information, such as space, time, and frequency, and of well-learned information, such as word meanings.

implicit memory retention independent of conscious recollection. (Also called *nondeclarative memory.*)

Building Memories: Encoding

Dual-Track Memory: Effortful Versus Automatic Processing

31-3 How do explicit and implicit memories differ?

As we have seen throughout this text, our mind operates on two tracks:

- Atkinson and Shiffrin's model focused on how we process our **explicit memories**—the facts and experiences we can consciously know and declare (thus, also called *declarative memories*). We encode explicit memories through conscious, **effortful processing.**
- Behind the scenes, outside the Atkinson-Shiffrin stages, other information skips the conscious encoding track and barges directly into storage. This **automatic processing,** which happens without our awareness, produces **implicit memories** (also called *nondeclarative memories*).

Automatic Processing and Implicit Memories

31-4 What information do we automatically process?

Our implicit memories include *procedural* memory for automatic skills (such as how to ride a bike) and classically conditioned *associations* among stimuli. Visiting your dentist, you may, thanks to a conditioned association linking the dentist's office with the painful drill, find yourself with sweaty palms. You didn't plan to feel that way when you got to the dentist's office; it happened *automatically*.

Without conscious effort you also automatically process information about

- *space.* While studying, you often encode the place on a page or in your notebook where certain material appears; later, when you want to retrieve information about automatic processing, for example, you may visualize the location of that information on this page.
- *time.* While going about your day, you unintentionally note the sequence of its events. Later, realizing you've left your backpack somewhere, the event sequence your brain automatically encoded will enable you to retrace your steps.
- *frequency.* You effortlessly keep track of how many times things happen, as when you suddenly realize, *This is the third time I've run into her today.*

Our two-track mind engages in impressively efficient information processing. As one track automatically tucks away many routine details, the other track is free to focus on conscious, effortful processing. This reinforces an important principle introduced in Module 18's description of parallel processing: Mental feats such as vision, thinking, and memory may seem to be single abilities, but they are not. Rather, we split information into different components for separate and simultaneous processing.

Effortful Processing and Explicit Memories

Automatic processing happens so effortlessly that it is difficult to shut off. When you see words in your native language, perhaps on the side of a delivery truck, you can't help but read them and register their meaning. *Learning* to read wasn't automatic. You may recall working hard to pick out letters and connect them to certain sounds. But with experience and practice, your reading became automatic. Imagine now learning to read reversed sentences like this:

.citamotua emoceb nac gnissecorp luftroffE

At first, this requires effort, but after enough practice, you would also perform this task much more automatically. We develop many skills in this way. We learn to drive, to text, to speak a new language with effort, but then these tasks become automatic.

SENSORY MEMORY

31-5 How does sensory memory work?

Sensory memory (recall Figure 31.2) feeds our active working memory, recording momentary images of scenes or echoes of sounds. How much of this page could you sense and recall with less exposure than a lightning flash? In one experiment (Sperling, 1960), people viewed three rows of three letters each, for only one-twentieth of a second (**FIGURE 31.5**). After the nine letters disappeared, they could recall only about half of them.

Was it because they had insufficient time to glimpse them? *No.* The researcher, George Sperling, cleverly demonstrated that people actually *could* see and recall all the letters, but only momentarily. Rather than ask them to recall all nine letters at

Figure 31.5

Total recall—briefly When George Sperling flashed a group of letters similar to this for one-twentieth of a second, people could recall only about half the letters. But when signaled to recall a particular row immediately after the letters had disappeared, they could do so with near-perfect accuracy.

K	Z	R
Q	B	T
S	G	N

iconic memory a momentary sensory memory of visual stimuli; a photographic or picture-image memory lasting no more than a few tenths of a second.

echoic memory a momentary sensory memory of auditory stimuli; if attention is elsewhere, sounds and words can still be recalled within 3 or 4 seconds.

once, he sounded a high, medium, or low tone immediately *after* flashing the nine letters. This tone directed participants to report only the letters of the top, middle, or bottom row, respectively. Now they rarely missed a letter, showing that all nine letters were momentarily available for recall.

Sperling's experiment demonstrated **iconic memory,** a fleeting sensory memory of visual stimuli. For a few tenths of a second, our eyes register a photographic or picture-image memory of a scene, and we can recall any part of it in amazing detail. But if Sperling delayed the tone signal by more than half a second, the image faded and participants again recalled only about half the letters. Our visual screen clears quickly, as new images are superimposed over old ones.

We also have an impeccable, though fleeting, memory for auditory stimuli, called **echoic memory** (Cowan, 1988; Lu et al., 1992). Picture yourself in class, as your attention veers to thoughts of the weekend. If your mildly irked teacher tests you by asking, "What did I just say?" you can recover the last few words from your mind's echo chamber. Auditory echoes tend to linger for 3 or 4 seconds.

CAPACITY OF SHORT-TERM AND WORKING MEMORY

31-6 What is the capacity of our short-term and working memory?

FYI

The Magical Number Seven has become psychology's contribution to an intriguing list of magic sevens—the Seven Wonders of the Ancient World, the seven seas, the seven deadly sins, the seven primary colors, the seven musical scale notes, the seven days of the week—seven magical sevens.

George Miller (1956) proposed that short-term memory can retain about seven information bits (give or take two). Other researchers have confirmed that we can, if nothing distracts us, recall about seven digits, or about six letters or five words (Baddeley et al., 1975). How quickly do our short-term memories disappear? To find out, researchers asked people to remember three-consonant groups, such as *CHJ* (Peterson & Peterson, 1959). To prevent rehearsal, the researchers asked them, for example, to start at 100 and count aloud backward by threes. After 3 seconds, people recalled the letters only about half the time; after 12 seconds, they seldom recalled them at all (**FIGURE 31.6**). Without the active processing that we now understand to be a part of our working memory, short-term memories have a limited life.

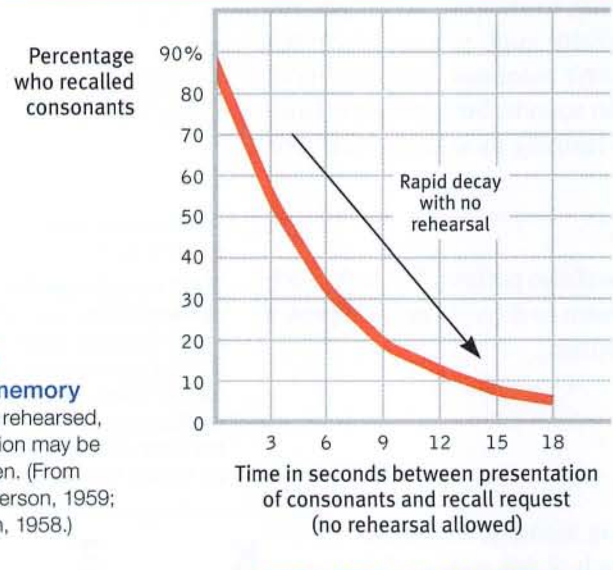


Figure 31.6
Short-term memory decay Unless rehearsed, verbal information may be quickly forgotten. (From Peterson & Peterson, 1959; see also Brown, 1958.)

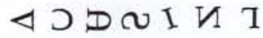
Working-memory capacity varies, depending on age and other factors. Compared with children and older adults, young adults have more working-memory capacity, so they can use their mental workspace more efficiently. This means their ability to multitask is relatively greater. But whatever our age, we do better and more efficient work when focused, without distractions, on one task at a time. "One of the most stubborn, persistent phenomenon of the mind," notes cognitive psychologist Daniel Willingham (2010), "is that when you do two things at once, you don't do either one as well as when you do them one at a time." *The bottom line:* It's probably a bad idea to try to watch TV, text your friends, and write a psychology paper all at the same time!

EFFORTFUL PROCESSING STRATEGIES

31-7 What are some effortful processing strategies that can help us remember new information?

Research shows that several effortful processing strategies can boost our ability to form new memories. Later, when we try to retrieve a memory, these strategies can make the difference between success and failure.

CHUNKING Glance for a few seconds at row 1 of **FIGURE 31.7,** then look away and try to reproduce what you saw. Impossible, yes? But you can easily reproduce the second row, which is no less complex. Similarly, you will probably find row 4 much easier to remember than row 3, although both contain the same letters. And you could remember the sixth cluster more easily than the fifth, although both contain the same words. As these units demonstrate, **chunking** information—organizing items into familiar, manageable units—enables us to recall it more easily. Try remembering 43 individual numbers and letters. It would be impossible, unless chunked into, say, seven meaningful chunks, such as "Try remembering 43 individual numbers and letters."☺

1. 

2. K L C I S N E

3. KLCISNE NVESE YNA NI CSTTIH TNDO
4. NICKELS SEVEN ANY IN STITCH DONT

5. NICKELS SEVEN ANY IN STITCH DONT SAVES AGO A SCORE TIME AND NINE WOODEN FOUR YEARS TAKE

6. DONT TAKE ANY WOODEN NICKELS FOUR SCORE AND SEVEN YEARS AGO A STITCH IN TIME SAVES NINE

Figure 31.7
Effects of chunking on memory When we organize information into meaningful units, such as letters, words, and phrases, we recall it more easily. (From Hintzman, 1978.)

Chunking usually occurs so naturally that we take it for granted. If you are a native English speaker, you can reproduce perfectly the 150 or so line segments that make up the words in the three phrases of item 6 in Figure 31.7. It would astonish someone unfamiliar with the language. I am similarly awed at a Chinese reader's ability to glance at **FIGURE 31.8** and then reproduce all the strokes; or of a varsity basketball player's recall of the positions of the players after a 4-second glance at a basketball play (Allard & Burnett, 1985). We all remember information best when we can organize it into personally meaningful arrangements.

春
夏
秋
冬

Figure 31.8
An example of chunking—for those who read Chinese After looking at these characters, can you reproduce them exactly? If so, you are literate in Chinese.

MNEMONICS To help them encode lengthy passages and speeches, ancient Greek scholars and orators also developed **mnemonics** (nih-MON-iks). Many of these memory aids use vivid imagery, because we are particularly good at remembering mental pictures. We more easily remember concrete, visualizable words than we do abstract words. (When I quiz you later, in Module 33, which three of these words—*bicycle, void, cigarette, inherent, fire, process*—will you most likely recall?) If you still recall the rock-throwing rioter sentence, it is probably not only because of the meaning you encoded but also because the sentence painted a mental image.

The *peg-word system* harnesses our superior visual-imagery skill. This mnemonic requires you to memorize a jingle: *"One is a bun; two is a shoe; three is a tree; four is a door; five is a hive; six is sticks; seven is heaven; eight is a gate; nine is swine; ten is a hen."* Without much effort, you will soon be able to count by peg words instead of numbers: *bun, shoe, tree* . . . and then to visually associate the peg words with to-be-remembered items. Now you are ready to challenge anyone to give you a grocery list to remember. Carrots? Stick them into the imaginary bun. Milk? Fill the shoe with it. Paper towels? Drape them over the tree branch. Think *bun, shoe, tree* and you see their associated images: carrots, milk, paper towels. With few errors, you will be able to recall the items in any order and to name any given item (Bugelski et al., 1968). Memory whizzes understand the power of such systems. A study of star performers in the World Memory Championships showed them not to have exceptional intelligence, but rather to be superior at using mnemonic strategies (Maguire et al., 2003).

Chunking and mnemonic techniques combined can be great memory aids for unfamiliar material. Want to remember the colors of the rainbow in order of wavelength? Think of the mnemonic ROY G. BIV (*r*ed, *o*range, *y*ellow, *g*reen, *b*lue, *i*ndigo, *v*iolet). Need to recall the names of North America's five Great Lakes? Just remember HOMES (*H*uron, *O*ntario, *M*ichigan, *E*rie, *S*uperior). In each case, we chunk information into a more familiar form by creating a word (called an *acronym*) from the first letters of the to-be-remembered items.

chunking organizing items into familiar, manageable units; often occurs automatically.

mnemonics [nih-MON-iks] memory aids, especially those techniques that use vivid imagery and organizational devices.

HIERARCHIES When people develop expertise in an area, they process information not only in chunks but also in *hierarchies* composed of a few broad concepts divided and subdivided into narrower concepts and facts. This section, for example, aims to help you organize some of the memory concepts we have been discussing (**FIGURE 31.9**).

Organizing knowledge in hierarchies helps us retrieve information efficiently, as Gordon Bower and his colleagues (1969) demonstrated by presenting words either randomly or grouped into categories. When the words were organized into categories, recall was two to three times better. Such results show the benefits of organizing what you study—of giving special attention to the module objectives, headings, and Ask Yourself and Test Yourself questions. Taking class and text notes in outline format—a type of hierarchical organization—may also prove helpful.

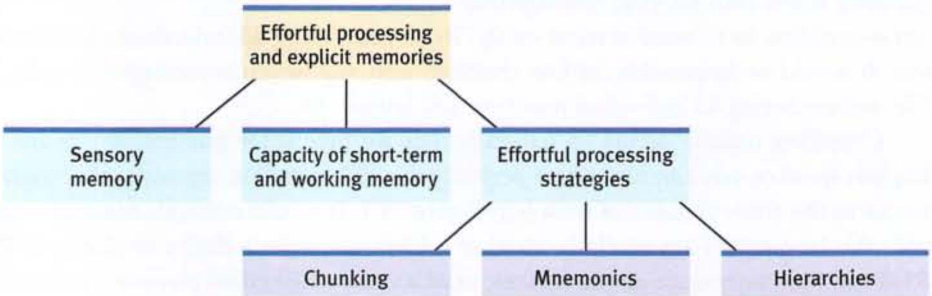


Figure 31.9
Hierarchies aid retrieval When we organize words or concepts into hierarchical groups, as illustrated here with some of the concepts from this section, we remember them better than when we see them presented randomly.

DISTRIBUTED PRACTICE

We retain information (such as classmates' names) better when our encoding is distributed over time. More than 300 experiments over the last century have consistently revealed the benefits of this **spacing effect** (Cepeda et al., 2006). *Massed practice* (cramming) can produce speedy short-term learning and a feeling of confidence. But to paraphrase pioneer memory researcher Hermann Ebbinghaus (1885), those who learn quickly also forget quickly. *Distributed practice* produces better long-term recall. After you've studied long enough to master the material, further study at that time becomes inefficient (Rohrer & Pashler, 2007). Better to spend that extra reviewing time later—a day later if you need to remember something 10 days hence, or a month later if you need to remember something 6 months hence (Cepeda et al., 2008).

"The mind is slow in unlearning what it has been long in learning."
-Roman philosopher Seneca (4 B.C.E.–65 C.E.)

AP® Exam Tip

It's not the studying you do in May that will determine your success on the AP® exam; it's the studying you do now. It's a good idea to take a little time each week to quickly review material from earlier in the course. When was the last time you looked at information from the previous units?

Spreading your learning over several months, rather than over a shorter term, can help you retain information for a lifetime. In a 9-year experiment, Harry Bahrick and three of his family members (1993) practiced foreign language word translations for a given number of times, at intervals ranging from 14 to 56 days. Their consistent finding: The longer the space between practice sessions, the better their retention up to 5 years later.

One effective way to distribute practice is *repeated self-testing,* a phenomenon that researchers Henry Roediger and Jeffrey Karpicke (2006) have called the **testing effect.** In this text, for example, the testing questions interspersed throughout and at the end of each module and unit offer such opportunities. Better to practice retrieval (as any exam will demand) than merely to reread material (which may lull you into a false sense of mastery).

The point to remember: Spaced study and self-assessment beat cramming and rereading. Practice may not make perfect, but smart practice—occasional rehearsal with self-testing—makes for lasting memories.

spacing effect the tendency for distributed study or practice to yield better long-term retention than is achieved through massed study or practice.

testing effect enhanced memory after retrieving, rather than simply rereading, information. Also sometimes referred to as a *retrieval practice effect* or *test-enhanced learning.*

shallow processing encoding on a basic level based on the structure or appearance of words.

LEVELS OF PROCESSING

31-8 What are the levels of processing, and how do they affect encoding?

Memory researchers have discovered that we process verbal information at different levels, and that depth of processing affects our long-term retention. **Shallow processing** encodes on a very basic level, such as a word's letters or, at a more intermediate level, a word's sound.

Making things memorable
For suggestions on how to apply the *testing effect* to your own learning, watch this 5-minute YouTube animation: tinyurl.com/HowToRemember.

Deep processing encodes *semantically,* based on the meaning of the words. The deeper (more meaningful) the processing, the better our retention.

deep processing encoding semantically, based on the meaning of the words; tends to yield the best retention.

In one classic experiment, researchers Fergus Craik and Endel Tulving (1975) flashed words at people. Then they asked the viewers a question that would elicit different levels of processing. To experience the task yourself, rapidly answer the following sample questions:

Sample Questions to Elicit Processing	Word Flashed	Yes	No
1. Is the word in capital letters?	CHAIR	______	______
2. Does the word rhyme with train?	brain	______	______
3. Would the word fit in this sentence? The girl put the __________ on the table.	doll	______	______

Which type of processing would best prepare you to recognize the words at a later time? In Craik and Tulving's experiment, the deeper, semantic processing triggered by the third question yielded a much better memory than did the shallower processing elicited by the second question or the very shallow processing elicited by question 1 (which was especially ineffective).

MAKING MATERIAL PERSONALLY MEANINGFUL

If new information is not meaningful or related to our experience, we have trouble processing it. Put yourself in the place of the students whom John Bransford and Marcia Johnson (1972) asked to remember the following recorded passage:

> The procedure is actually quite simple. First you arrange things into different groups. Of course, one pile may be sufficient depending on how much there is to do. . . . After the procedure is completed one arranges the materials into different groups again. Then they can be put into their appropriate places. Eventually they will be used once more and the whole cycle will then have to be repeated. However, that is part of life.

When the students heard the paragraph you have just read, without a meaningful context, they remembered little of it. When told the paragraph described washing clothes (something meaningful to them), they remembered much more of it—as you probably could now after rereading it.

AP® Exam Tip

Are you often pressed for time? The most effective way to cut down on the amount of time you need to spend studying is to increase the meaningfulness of the material. If you can relate the material to your own life—and that's pretty easy when you're studying psychology—it takes less time to master it.

Try This

Here is another sentence I will ask you about later (in Module 33): "The fish attacked the swimmer."

Can you repeat the sentence about the rioter that I gave you at this module's beginning? ("The angry rioter threw . . .") Perhaps, like those in an experiment by William Brewer (1977), you recalled the sentence by the meaning you encoded when you read it (for example, "The angry rioter threw the rock *through* the window") and not as it was written ("The angry rioter threw the rock *at* the window"). Referring to such mental mismatches, researchers have likened our minds to theater directors who, given a raw script, imagine the finished stage production (Bower & Morrow, 1990). Asked later what we heard or read, we recall not the literal text but *what we encoded*. Thus, studying for a test, you may remember your class notes rather than the class itself.

We can avoid some of these mismatches by rephrasing what we see and hear into meaningful terms. From his experiments on himself, German philosopher Hermann Ebbinghaus (1850–1909) estimated that, compared with learning nonsense material, learning meaningful material required one-tenth the effort. As memory researcher Wayne Wickelgren (1977, p. 346) noted, "The time you spend thinking about material you are reading and relating it to previously stored material is about the most useful thing you can do in learning any new subject matter."

Psychologist-actor team Helga Noice and Tony Noice (2006) have described how actors inject meaning into the daunting task of learning "all those lines." They do it by first coming to understand the flow of meaning: "One actor divided a half-page of dialogue into three [intentions]: 'to flatter,' 'to draw him out,' and 'to allay his fears.'" With this meaningful sequence in mind, the actor more easily remembered the lines.

We have especially good recall for information we can meaningfully relate to ourselves. Asked how well certain adjectives describe someone else, we often forget them; asked how well the adjectives describe us, we remember the words well. This tendency, called the *self-reference effect,* is especially strong in members of individualist Western cultures (Symons & Johnson, 1997; Wagar & Cohen, 2003). Information deemed "relevant to me" is processed more deeply and remains more accessible. Knowing this, you can profit from taking time to find personal meaning in what you are studying.

The point to remember: The amount remembered depends both on the time spent learning and on your making it meaningful for deep processing.

Before You Move On

► ASK YOURSELF

Can you think of three ways to employ the principles in this section to improve your own learning and retention of important ideas?

► TEST YOURSELF

What would be the most effective strategy to learn and retain a list of names of key historical figures for a week? For a year?

Answers to the Test Yourself questions can be found in Appendix E at the end of the book.

Module 31 Review

31-1 What is memory?

- *Memory* is learning that has persisted over time, through the storage and retrieval of information.

31-2 How do psychologists describe the human memory system?

- Psychologists use memory models to think and communicate about memory.
- Information-processing models involve three processes: *encoding, storage,* and *retrieval.*
- The connectionism information-processing model views memories as products of interconnected neural networks.
- The three processing stages in the Atkinson-Shiffrin model are *sensory memory, short-term memory,* and *long-term memory.* More recent research has updated this model to include two important concepts: (1) *working memory,* to stress the active processing occurring in the second memory stage; and (2) automatic processing, to address the processing of information outside of conscious awareness.

31-3 How do explicit and implicit memories differ?

- Through *parallel processing,* the human brain processes many things simultaneously, on dual tracks.
- *Explicit* (declarative) *memories*—our conscious memories of facts and experiences—form through *effortful processing,* which requires conscious effort and attention.
- *Implicit* (nondeclarative) *memories*—of skills and classically conditioned associations—happen without our awareness, through *automatic processing.*

31-4 What information do we automatically process?

- In addition to skills and classically conditioned associations, we automatically process incidental information about space, time, and frequency.

31-5 How does sensory memory work?

- Sensory memory feeds some information into working memory for active processing there.
- An *iconic memory* is a very brief (a few tenths of a second) sensory memory of visual stimuli; an *echoic memory* is a three- or four-second sensory memory of auditory stimuli.

31-6 What is the capacity of our short-term and working memory?

- Short-term memory capacity is about seven items, plus or minus two, but this information disappears from memory quickly without rehearsal.
- Working memory capacity varies, depending on age, intelligence level, and other factors.

31-7 What are some effortful processing strategies that can help us remember new information?

- Effective effortful processing strategies include *chunking, mnemonics,* hierarchies, and distributed practice sessions.
- The *testing effect* is the finding that consciously retrieving, rather than simply rereading, information enhances memory.

31-8 What are the levels of processing, and how do they affect encoding?

- Depth of processing affects long-term retention.
  - In *shallow processing,* we encode words based on their structure or appearance.
  - Retention is best when we use *deep processing,* encoding words based on their meaning.
- We also more easily remember material that is personally meaningful—the self-reference effect.

Multiple-Choice Questions

1. Caitlin, a fifth grader, is asked to remember her second-grade teacher's name. What measure of retention will Caitlin use to answer this question?

a. Storage
b. Recognition
c. Relearning
d. Recall
e. Encoding

2. Working memory is most active during which portion of the information-processing model?

a. Short-term memory
b. Sensory memory
c. Retrieval
d. Encoding
e. Long-term memory

3. Your memory of which of the following is an example of implicit memory?

a. What you had for breakfast yesterday
b. The need to spend some time reviewing tomorrow for an upcoming psychology quiz
c. Which way to turn the car key to start the engine
d. That George Washington was the first President
e. How exciting it was to get the best birthday present ever

4. Which of the following is the most accurate description of the capacity of short-term and working memory?

a. Lasts for about 2 days in most circumstances
b. Lasts for less than half a minute unless you rehearse the information
c. Is thought to be unlimited—there is always room for more information
d. Can handle about a half dozen items for each of the tasks you are working on at any time
e. Can handle about a half dozen items total

5. Which of the following is most likely to lead to semantic encoding of a list of words?

a. Thinking about how the words relate to your own life
b. Practicing the words for a single extended period
c. Breaking up the practice into several relatively short sessions
d. Noticing where in a sentence the words appear
e. Focusing on the number of vowels and consonants in the words

Practice FRQs

1. To remember something, we must get information into our brain, retain the information, and later get the information back out. Making sure you use the terms for these three steps of the process, explain how this system would apply if you needed to learn the name of a new student who just enrolled in your school today.

Answer

1 point: Encoding is the process of getting the new student's name into your brain.

1 point: Storage is keeping that name in your memory.

1 point: Retrieval is the process of using that name when greeting the new student later.

2. Last evening, Carlos' mom told him he needed to buy milk today. So, he hopped on his bicycle this morning and headed to the corner store to pick up a gallon. Explain how both implicit and explicit memories were involved in Carlos' errand.

(4 points)

Module 32

Memory Storage and Retrieval


Arthur Tilley/Getty Images

Module Learning Objectives

32-1 Describe the capacity and location of our long-term memories.

32-2 Describe the roles of the frontal lobes and hippocampus in memory processing.

32-3 Describe the roles of the cerebellum and basal ganglia in our memory processing.

32-4 Discuss how emotions affect our memory processing.

32-5 Explain how changes at the synapse level affect our memory processing.

32-6 Explain how memory is measured.

32-7 Describe how external cues, internal emotions, and order of appearance influence memory retrieval.

Memory Storage

32-1 What is the capacity of long-term memory? Are our long-term memories processed and stored in specific locations?

In Arthur Conan Doyle's *A Study in Scarlet,* Sherlock Holmes offers a popular theory of memory capacity:

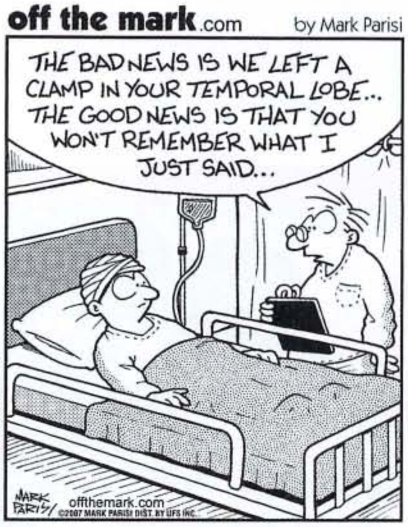
> I consider that a man's brain originally is like a little empty attic, and you have to stock it with such furniture as you choose. . . . It is a mistake to think that that little room has elastic walls and can distend to any extent. Depend upon it, there comes a time when for every addition of knowledge you forget something that you knew before.

Contrary to Holmes'"memory model," our capacity for storing long-term memories is essentially limitless. Our brains are not like attics, which once filled can store more items only if we discard old ones.

"Our memories are flexible and superimposable, a panoramic blackboard with an endless supply of chalk and erasers."
-Elizabeth Loftus and Katherine Ketcham, *The Myth of Repressed Memory,* 1994

Retaining Information in the Brain

I marveled at my aging mother-in-law, a retired pianist and organist. At age 88, her blind eyes could no longer read music. But let her sit at a keyboard and she would flawlessly play any of hundreds of hymns, including ones she had not thought of for 20 years. Where did her brain store those thousands of sequenced notes?



Mark Parisi/offthemark.com

For a time, some surgeons and memory researchers marveled at patients' seeming vivid memories triggered by brain stimulation during surgery. Did this prove that our whole past, not just well-practiced music, is "in there," in complete detail, just waiting to be relived? On closer analysis, the seeming flashbacks appeared to have been invented, not relived (Loftus & Loftus, 1980). In a further demonstration that memories do not reside in single, specific spots, psychologist Karl Lashley (1950) trained rats to find their way out of a maze, then surgically removed pieces of their brain's cortex and retested their memory. No matter which small brain section he removed, the rats retained at least a partial memory of how to navigate the maze.

The point to remember: Despite the brain's vast storage capacity, 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.

EXPLICIT-MEMORY SYSTEM: THE FRONTAL LOBES AND HIPPOCAMPUS

32-2 What roles do the frontal lobes and hippocampus play in memory processing?

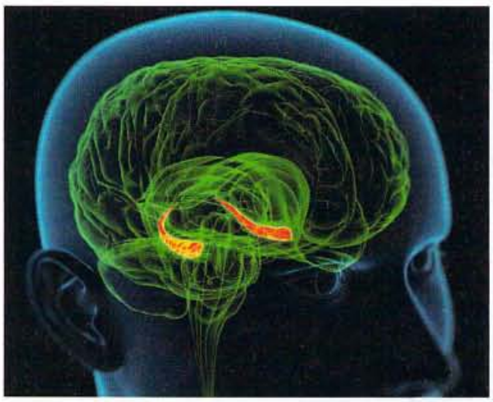
As with perception, language, emotion, and much more, memory requires brain networks. The network that processes and stores your explicit memories for facts and episodes includes your frontal lobes and hippocampus. When you summon up a mental encore of a past experience, many brain regions send input to your frontal lobes for working memory processing (Fink et al., 1996; Gabrieli et al., 1996; Markowitsch, 1995). The left and right frontal lobes process different types of memories. Recalling a password and holding it in working memory, for example, would activate the left frontal lobe. Calling up a visual party scene would more likely activate the right frontal lobe.

hippocampus a neural center located in the limbic system; helps process explicit memories for storage.

Cognitive neuroscientists have found that the **hippocampus,** a temporal-lobe neural center located in the limbic system, is the brain's equivalent of a "save" button for explicit memories (**FIGURE 32.1**). Brain scans, such as PET scans of people recalling words, and autopsies of people who had *amnesia* (memory loss) have revealed that new explicit memories of names, images, and events are laid down via the hippocampus (Squire, 1992).

Damage to this structure therefore disrupts recall of explicit memories. Chickadees and other birds can store food in hundreds of places and return to these unmarked caches months later—but not if their hippocampus has been removed (Kamil & Cheng, 2001; Sherry & Vaccarino, 1989). With left-hippocampus damage, people have trouble remembering verbal information, but they have no trouble recalling visual designs and locations. With right-hippocampus damage, the problem is reversed (Schacter, 1996).

Figure 32.1
The hippocampus Explicit memories for facts and episodes are processed in the hippocampus and fed to other brain regions for storage.



Roger Harris/Science Source

Subregions of the hippocampus also serve different functions. One part is active as people learn to associate names with faces (Zeineh et al., 2003). Another part is active as memory champions engage in spatial mnemonics (Maguire et al., 2003b). The rear area, which processes spatial memory, grows bigger the longer a London cabbie has navigated the maze of streets (Maguire et al., 2003a).

Memories are not permanently stored in the hippocampus. Instead, this structure seems to act as a loading dock where the brain registers and temporarily holds the elements of a remembered episode—its smell, feel, sound, and location. Then, like older files shifted to a basement storeroom, memories migrate for storage elsewhere.

Sleep supports memory consolidation. During deep sleep, the hippocampus processes memories for later retrieval. After a training experience, the greater the hippocampus activity during sleep, the better the next day's memory will be (Peigneux et al., 2004). Researchers have watched the hippocampus and brain cortex displaying simultaneous activity rhythms during sleep, as if they were having a dialogue (Euston et al., 2007; Mehta, 2007). They suspect that the brain is replaying the day's experiences as it transfers them to the cortex for long-term storage. Cortex areas surrounding the hippocampus support the processing and storing of explicit memories (Squire & Zola-Morgan, 1991).

Hippocampus hero Among animals, one contender for champion memorist would be a mere birdbrain—the Clark's Nutcracker—which during winter and spring can locate up to 6000 caches of pine seed it had previously buried (Shettleworth, 1993).

IMPLICIT-MEMORY SYSTEM: THE CEREBELLUM AND BASAL GANGLIA

32-3 What roles do the cerebellum and basal ganglia play in our memory processing?

Your hippocampus and frontal lobes are processing sites for your *explicit* memories. But you could lose those areas and still, thanks to automatic processing, lay down *implicit* memories for skills and conditioned associations. Joseph LeDoux (1996) recounted the story of a brain-damaged patient whose amnesia left her unable to recognize her physician as, each day, he shook her hand and introduced himself. One day, she yanked her hand back, for the physician had pricked her with a tack in his palm. The next time he returned to introduce himself she refused to shake his hand but couldn't explain why. Having been *classically conditioned,* she just wouldn't do it.

The *cerebellum* plays a key role in forming and storing the implicit memories created by classical conditioning. With a damaged cerebellum, people cannot develop certain conditioned reflexes, such as associating a tone with an impending puff of air—and thus do not blink in anticipation of the puff (Daum & Schugens, 1996; Green & Woodruff-Pak, 2000). When researchers surgically disrupted the function of different pathways in the cerebellum of rabbits, the rabbits became unable to learn a conditioned eyeblink response (Krupa et al., 1993; Steinmetz, 1999). Implicit memory formation needs the cerebellum (**FIGURE 32.2**).

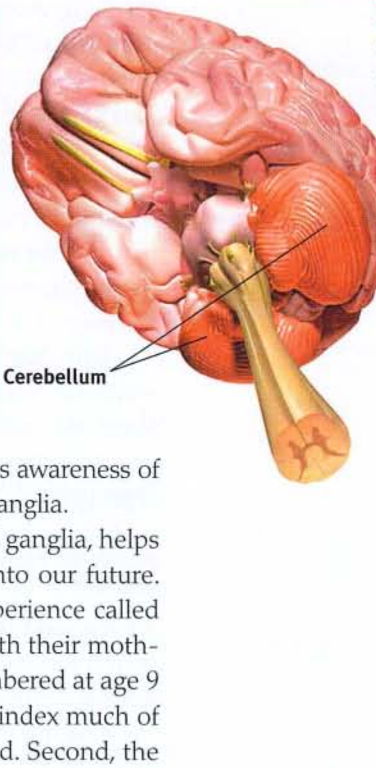


Figure 32.2
Cerebellum The cerebellum plays an important part in our forming and storing of implicit memories.

The *basal ganglia,* deep brain structures involved in motor movement, facilitate formation of our procedural memories for skills (Mishkin, 1982; Mishkin et al., 1997). The basal ganglia receive input from the cortex but do not return the favor of sending information back to the cortex for conscious awareness of procedural learning. If you have learned how to ride a bike, thank your basal ganglia.

Our implicit memory system, enabled partly 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*. In one study, events children experienced and discussed with their mothers at age 3 were 60 percent remembered at age 7 but only 34 percent remembered at age 9 (Bauer et al., 2007). Two influences contribute to infantile amnesia: First, we index much of our explicit memory using words that nonspeaking children have not learned. Second, the hippocampus is one of the last brain structures to mature.

The Amygdala, Emotions, and Memory

32-4 How do emotions affect our memory processing?

Our emotions trigger stress hormones that influence memory formation. When we are excited or stressed, these hormones make more glucose energy available to fuel brain activity, signaling the brain that something important has happened. Moreover, stress hormones provoke the *amygdala* (two limbic system, emotion-processing clusters) to initiate a memory

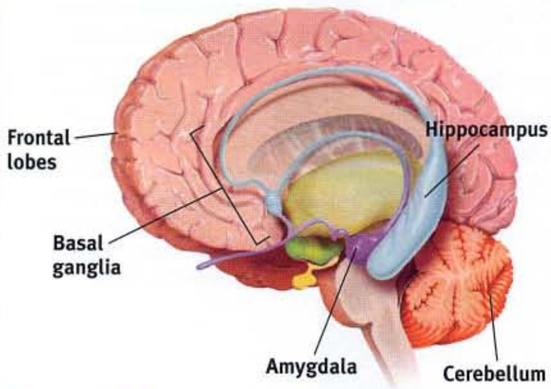


Figure 32.3
Review key memory structures in the brain
Frontal lobes and *hippocampus:* explicit memory formation
Cerebellum and *basal ganglia:* implicit memory formation
Amygdala: emotion-related memory formation

flashbulb memory a clear memory of an emotionally significant moment or event.

Try This
Which is more important—your experiences or your memories of them?

trace in the frontal lobes and basal ganglia and to boost activity in the brain's memory-forming areas (Buchanan, 2007; Kensinger, 2007) (**FIGURE 32.3**). The result? Emotional arousal can sear certain events into the brain, while disrupting memory for neutral events around the same time (Birnbaum et al., 2004; Brewin et al., 2007).

Emotions often persist without our conscious awareness of what caused them. In one ingenious experiment, patients with hippocampal damage (which left them unable to form new explicit memories) watched a sad film and later a happy film. After the viewing, they did not consciously recall the films, but the sad or happy emotion persisted (Feinstein et al., 2010).

Significantly stressful events can form almost indelible (unforgettable) memories. After traumatic experiences—a school shooting, a house fire, a rape—vivid recollections of the horrific event may intrude again and again. It is as if they were burned in: "Stronger emotional experiences make for stronger, more reliable memories," noted James McGaugh (1994, 2003). This makes adaptive sense. Memory serves to predict the future and to alert us to potential dangers. Conversely, weaker emotions mean weaker memories. People given a drug that blocked the effects of stress hormones later had more trouble remembering the details of an upsetting story (Cahill, 1994).

Emotion-triggered hormonal changes help explain why we long remember exciting or shocking events, such as our first kiss or our whereabouts when learning of a loved one's death. In a 2006 Pew survey, 95 percent of American adults said they could recall exactly where they were or what they were doing when they first heard the news of the 9/11 terrorist attacks. This perceived clarity of memories of surprising, significant events leads some psychologists to call them **flashbulb memories.** It's as if the brain commands, "Capture this!"

The people who experienced a 1989 San Francisco earthquake did just that. A year and a half later, they had perfect recall of where they had been and what they were doing (verified by their recorded thoughts within a day or two of the quake). Others' memories for the circumstances under which they merely *heard* about the quake were more prone to errors (Neisser et al., 1991; Palmer et al., 1991).

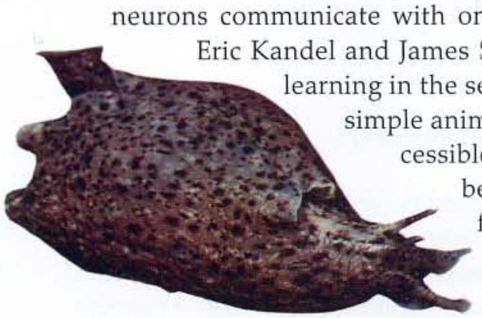
Our flashbulb memories are noteworthy for their vividness and the confidence with which we recall them. But as we relive, rehearse, and discuss them, these memories may come to err, as misinformation seeps in (Conway et al., 2009; Talarico & Rubin, 2003, 2007).

Synaptic Changes

32-5 How do changes at the synapse level affect our memory processing?

As you read this module and think and learn about memory characteristics and processes, your brain is changing. Given increased activity in particular pathways, neural interconnections are forming and strengthening.

The quest to understand the physical basis of memory—how information becomes embedded in brain matter—has sparked study of the synaptic meeting places where neurons communicate with one another via their neurotransmitter messengers. Eric Kandel and James Schwartz (1982) observed synaptic changes during learning in the sending neurons of the California sea slug, *Aplysia,* a simple animal with a mere 20,000 or so unusually large and accessible nerve cells. Module 26 noted how the sea slug can be classically conditioned (with electric shock) to reflexively withdraw its gills when squirted with water, much as a shell-shocked soldier jumps at the sound of a snapping twig. By observing the slug's neural connections before and after conditioning,


Art Directors & TRIP/Alamy

Aplysia The California sea slug, which neuroscientist Eric Kandel studied for 45 years, has increased our understanding of the neural basis of learning.

Kandel and Schwartz pinpointed changes. When learning occurs, the slug releases more of the neurotransmitter *serotonin* into certain synapses. Those synapses then become more efficient at transmitting signals.

In experiments with people, rapidly stimulating certain memory-circuit connections has increased their sensitivity for hours or even weeks to come. The sending neuron now needs less prompting to release its neurotransmitter, and more connections exist between neurons (**FIGURE 32.4**). This increased efficiency of potential neural firing, called **long-term potentiation (LTP),** provides a neural basis for learning and remembering associations (Lynch, 2002; Whitlock et al., 2006). Several lines of evidence confirm that LTP is a physical basis for memory:

- Drugs that block LTP interfere with learning (Lynch & Staubli, 1991).
- Mutant mice engineered to lack an enzyme needed for LTP couldn't learn their way out of a maze (Silva et al., 1992).
- Rats given a drug that enhanced LTP learned a maze with half the usual number of mistakes (Service, 1994).
- Injecting rats with a chemical that blocked the preservation of LTP erased recent learning (Pastalkova et al., 2006).

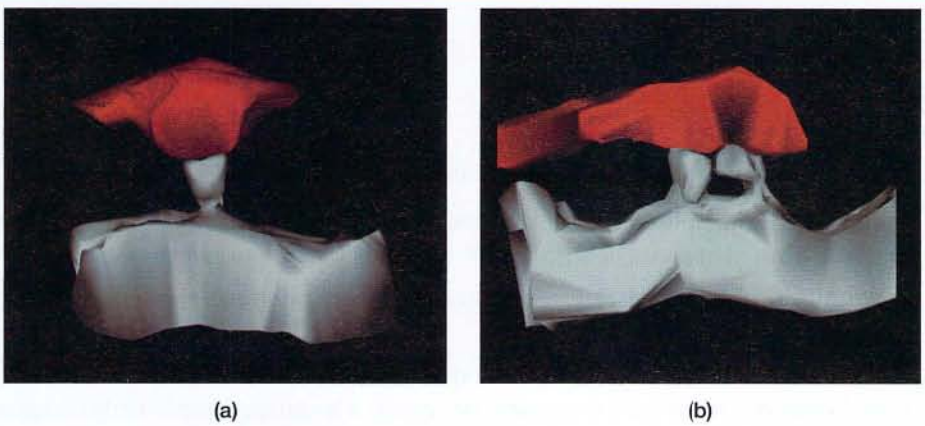
After long-term potentiation has occurred, passing an electric current through the brain won't disrupt old memories. But the current will wipe out very recent memories. Such is the experience both of laboratory animals and of severely depressed people given *electroconvulsive therapy* (see Module 73). A blow to the head can do the same. Football players and boxers momentarily knocked unconscious typically have no memory of events just before the knockout (Yarnell & Lynch, 1970). Their working memory had no time to consolidate the information into long-term memory before the lights went out.

Some memory-biology explorers have helped found companies that are competing to develop memory-altering drugs. The target market for memory-boosting drugs includes millions of people with Alzheimer's disease, millions more with *mild neurocognitive disorder* that often becomes Alzheimer's, and countless millions who would love to turn back the clock on age-related memory decline. From expanding memories perhaps will come bulging profits.

In your lifetime, will you have access to safe and legal drugs that boost your fading memory without nasty side effects and without cluttering your mind with trivia best forgotten? That question has yet to be answered. But in the meantime, one safe and free memory enhancer is already available for high schoolers everywhere: effective study techniques followed by adequate *sleep!* (You'll find study tips in Module 2 and at the end of this module, and sleep coverage in Modules 23 and 24.)

"The biology of the mind will be as scientifically important to this [new] century as the biology of the gene [was] to the twentieth century." -Eric Kandel, acceptance remarks for his 2000 Nobel Prize

long-term potentiation (LTP) an increase in a cell's firing potential after brief, rapid stimulation. Believed to be a neural basis for learning and memory.



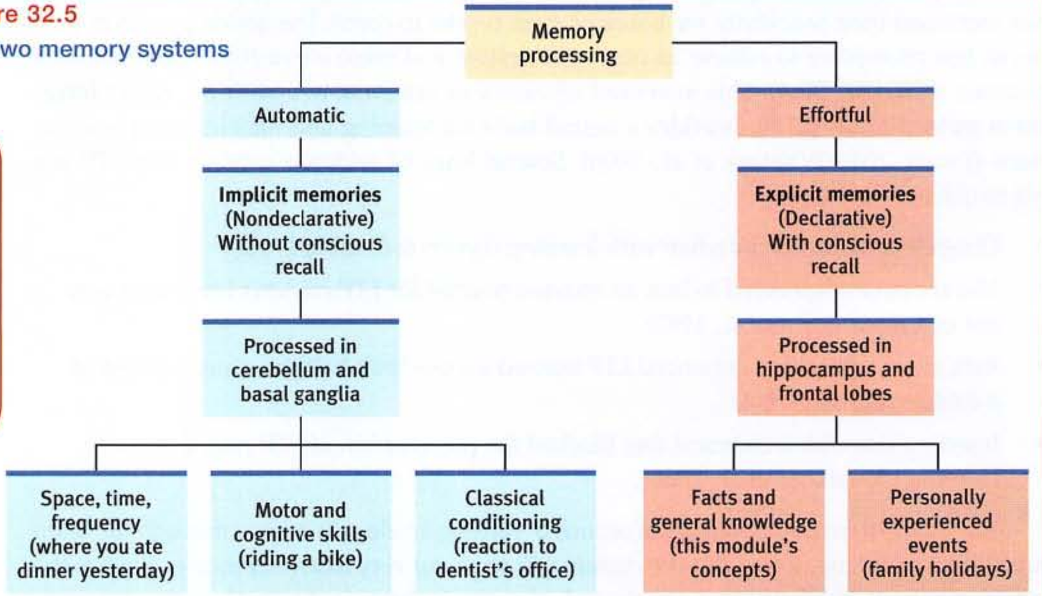
(a) (b)

Figure 32.4

Doubled receptor sites Electron microscope image (a) shows just one receptor site (gray) reaching toward a sending neuron before long-term potentiation. Image (b) shows that, after LTP, the receptor sites have doubled. This means that the receiving neuron has increased sensitivity for detecting the presence of the neurotransmitter molecules that may be released by the sending neuron. (From Toni et al., 1999.)

FIGURE 32.5 summarizes the brain's two-track memory processing and storage system for implicit (automatic) and explicit (effortful) memories.

Figure 32.5
Our two memory systems



AP® Exam Tip

Figure 32.5 is an excellent summary. Why don't you review it for a few minutes and then see how much of it you can reproduce on a piece of paper? That will give you a good assessment of which parts of the memory process you know and which parts you still need to work on.

Before You Move On

▶ ASK YOURSELF

Can you name an instance in which stress has helped you remember something, and another instance in which stress has interfered with remembering something?

▶ TEST YOURSELF

Your friend tells you that her father experienced brain damage in an accident. She wonders if psychology can explain why he can still play checkers very well but has a hard time holding a sensible conversation. What can you tell her?

Answers to the Test Yourself questions can be found in Appendix E at the end of the book.

Retrieval: Getting Information Out

After the magic of brain encoding and storage, we still have the daunting task of retrieving the information. What triggers retrieval? How do psychologists study this phenomenon?

Measuring Retention

32-6 How is memory measured?

To a psychologist, evidence of memory includes these three *measures of retention:*

- **recall**—retrieving information that is not currently in your conscious awareness but that was learned at an earlier time. A fill-in-the-blank question tests your recall.
- **recognition**—identifying items previously learned. A multiple-choice question tests your recognition.
- **relearning**—learning something more quickly when you learn it a second or later time. When you study for a final exam or engage a language used in early childhood, you will relearn the material more easily than you did initially.

recall a measure of memory in which the person must retrieve information learned earlier, as on a fill-in-the-blank test.

recognition a measure of memory in which the person need only identify items previously learned, as on a multiple-choice test.

relearning a measure of memory that assesses the amount of time saved when learning material again.

Long after you cannot recall most of the people in your high school graduating class, you may still be able to recognize their yearbook pictures from a photographic lineup and pick their names from a list of names. In one experiment, people who had graduated 25 years earlier could not *recall* many of their old classmates, but they could *recognize* 90 percent of their pictures and names (Bahrick et al., 1975). If you are like most students, you, too, could probably recognize more names of Snow White's Seven Dwarfs than you could recall (Miserandino, 1991).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Remembering things past Even if Taylor Swift and Leonardo DiCaprio had not become famous, their high school classmates would most likely still recognize their high school photos.

Our recognition memory is impressively quick and vast. "Is your friend wearing a new or old outfit?""Old.""Is this 5-second movie clip from a film you've ever seen?""Yes.""Have you ever seen this person before—this minor variation on the same old human features (two eyes, one nose, and so on)?""No."Before the mouth can form our answer to any of millions of such questions, the mind knows, and knows that it knows.

Our speed at *relearning* also reveals memory. Hermann Ebbinghaus showed this more than a century ago, in his learning experiments, using nonsense syllables. He randomly selected a sample of syllables, practiced them, and tested himself. To get a feel for his experiments, rapidly read aloud, eight times over, the following list (from Baddeley, 1982), then look away and try to recall the items:

> JIH, BAZ, FUB, YOX, SUJ, XIR, DAX, LEQ, VUM, PID, KEL, WAV, TUV, ZOF, GEK, HIW.

The day after learning such a list, Ebbinghaus could recall few of the syllables. But they weren't entirely forgotten. As **FIGURE 32.6** portrays, the more frequently he repeated the list aloud on day 1, the fewer repetitions he required to *relearn* the list on day 2. Additional rehearsal *(overlearning)* of verbal information increases retention, especially when practice is distributed over time. For students, this means that it is important to continue to rehearse course material even after you know it.

The point to remember: Tests of recognition and of time spent relearning demonstrate that *we remember more than we can recall.*

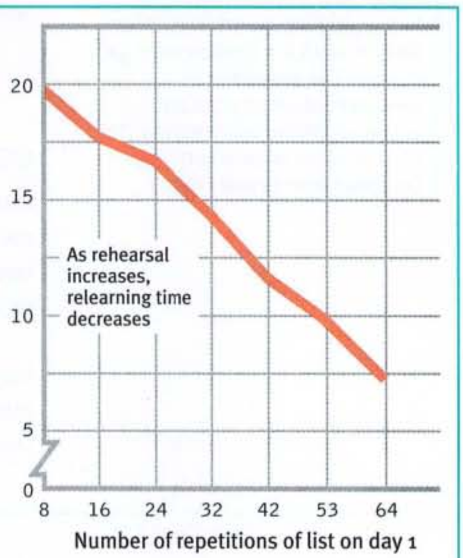


Figure 32.6
Ebbinghaus' retention curve Ebbinghaus found that the more times he practiced a list of nonsense syllables on day 1, the fewer repetitions he required to relearn it on day 2. Speed of relearning is one measure of memory retention. (From Baddeley, 1982.)

Retrieval Cues

32-7 How do external cues, internal emotions, and order of appearance influence memory retrieval?

Imagine a spider suspended in the middle of her web, held up by the many strands extending outward from her in all directions to different points. If you were to trace a pathway to the spider, you would first need to create a path from one of these anchor points and then follow the strand down into the web.

The process of retrieving a memory follows a similar principle, because memories are held in storage by a web of associations, each piece of information interconnected with others. When you encode into memory a target piece of information, such as the name of the person sitting next to you in class, you associate with it other bits of information about your surroundings, mood, seating position, and so on. These bits can serve as *retrieval cues* that you can later use to access the information. The more retrieval cues you have, the better your chances of finding a route to the suspended memory.

> "Memory is not like a container that gradually fills up; it is more like a tree growing hooks onto which memories are hung." -Peter Russell, *The Brain Book*, 1979

PRIMING

The best retrieval cues come from associations we form at the time we encode a memory—smells, tastes, and sights that can evoke our memory of the associated person or event. To call up visual cues when trying to recall something, we may mentally place ourselves in the

priming the activation, often unconsciously, of particular associations in memory.

original context. After losing his sight, British scholar John Hull (1990, p. 174) described his difficulty recalling such details:

> I knew I had been somewhere, and had done particular things with certain people, but where? I could not put the conversations . . . into a context. There was no background, no features against which to identify the place. Normally, the memories of people you have spoken to during the day are stored in frames which include the background.

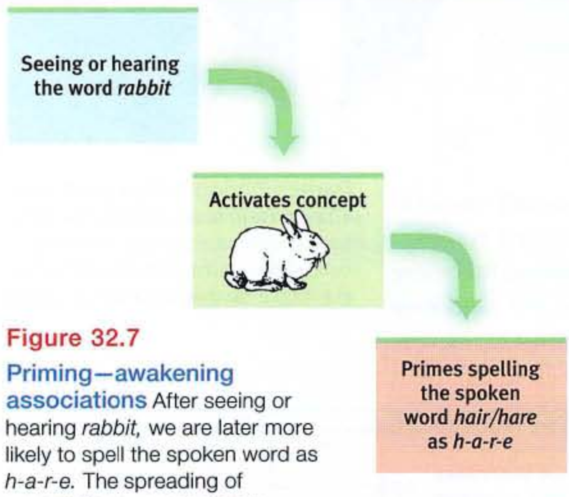


Figure 32.7
Priming—awakening associations After seeing or hearing *rabbit,* we are later more likely to spell the spoken word as *h-a-r-e.* The spreading of associations unconsciously activates related associations. This phenomenon is called priming. (Adapted from Bower, 1986.)

Often our associations are activated without our awareness. The philosopher-psychologist William James referred to this process, which we call **priming,** as the "wakening of associations." Seeing or hearing the word *rabbit* primes associations with *hare,* even though we may not recall having seen or heard *rabbit* (**FIGURE 32.7**).

Priming is often "memoryless memory"—invisible memory, without your conscious awareness. If, walking down a hallway, you see a poster of a missing child, you may then unconsciously be primed to interpret an ambiguous adult-child interaction as a possible kidnapping (James, 1986). Although you no longer have the poster in mind, it predisposes your interpretation.

Priming can influence behaviors as well. In one study, participants primed with money-related words were less likely to help another person when asked (Vohs et al., 2006). In such cases, money may prime our materialism and self-interest rather than the social norms that encourage us to help (Ariely, 2009).

CONTEXT-DEPENDENT MEMORY

Putting yourself back in the context where you experienced something can prime your memory retrieval. As **FIGURE 32.8** illustrates, when scuba divers listened to a word list in two different settings (either 10 feet underwater or sitting on the beach), they recalled more words if retested in the same place (Godden & Baddeley, 1975).

You may have experienced similar context effects. Consider this scenario: While taking notes from this book, you realize you need to sharpen your pencil. You get up and walk into another room, but then you cannot remember why. After returning to your desk it hits you: "I wanted to sharpen this pencil!" What happens to create this frustrating experience?

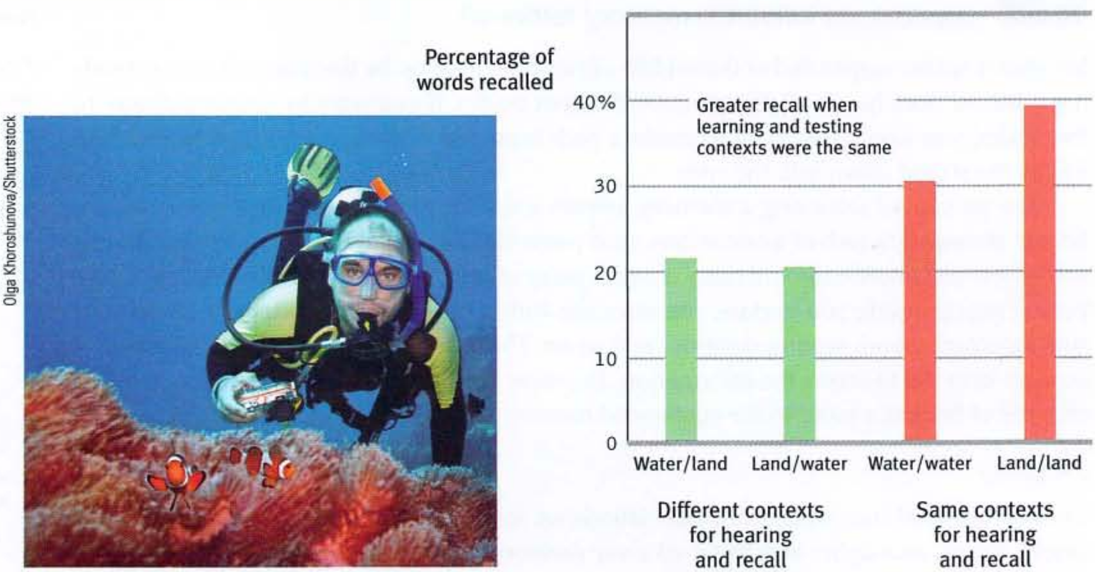


Figure 32.8
The effects of context on memory In this experiment, words heard underwater were best recalled underwater. Words heard on land were best recalled on land. (Adapted from Godden & Baddeley, 1975.)

In one context (desk, reading psychology), you realize your pencil needs sharpening. When you go to the other room and are in a different context, you have few cues to lead you back to that thought. When you are once again at your desk, you are back in the context in which you encoded the thought *("This pencil is dull")*.

In several experiments, one researcher found that a familiar context could activate memories even in 3-month-olds (Rovee-Collier, 1993). After infants learned that kicking a crib mobile would make it move (via a connecting ribbon from the ankle), the infants kicked more when tested again in the same crib with the same bumper than when in a different context.

Try This

Ask a friend two rapid-fire questions: (a) How do you pronounce the word spelled by the letters s-h-o-p? (b) What do you do when you come to a green light? If your friend answers "stop" to the second question, you have demonstrated priming.

STATE-DEPENDENT MEMORY

Closely related to context-dependent memory is *state-dependent memory*. What we learn in one state—be it drunk or sober—may be more easily recalled when we are again in that state. What people learn when drunk they don't recall well in *any* state (alcohol disrupts storage). But they recall it slightly better when again drunk. Someone who hides money when drunk may forget the location until drunk again.

"I can't remember what we're arguing about, either. Let's keep yelling, and maybe it will come back to us."

Our mood states provide an example of memory's state dependence. Emotions that accompany good or bad events become retrieval cues (Fiedler et al., 2001). Thus, our memories are somewhat **mood congruent.** If you've had a bad evening—your date never showed, your Chicago Cubs hat disappeared, your TV went out 10 minutes before the end of a show—your gloomy mood may facilitate recalling other bad times. Being depressed sours memories by priming negative associations, which we then use to explain our current mood. In many experiments, people put in a buoyant mood—whether under hypnosis or just by the day's events (a World Cup soccer victory for German participants in one study)—have recalled the world through rose-colored glasses (DeSteno et al., 2000; Forgas et al., 1984; Schwarz et al., 1987). They judged themselves competent and effective, other people benevolent, happy events more likely.

Knowing this mood-memory connection, we should not be surprised that in some studies *currently* depressed people have recalled their parents as rejecting, punitive, and guilt promoting, whereas *formerly* depressed people's recollections more closely resembled the more positive descriptions given by those who never suffered depression (Lewinsohn & Rosenbaum, 1987; Lewis, 1992). Similarly, adolescents' ratings of parental warmth in one week gave little clue to how they would rate their parents six weeks later (Bornstein et al., 1991). When teens were down, their parents seemed inhuman; as their mood brightened, their parents morphed from devils into angels. In a good or bad mood, we persist in attributing to reality our own changing judgments, memories, and interpretations. In a bad mood, we may read someone's look as a glare and feel even worse. In a good mood, we may encode the same look as interest and feel even better. Passions exaggerate.

"When a feeling was there, they felt as if it would never go; when it was gone, they felt as if it had never been; when it returned, they felt as if it had never gone." -George MacDonald, *What's Mine's Mine*, 1886

This retrieval effect helps explain why our moods persist. When happy, we recall happy events and therefore see the world as a happy place, which helps prolong our good mood. When depressed, we recall sad events, which darkens our interpretations of current events. For those of us with a predisposition to depression, this process can help maintain a vicious, dark cycle.

SERIAL POSITION EFFECT

Another memory-retrieval quirk, the **serial position effect,** can leave us wondering why we have large holes in our memory of a list of recent events. Imagine it's your first day in a new job, and your manager is introducing co-workers. As you meet each person, you silently repeat everyone's name, starting from the beginning. As the last person smiles and turns away, you feel confident you'll be able to greet your new co-workers by name the next day.

Don't count on it. Because you have spent more time rehearsing the earlier names than the later ones, those are the names you'll probably recall more easily the next day.

mood-congruent memory the tendency to recall experiences that are consistent with one's current good or bad mood.

serial position effect our tendency to recall best the last (a *recency effect*) and first items (a *primacy effect*) in a list.

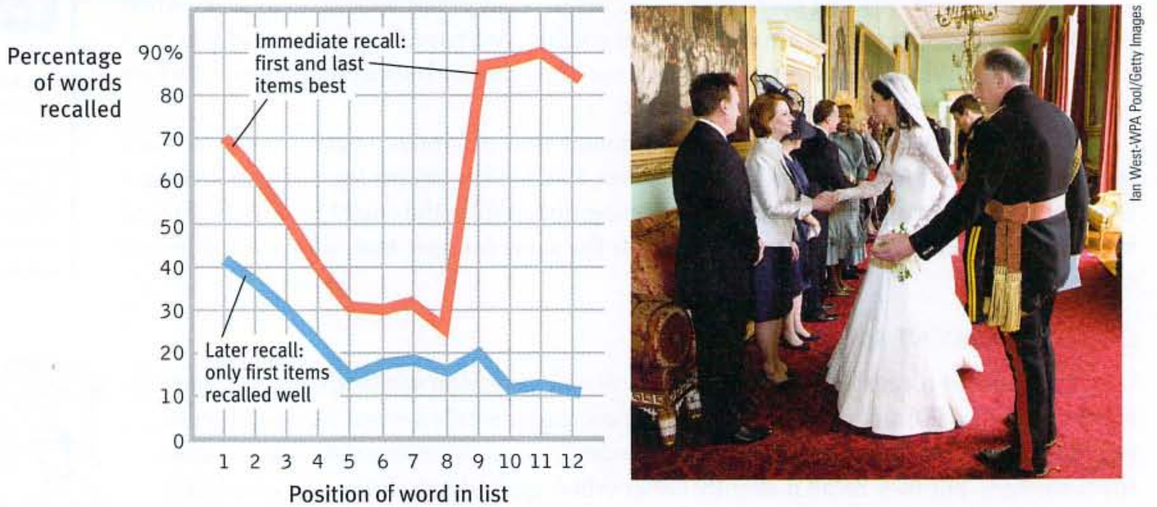


Figure 32.9

The serial position effect Immediately after the royal newlyweds, William and Kate, made their way through the receiving line of special guests, they would probably have recalled the names of the last few people best. But later they may have been able to recall the first few people best.

In experiments, when people view a list of items (words, names, dates, even odors) and immediately try to recall them in any order, they fall prey to the serial position effect (Reed, 2000). They briefly recall the last items especially quickly and well *(a recency effect)*, perhaps because those last items are still in working memory. But after a delay, when they have shifted their attention away from the last items, their recall is best for the first items *(a primacy effect;* see **FIGURE 32.9**).

Before You Move On

▶ ASK YOURSELF

What sort of mood have you been in lately? How has your mood colored your memories, perceptions, and expectations?

▶ TEST YOURSELF

You have just watched a movie that includes a chocolate factory. After the chocolate factory is out of mind, you nevertheless feel a strange urge for a chocolate bar. How do you explain this in terms of priming?

Answers to the Test Yourself questions can be found in Appendix E at the end of the book.

Module 32 Review

32-1 What is the capacity of long-term memory? Are our long-term memories processed and stored in specific locations?

- Our long-term memory capacity is essentially unlimited.
- Memories are not stored intact in the brain in single spots. Many parts of the brain interact as we form and retrieve memories.

32-2 What are the roles of the frontal lobes and hippocampus in memory processing?

- The frontal lobes and *hippocampus* are parts of the brain network dedicated to explicit memory formation.
  - Many brain regions send information to the frontal lobes for processing.
  - The hippocampus, with the help of surrounding areas of cortex, registers and temporarily holds elements of explicit memories before moving them to other brain regions for long-term storage.

32-3 What roles do the cerebellum and basal ganglia play in our memory processing?

- The cerebellum and basal ganglia are parts of the brain network dedicated to implicit memory formation.
  - The cerebellum is important for storing classically conditioned memories.
  - The basal ganglia are involved in motor movement and help form procedural memories for skills.
- Many reactions and skills learned during our first three years continue into our adult lives, but we cannot consciously remember learning these associations and skills, a phenomenon psychologists call "infantile amnesia."

32-4 How do emotions affect our memory processing?

- Emotional arousal causes an outpouring of stress hormones, which lead to activity in the brain's memory-forming areas. Significantly stressful events can trigger very clear *flashbulb memories.*

32-5 How do changes at the synapse level affect our memory processing?

- *Long-term potentiation (LTP)* appears to be the neural basis for learning and memory. In LTP, neurons become more efficient at releasing and sensing the presence of neurotransmitters, and more connections develop between neurons.

32-6 How is memory measured?

- Evidence of memory may be seen in an ability to *recall* information, *recognize* it, or *relearn* it more easily on a later attempt.

32-7 How do external cues, internal emotions, and order of appearance influence memory retrieval?

- External cues activate associations that help us retrieve memories; this process may occur without our awareness, as it does in *priming.*
- Returning to the same physical context or emotional state *(mood congruency)* in which we formed a memory can help us retrieve it.
- The *serial position effect* accounts for our tendency to recall best the last items (which may still be in working memory) and the first items (which we've spent more time rehearsing) in a list.

Multiple-Choice Questions

1. What two parts of the brain are most involved in explicit memory?

a. Frontal lobes and basal ganglia
b. Amygdala and hippocampus
c. Amygdala and cerebellum
d. Cerebellum and basal ganglia
e. Frontal lobes and hippocampus

2. Which of the following statements most accurately reflects the relationship between emotions and memory?

a. Emotion blocks memory, and it is generally true that we are unable to recall highly emotional events.
b. Excitement tends to increase the chance that an event will be remembered, but stress decreases the chance that an event will be remembered.
c. Stress tends to increase the chance that an event will be remembered, but excitement decreases the chance that an event will be remembered.
d. The effect of emotion on memory depends on the interpretation of the event in the frontal lobes.
e. Emotion enhances memory because it is important for our survival to remember events that make us emotional.

3. Which of the following is an example of flashbulb memory?

a. Barry remembers an especially bright sunrise because he was by the ocean and the sunlight reflected off the water.
b. Robert remembers that correlation does not prove a cause–effect relationship because his teacher emphasized this fact over and over again.
c. Anna remembers when her father returned from an overseas military deployment because the day was very emotional for her.
d. Kris has stronger memories of her second grade teacher than she does of her third grade teacher because her second grade teacher has the same name as her neighbor.
e. Anton remembers a moment from his last homecoming dance because a strobe light seemed to freeze the scene in his imagination.

4. Juan returns to his grandparent's house after a 10-year absence. The flood of memories about his childhood visits is best explained by which of the following?

a. Recall
b. Priming
c. Explicit memory
d. The serial position effect
e. Flashbulb memory

5. Which of the following is an example of the primacy effect?

a. Remembering the most important assignment you have to complete for school tomorrow
b. Remembering the skills you learned early in life, such as walking
c. Remembering the last thing your English teacher talked about in class yesterday, but nothing from earlier in the class period
d. Remembering the names of the first two co-workers you met on the first day of your new job
e. Remembering that your clocks must be moved ahead one hour when daylight savings time begins in the spring

Practice FRQs

1. Consider an explicit memory, such as a memory of what happened in your science class yesterday.

Explain the process that allows memory to occur at the synaptic level.

Explain the role of two parts of the brain in your memory of the class.

Answer

1 point: Long-term potentiation (LTP) increases the cells' firing potential at the synapse.

1 point: The hippocampus gives the command to "save" a memory.

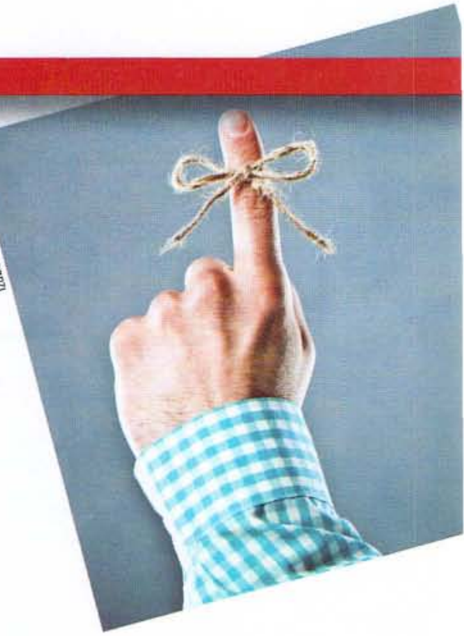
1 point: The frontal lobes allow you to process the memory information.

2. You have a friend, Rachel, who cannot remember where she left a check she had received from a relative for her birthday. She remembers having drunk several cups of tea the morning she received the check, and she remembers taking it to her bedroom. Explain how Rachel can take advantage of context-dependent memory and state-dependent memory to remember where in her bedroom she left the check.

(2 points)

Module 33

Forgetting, Memory Construction, and Memory Improvement


Izabela Habur/Getty Images

Module Learning Objectives

33-1 Explain why we forget.

33-2 Explain how misinformation, imagination, and source amnesia influence our memory construction, and describe how we decide whether a memory is real or false.

33-3 Describe the reliability of young children's eyewitness descriptions, and discuss the controversy related to claims of repressed and recovered memories.

33-4 Describe how you can use memory research findings to do better in this and other courses.

Forgetting

33-1 Why do we forget?

Amid all the applause for memory—all the efforts to understand it, all the books on how to improve it—have any voices been heard in praise of forgetting? William James (1890, p. 680) was such a voice: "If we remembered everything, we should on most occasions be as ill off as if we remembered nothing." To discard the clutter of useless or out-of-date information—last year's locker combination, a friend's old phone number, restaurant orders already cooked and served—is surely a blessing. The Russian memory whiz S, whom we met at the beginning of Module 31, was haunted by his junk heap of memories. They dominated his consciousness. He had difficulty thinking abstractly—generalizing, organizing, evaluating. After reading a story, he could recite it but would struggle to summarize its gist.

"Amnesia seeps into the crevices of our brains, and amnesia heals."
-Joyce Carol Oates, "Words Fail, Memory Blurs, Life Wins," 2001

A more recent case of a life overtaken by memory is "A. J.," whose experience has been studied and verified by a University of California at Irvine research team (Parker et al., 2006). A. J., who has identified herself as Jill Price, compares her memory with "a running movie that never stops. It's like a split screen. I'll be talking to someone and seeing something else. . . . Whenever I see a date flash on the television (or anywhere for that matter) I automatically go back to that day and remember where I was, what I was doing, what day it fell on, and on and on and on and on. It is nonstop, uncontrollable, and totally exhausting." A good memory is helpful, but so is the ability to forget. If a memory-enhancing pill becomes available, it had better not be *too* effective.

More often, however, our unpredictable memory dismays and frustrates us. Memories are quirky. My own memory can easily call up such episodes as that wonderful first kiss with the woman I love, or trivial facts like the air mileage from London to Detroit. Then it abandons me when I discover I have failed to encode, store, or retrieve a student's name, or where I left my sunglasses.

Forgetting and the Two-Track Mind

FYI

Cellist Yo-Yo Ma forgot his 266-year-old, $2.5 million cello in a New York taxi. (He later recovered it.)

English novelist and critic C. S. Lewis described the forgetting that plagues us all. We are

> bombarded every second by sensations, emotions, thoughts . . . nine-tenths of which [we] must simply ignore. The past [is] a roaring cataract of billions upon billions of such moments: Any one of them too complex to grasp in its entirety, and the aggregate beyond all imagination. . . . At every tick of the clock, in every inhabited part of the world, an unimaginable richness and variety of 'history' falls off the world into total oblivion.

For some, memory loss is severe and permanent. Consider Henry Molaison (known as "H. M.," 1926–2008). For 55 years after having brain surgery to stop severe seizures, Molaison was unable to form new conscious memories. He was, as before his surgery, intelligent and did daily crossword puzzles. Yet, reported neuroscientist Suzanne Corkin (2005), "I've known H. M. since 1962, and he still doesn't know who I am." For about 20 seconds during a conversation he could keep something in mind. When distracted, he would lose what was just said or what had just occurred. Thus, he never could name the current president of the United States (Ogden, 2012).

AP® Exam Tip

Retrograde amnesia acts backward in time, just like when you choose a "retro" look for a party and wear clothes from an earlier time.

Molaison suffered from **anterograde amnesia**—he could recall his past, but he could not form new memories. (Those who cannot recall their past—the old information stored in long-term memory—suffer from **retrograde amnesia.**)

anterograde amnesia an inability to form new memories.

retrograde amnesia an inability to retrieve information from one's past.

Neurologist Oliver Sacks (1985, pp. 26–27) described another patient, Jimmie, who had anterograde amnesia resulting from brain damage. Jimmie had no memories—thus, no sense of elapsed time—beyond his injury in 1945.

When Jimmie gave his age as 19, Sacks set a mirror before him: "Look in the mirror and tell me what you see. Is that a 19-year-old looking out from the mirror?"

Jimmie turned ashen, gripped the chair, cursed, then became frantic: "What's going on? What's happened to me? Is this a nightmare? Am I crazy? Is this a joke?" When his attention was diverted to some children playing baseball, his panic ended, the dreadful mirror forgotten.

Sacks showed Jimmie a photo from *National Geographic*. "What is this?" he asked.

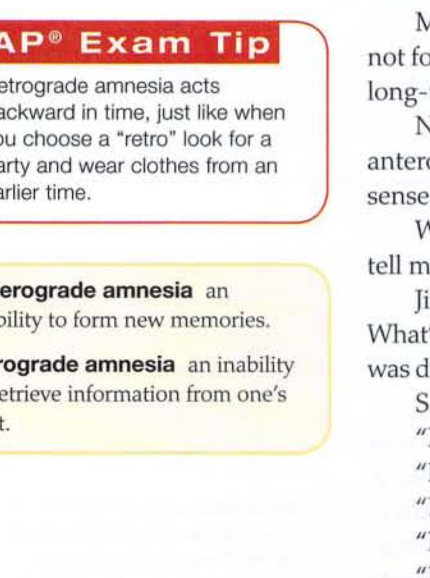
"It's the Moon," Jimmie replied.

"No, it's not," Sacks answered. "It's a picture of the Earth taken from the Moon."

"Doc, you're kidding? Someone would've had to get a camera up there!"

"Naturally."

"Hell! You're joking—how the hell would you do that?" Jimmie's wonder was that of a bright young man from nearly 70 years ago reacting with amazement to his travel back to the future.



"Waiter, I'd like to order, unless I've eaten, in which case bring me the check."

Careful testing of these unique people reveals something even stranger: Although incapable of recalling new facts or anything they have done recently, Molaison, Jimmie, and others with similar conditions can learn nonverbal tasks. Shown hard-to-find figures in pictures (in the *Where's Waldo?* series), they can quickly spot them again later. They can find their way to the bathroom, though without being able to tell you where it is. They can learn to read mirror-image writing or do a jigsaw puzzle, and they have even been taught complicated job skills (Schacter, 1992, 1996; Xu & Corkin, 2001). They can be classically conditioned. However, *they do all these things with no awareness of having learned them.*

Molaison and Jimmie lost their ability to form new explicit memories, but their automatic processing ability remained intact. Like Alzheimer's patients, whose *explicit* memories for new people and events are lost, they can form new *implicit* memories (Lustig & Buckner, 2004). They can learn *how* to do something, but they will have no conscious recall of learning their new skill. Such sad cases confirm that we have two distinct memory systems, controlled by different parts of the brain.

For most of us, forgetting is a less drastic process. Let's consider some of the reasons we forget.


San Diego Union-Tribune/Newscom

Studying a famous brain Jacopo Annese and other scientists at the University of California, San Diego's Brain Observatory are preserving Henry Molaison's brain for the benefit of future generations. Their careful work will result in a freely available online brain atlas.

Encoding Failure

Much of what we sense we never notice, and what we fail to encode, we will never remember (**FIGURE 33.1**). Age can affect encoding efficiency. The brain areas that jump into action when young adults encode new information are less responsive in older adults. This slower encoding helps explain age-related memory decline (Grady et al., 1995).

But no matter how young we are, we selectively attend to few of the myriad sights and sounds continually bombarding us. When texting during class, students may fail to encode details that their more attentive classmates are encoding for next week's test. Without effort, many potential memories never form.

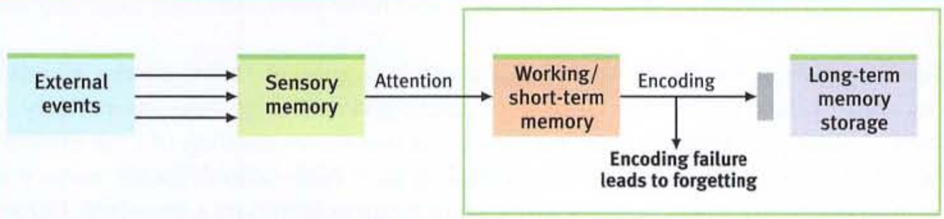


Figure 33.1
Forgetting as encoding failure We cannot remember what we have not encoded.

Storage Decay

Even after encoding something well, we sometimes later forget it. To study the durability of stored memories, Hermann Ebbinghaus (1885) learned more lists of nonsense syllables and measured how much he retained when relearning each list, from 20 minutes to 30 days later. The result, confirmed by later experiments, was his famous forgetting curve: *The course of forgetting is initially rapid, then levels off with time* (**FIGURE 33.2;** Wixted & Ebbesen, 1991).

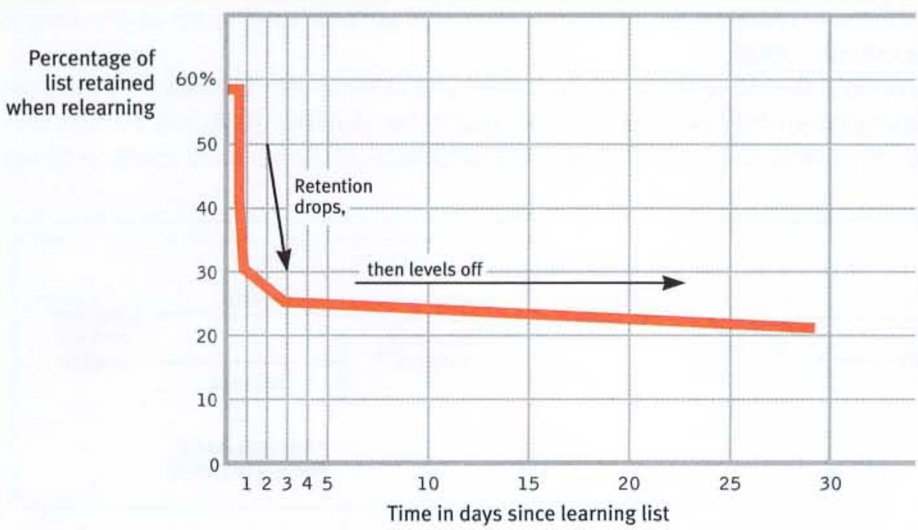
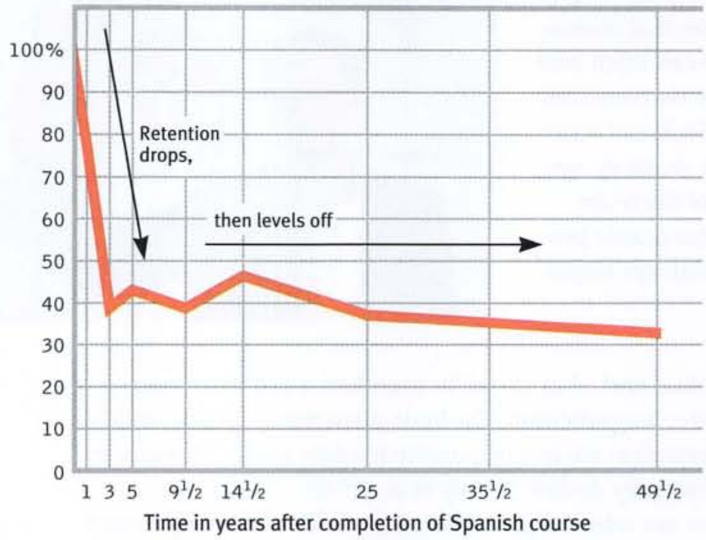


Figure 33.2
Ebbinghaus' forgetting curve After learning lists of nonsense syllables, such as YOX and JIH, Ebbinghaus studied how much he retained up to 30 days later. He found that memory for novel information fades quickly, then levels out. (Adapted from Ebbinghaus, 1885.)



Bill Aron/Photo Edit

Figure 33.3
The forgetting curve for Spanish learned in school Compared with people just completing a Spanish course, those 3 years out of the course remembered much less. Compared with the 3-year group, however, those who studied Spanish even longer ago did not forget much more. (Adapted from Bahrick, 1984.)

Harry Bahrick (1984) found a similar forgetting curve for Spanish vocabulary learned in school. Compared with those just completing a high school or college Spanish course, people 3 years out of school had forgotten much of what they had learned (**FIGURE 33.3**). However, what people remembered then, they still remembered 25 and more years later. Their forgetting had leveled off.

One explanation for these forgetting curves is a gradual fading of the physical memory trace. Cognitive neuroscientists are getting closer to solving the mystery of the physical storage of memory and are increasing our understanding of how memory storage could decay. Like books you can't find in your high school library, memories may be inaccessible for many reasons. Some were never acquired (not encoded). Others were discarded (stored memories decay). And others are out of reach because we can't retrieve them.

Retrieval Failure

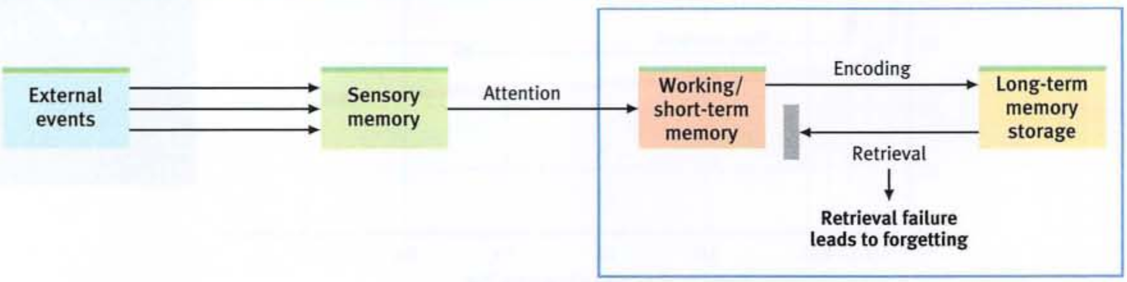
Often, forgetting is not memories faded but memories unretrieved. We store in long-term memory what's important to us or what we've rehearsed. But sometimes important events defy our attempts to access them (**FIGURE 33.4**). How frustrating when a name lies poised on the tip of our tongue, just beyond reach. Given retrieval cues *("It begins with an M")*, we may easily retrieve the elusive memory. Retrieval problems contribute to the occasional memory failures of older adults, who more frequently are frustrated by tip-of-the-tongue forgetting (Abrams, 2008).

FYI

Deaf persons fluent in sign language experience a parallel "tip of the fingers" phenomenon (Thompson et al., 2005).

Do you recall the gist of the sentence I asked you to remember in Module 32's discussion of making information personally meaningful? If not, does the word *shark* serve as a retrieval cue? Experiments show that *shark* (likely what you visualized) more readily retrieves

Figure 33.4
Retrieval failure Sometimes even stored information cannot be accessed, which leads to forgetting.



the image you stored than does the sentence's actual word, *fish* (Anderson et al., 1976). (The sentence was *"The fish attacked the swimmer."*)

But retrieval problems occasionally stem from interference and, perhaps, from motivated forgetting.

proactive interference the disruptive effect of prior learning on the recall of new information.

retroactive interference the disruptive effect of new learning on the recall of old information.

INTERFERENCE

As you collect more and more information, your mental attic never fills, but it surely gets cluttered. Sometimes the clutter interferes, as new learning and old collide. **Proactive** *(forward-acting)* **interference** occurs when prior learning disrupts your recall of new information. Your well-rehearsed Facebook password may interfere with your retrieval of your newly learned copy machine code.

Retroactive *(backward-acting)* **interference** occurs when new learning disrupts recall of old information. If someone sings new lyrics to the tune of an old song, you may have trouble remembering the original words. It is rather like a second stone tossed in a pond, disrupting the waves rippling out from the first.

AP® Exam Tip

Here's the prefix "retro" again and it means exactly the same thing with interference that it did for amnesia. In both cases, they're exerting an influence back in time.

Information presented in the hour before sleep is protected from retroactive interference because the opportunity for interfering events is minimized (Diekelmann & Born, 2010; Nesca & Koulack, 1994). Researchers John Jenkins and Karl Dallenbach (1924) first discovered this in a now-classic experiment. Day after day, two people each learned some nonsense syllables, then tried to recall them after up to 8 hours of being awake or asleep at night. As **FIGURE 33.5** shows, forgetting occurred more rapidly after being awake and involved with other activities. The investigators surmised that "forgetting is not so much a matter of the decay of old impressions and associations as it is a matter of interference, inhibition, or obliteration of the old by the new" (1924, p. 612).

The hour before sleep is a good time to commit information to memory (Scullin & McDaniel, 2010), though information presented in the *seconds* just before sleep is seldom remembered (Wyatt & Bootzin, 1994). If you're considering learning *while* sleeping, forget it. We have little memory for information played aloud in the room during sleep, although the ears do register it (Wood et al., 1992).

Old and new learning do not always compete with each other, of course. Previously learned information (Latin) often facilitates our learning of new information (French). This phenomenon is called *positive transfer.*

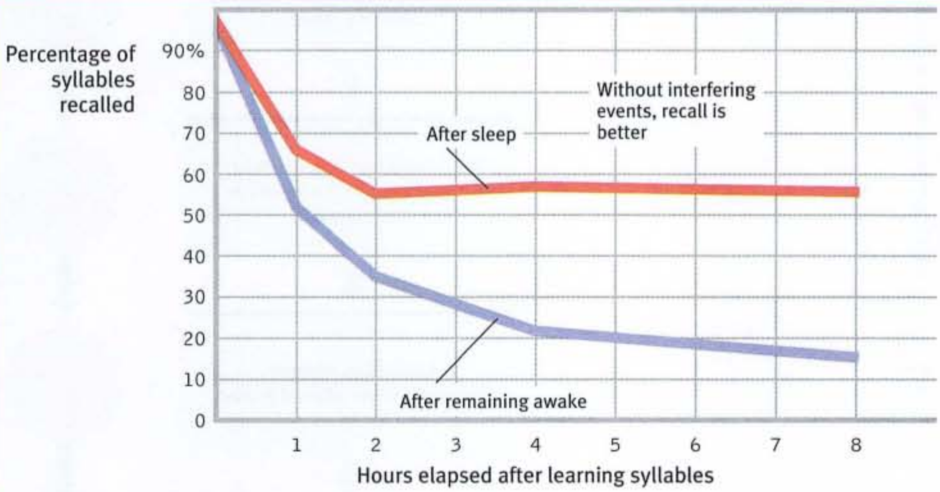


Figure 33.5
Retroactive interference More forgetting occurred when a person stayed awake and experienced other new material. (From Jenkins & Dallenbach, 1924.)

MOTIVATED FORGETTING

To remember our past is often to revise it. Years ago, the huge cookie jar in our kitchen was jammed with freshly baked chocolate chip cookies. Still more were cooling across racks on the counter. Twenty-four hours later, not a crumb was left. Who had taken them?

During that time, my wife, three children, and I were the only people in the house. So while memories were still fresh, I conducted a little memory test. Andy admitted wolfing down as many as 20. Peter thought he had eaten 15. Laura guessed she had stuffed her then-6-year-old body with 15 cookies. My wife, Carol, recalled eating 6, and I remembered consuming 15 and taking 18 more to the office. We sheepishly accepted responsibility for 89 cookies. Still, we had not come close; there had been 160.

Why do our memories fail us? This happens in part because, as Carol Tavris and Elliot Aronson have pointed out, memory is an "unreliable, self-serving historian" (2007, p. 6). Consider one study, in which researchers told some participants about the benefits of frequent toothbrushing. Those individuals then recalled (more than others did) having frequently brushed their teeth in the preceding 2 weeks (Ross et al., 1981).

FIGURE 33.6 reminds us that as we process information, we filter, alter, or lose much of it. So why were my family and I so far off in our estimates of the cookies we had eaten? Was it an *encoding* problem? (Did we just not notice what we had eaten?) Was it a storage problem? (Might our memories of cookies, like Ebbinghaus' memory of nonsense syllables, have melted away almost as fast as the cookies themselves?) Or was the information still intact but not *retrievable* because it would be embarrassing to remember?[1]

Sigmund Freud might have argued that our memory systems self-censored this information. He proposed that we **repress** painful or unacceptable memories to protect

[1] One of my cookie-scarfing sons, on reading this in his father's textbook years later, confessed he had fibbed "a little."

repression in psychoanalytic theory, the basic defense mechanism that banishes from consciousness anxiety-arousing thoughts, feelings, and memories.

AP® Exam Tip

There are many references to Sigmund Freud in the text. Most of your knowledge of Freud probably came from popular culture, and it often conflicts with the discoveries of modern researchers. The AP® exam may test your understanding of researchers' views of Freud.

"Someday we'll look back at this time in our lives and be unable to remember it."

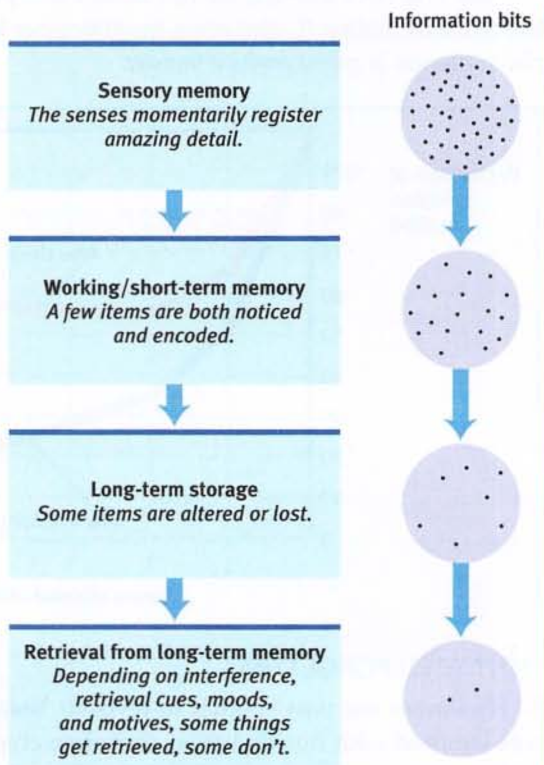


Figure 33.6
When do we forget? Forgetting can occur at any memory stage. As we process information, we filter, alter, or lose much of it.

our self-concept and to minimize anxiety. But the repressed memory lingers, he believed, and can be retrieved by some later cue or during therapy. Repression was central to Freud's psychoanalytic theory (more on that in Module 55) and was a popular idea in mid-twentieth-century psychology and beyond. In one study, 9 in 10 university students agreed that "memories for painful experiences are sometimes pushed into unconsciousness" (Brown et al., 1996). Some therapists assume it. Today, however, increasing numbers of memory researchers think repression rarely, if ever, occurs. People succeed in forgetting unwanted neutral information (yesterday's parking place), but it's harder to forget emotional events (Payne & Corrigan, 2007). Thus, we may have intrusive memories of the very traumatic experiences we would most like to forget.

Before You Move On

▶ ASK YOURSELF

Most people, especially as they grow older, wish for a better memory. Is that true of you? Or do you more often wish you could better discard old memories?

▶ TEST YOURSELF

Can you offer examples of proactive and retroactive interference?

Answers to the Test Yourself questions can be found in Appendix E at the end of the book.

Memory Construction Errors

33-2 How do misinformation, imagination, and source amnesia influence our memory construction? How do we decide whether a memory is real or false?

Memory is not precise. Like scientists who infer a dinosaur's appearance from its remains, we infer our past from stored information plus what we later imagined, expected, saw, and heard. We don't just retrieve memories, we reweave them, noted Daniel Gilbert (2006, p. 79): "Information acquired after an event alters memory of the event." We often construct our memories as we encode them, and every time we "replay" a memory, we replace the original with a slightly modified version (Hardt et al., 2010). (Memory researchers call this *reconsolidation*.) So, in a sense, said Joseph LeDoux (2009), "your memory is only as good as your last memory. The fewer times you use it, the more pristine it is." This means that, to some degree, "all memory is false" (Bernstein & Loftus, 2009b). Let's examine some of the ways we rewrite our past.

AP® Exam Tip

Read this entire section particularly carefully. Many people harbor misconceptions about how memory works, and a lot of the misconceptions are dealt with in the next few pages. Memory does *not* function like a video recorder!

Misinformation and Imagination Effects

In more than 200 experiments, involving more than 20,000 people, Elizabeth Loftus has shown how eyewitnesses reconstruct their memories after a crime or an accident. In one experiment, two groups of people watched a film of a traffic accident and then answered questions about what they had seen (Loftus & Palmer, 1974). Those asked, "About how fast were the cars going when they *smashed* into each other?" gave higher speed estimates than those asked, "About how fast were the cars going when they *hit* each other?" A week later, when asked whether they recalled seeing any broken glass, people who had heard *smashed* were more than twice as likely to report seeing glass fragments (**FIGURE 33.7** on the next page). In fact, the film showed no broken glass.

misinformation effect incorporating misleading information into one's memory of an event.

In many follow-up experiments around the world, others 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:** Exposed to misleading information, we tend to

"Memory is insubstantial. Things keep replacing it. Your batch of snapshots will both fix and ruin your memory. . . . You can't remember anything from your trip except the wretched collection of snapshots." -Annie Dillard, "To Fashion a Text," 1988

Figure 33.7

Memory construction In this experiment, people viewed a film of a car accident (left). Those who later were asked a leading question recalled a more serious accident than they had witnessed. (From Loftus & Palmer, 1974.)

misremember. A yield sign becomes a stop sign, hammers become screwdrivers, Coke cans become peanut cans, breakfast cereal becomes eggs, and a clean-shaven man morphs into a man with a mustache (Loftus et al., 1992). So powerful is the misinformation effect that it can influence later attitudes and behaviors (Bernstein & Loftus, 2009).

Just hearing a vivid retelling of an event can implant false memories. One experiment falsely suggested to some Dutch university students that, as children, they became ill after eating spoiled egg salad (Geraerts et al., 2008). After absorbing that suggestion, a significant minority were less likely to eat egg-salad sandwiches, both immediately and 4 months later.

Even repeatedly *imagining* nonexistent actions and events can create false memories. American and British university students were asked to imagine certain childhood events, such as breaking a window with their hand or having a skin sample removed from a finger. One in four of them later recalled the imagined event as something that had really happened (Garry et al., 1996; Mazzoni & Memon, 2003).

Digitally altered photos have also produced this *imagination inflation.* In experiments, researchers have altered photos from a family album to show some family members taking a hot-air balloon ride. After viewing these photos (rather than photos showing just the balloon), children reported more false memories and indicated high confidence in those memories. When interviewed several days later, they reported even richer details of their false memories (Strange et al., 2008; Wade et al., 2002).

In British and Canadian university surveys, nearly one-fourth of students have reported autobiographical memories that they later realized were not accurate (Mazzoni et al., 2010).

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I empathize. For decades, my cherished earliest memory was of my parents getting off the bus and walking to our house, bringing my baby brother home from the hospital. When, in middle age, I shared that memory with my father, he assured me they did *not* bring their newborn home on the Seattle Transit System. The human mind, it seems, comes with built-in Photoshopping software.

"It isn't so astonishing, the number of things I can remember, as the number of things I can remember that aren't so." -MARK TWAIN (1835–1910)

Source Amnesia

Among the frailest parts of a memory is its source. We may recognize someone but have no idea where we have seen the person. We may dream an event and later be unsure whether it really happened. We may misrecall how we learned about something (Henkel et al., 2000). Psychologists are not immune to the process. Famed child psychologist Jean Piaget was startled as an adult to learn that a vivid, detailed memory from his childhood—a nursemaid's thwarting his kidnapping—was utterly false. He apparently constructed the memory from repeatedly hearing the story (which his nursemaid, after undergoing a religious conversion, later confessed had never happened). In attributing his "memory" to his own experiences, rather than to his nursemaid's stories, Piaget exhibited **source amnesia** (also called *source misattribution*). Misattribution is at the heart of many false memories. Authors and songwriters sometimes suffer from it. They think an idea came from their own creative imagination, when in fact they are unintentionally plagiarizing something they earlier read or heard.

Debra Poole and Stephen Lindsay (1995, 2001, 2002) demonstrated source amnesia among preschoolers. They had the children interact with "Mr. Science," who engaged them in activities such as blowing up a balloon with baking soda and vinegar. Three months later, on three successive days, their parents read them a story describing some things the children had experienced with Mr. Science and some they had not. When a new interviewer asked what Mr. Science had done with them—"Did Mr. Science have a machine with ropes to pull?"—4 in 10 children spontaneously recalled him doing things that had happened only in the story.

Try This

In the discussion of mnemonics in Module 31, I gave you six words and told you I would quiz you about them later. How many of these words can you now recall? Of these, how many are high-imagery words? How many are low-imagery? (You can check your list against the six inverted words below.)

Bicycle, void, cigarette, inherent, fire, process

Source amnesia also helps explain **déjà vu** (French for "already seen"). Two-thirds of us have experienced this fleeting, eerie sense that "I've been in this exact situation before." It happens most commonly to well-educated, imaginative young adults, especially when tired or stressed (Brown, 2003, 2004; McAneny, 1996). Some wonder, "How could I recognize a situation I'm experiencing for the first time?" Others may think of reincarnation ("I must have experienced this in a previous life") or precognition ("I viewed this scene in my mind before experiencing it").

"Do you ever get that strange feeling of vujà dé? Not déjà vu; vujà dé. It's the distinct sense that, somehow, something just happened that has never happened before. Nothing seems familiar. And then suddenly the feeling is gone. Vujà dé." -COMEDIAN GEORGE CARLIN (1937–2008), IN *FUNNY TIMES*, DECEMBER 2001

The key to déjà vu seems to be familiarity with a stimulus without a clear idea of where we encountered it before (Cleary, 2008). Normally, we experience a feeling of *familiarity* (thanks to temporal lobe processing) before we consciously remember details (thanks to hippocampus and frontal lobe processing). When these functions (and brain regions) are out of sync, we may experience a feeling of familiarity without conscious recall. Our amazing brains try to make sense of such an improbable situation, and we get an eerie feeling that we're reliving some earlier part of our life. After all, the situation is familiar, even though we have no idea why. Our source amnesia forces us to do our best to make sense of an odd moment.

source amnesia attributing to the wrong source an event we have experienced, heard about, read about, or imagined. (Also called *source misattribution*.) Source amnesia, along with the misinformation effect, is at the heart of many false memories.

déjà vu that eerie sense that "I've experienced this before." Cues from the current situation may unconsciously trigger retrieval of an earlier experience.

Discerning True and False Memories

Because the misinformation effect and source amnesia happen outside our awareness, it is nearly impossible to sift suggested ideas out of the larger pool of real memories (Schooler et al., 1986). Perhaps you can recall describing a childhood experience to a friend and filling in memory gaps with reasonable guesses and assumptions. We all do it, and after more retellings, those guessed details—now absorbed into our memories—may feel as real as if we had actually experienced them (Roediger et al., 1993). Much as perceptual illusions may seem like real perceptions, unreal memories feel like real memories.

False memories can be very persistent. Imagine that I were to read aloud a list of words such as *candy, sugar, honey,* and *taste.* Later, I ask you to recognize the presented words from a larger list. If you are at all like the people tested by Henry Roediger and Kathleen McDermott (1995), you would err three out of four times—by falsely remembering a nonpresented similar word, such as *sweet.* We more easily remember the gist than the words themselves.

Memory construction helps explain why 79 percent of 200 convicts exonerated by later DNA testing had been misjudged based on faulty eyewitness identification (Garrett, 2008). It explains why "hypnotically refreshed" memories of crimes so easily incorporate errors, some of which originate with the hypnotist's leading questions *("Did you hear loud noises?").* It explains why dating partners who fell in love have overestimated their first impressions of one another *("It was love at first sight"),* while those who broke up underestimated their earlier liking *("We never really clicked")* (McFarland & Ross, 1987). How people feel today tends to be how they recall they have always felt (Mazzoni & Vannucci, 2007; and recall from Module 4 our tendency to *hindsight bias*). As George Vaillant (1977, p. 197) noted after following adult lives through time, "It is all too common for caterpillars to become butterflies and then to maintain that in their youth they had been little butterflies. Maturation makes liars of us all."

Children's Eyewitness Recall

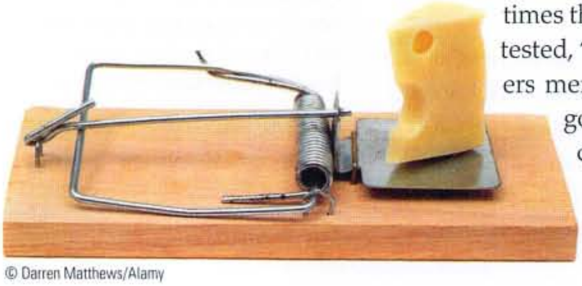
33-3 How reliable are young children's eyewitness descriptions, and why are reports of repressed and recovered memories so hotly debated?

If memories can be sincere, yet sincerely wrong, might children's recollections of sexual abuse be prone to error? "It would be truly awful to ever lose sight of the enormity of child abuse," observed Stephen Ceci (1993). Yet Ceci and Maggie Bruck's (1993, 1995) studies of children's memories have made them aware of how easily children's memories can be molded. For example, they asked 3-year-olds to show on anatomically correct dolls where a pediatrician had touched them. Of the children who had not received genital examinations, 55 percent pointed to either genital or anal areas.

In other experiments, the researchers studied the effect of suggestive interviewing techniques (Bruck & Ceci, 1999, 2004). In one study, children chose a card from a deck of possible happenings, and an adult then read the card to them. For example, "Think real hard, and tell me if this ever happened to you. Can you remember going to the hospital with a mousetrap on your finger?" In interviews, the same adult repeatedly asked children to think about several real and fictitious events. After 10 weeks of this, a new adult asked the same question. The stunning result: 58 percent of preschoolers produced false (often vivid) stories regarding one or more events they had never experienced (Ceci et al., 1994). Here's one of those stories:

> My brother Colin was trying to get Blowtorch [an action figure] from me, and I wouldn't let him take it from me, so he pushed me into the wood pile where the mousetrap was. And then my finger got caught in it. And then we went to the hospital, and my mommy, daddy, and Colin drove me there, to the hospital in our van, because it was far away. And the doctor put a bandage on this finger.

Given such detailed stories, professional psychologists who specialize in interviewing children could not reliably separate the real memories from the false ones. Nor could the children themselves. The above child, reminded that his parents had told him several times that the mousetrap incident never happened—that he had imagined it—protested, "But it really did happen. I remember it!" In another experiment, preschoolers merely overheard an erroneous remark that a magician's missing rabbit had gotten loose in their classroom. Later, when the children were suggestively questioned, 78 percent of them recalled actually seeing the rabbit (Principe et al., 2006). "[The] research leads me to worry about the possibility of false allegations. It is not a tribute to one's scientific integrity to walk down the middle of the road if the data are more to one side," said Ceci (1993).



Does this mean that children can never be accurate eyewitnesses? *No.* When questioned about their experiences in neutral words they understood, children often accurately recalled what happened and who did it (Goodman, 2006; Howe, 1997; Pipe, 1996). And when interviewers used less suggestive, more effective techniques, even 4- to 5-year-old children produced more accurate recall (Holliday & Albon, 2004; Pipe et al., 2004). Children were especially accurate when they had not talked with involved adults prior to the interview and when their disclosure was made in a first interview with a neutral person who asked nonleading questions.

Repressed or Constructed Memories of Abuse?

The research on source amnesia and the misinformation effect raises concerns about therapist-guided "recovered" memories. There are two tragedies related to adult recollections of child abuse. One happens when people don't believe abuse survivors who tell their secret. The other happens when innocent people are falsely accused.

Some well-intentioned therapists have reasoned with patients that "people who've been abused often have your symptoms, so you probably were abused. Let's see if, aided by hypnosis or drugs, or helped to dig back and visualize your trauma, you can recover it." Patients exposed to such techniques may then form an image of a threatening person. With further visualization, the image grows more vivid. The patient ends up stunned, angry, and ready to confront or sue the remembered abuser. The accused person (often a parent or relative) is equally stunned and devastated, and vigorously denies the accusation.

Critics are not questioning most therapists' professionalism. Nor are they questioning the accusers' sincerity; even if false, their memories are heartfelt. Critics' charges are specifically directed against clinicians who use "memory work" techniques, such as "guided imagery," hypnosis, and dream analysis to recover memories. "Thousands of families were cruelly ripped apart," with "previously loving adult daughters" suddenly accusing fathers (Gardner, 2006). Irate clinicians have countered that those who argue that recovered memories of abuse never happen are adding to abused people's trauma and playing into the hands of child molesters.

In an effort to find a sensible common ground that might resolve psychology's "memory war," professional organizations (the American Medical, American Psychological, and American Psychiatric Associations; the Australian Psychological Society; the British Psychological Society; and the Canadian Psychiatric Association) have convened study panels and issued public statements. Those committed to protecting abused children and those committed to protecting wrongly accused adults have agreed on the following:

- ***Sexual abuse happens.*** And it happens more often than we once supposed. Although sexual abuse can leave its victims at risk for problems ranging from sexual dysfunction to depression (Freyd et al., 2007), there is no characteristic "survivor syndrome"—no group of symptoms that lets us spot victims of sexual abuse (Kendall-Tackett et al., 1993).
- ***Injustice happens.*** Some innocent people have been falsely convicted. And some guilty people have evaded responsibility by casting doubt on their truth-telling accusers.
- ***Forgetting happens.*** Many of those actually abused were either very young when abused or may not have understood the meaning of their experience—circumstances under which forgetting is common. Forgetting isolated past events, both negative and positive, is an ordinary part of everyday life.
- ***Recovered memories are commonplace.*** Cued by a remark or an experience, we all recover memories of long-forgotten events, both pleasant and unpleasant. What many psychologists debate is twofold: Does the unconscious mind sometimes *forcibly repress* painful experiences? If so, can these experiences be retrieved by certain therapist-aided techniques? (Memories that surface naturally are more likely to be verified [Geraerts et al., 2007].)

"When memories are 'recovered' after long periods of amnesia, particularly when extraordinary means were used to secure the recovery of memory, there is a high probability that the memories are false." -Royal College of Psychiatrists Working Group on Reported Recovered Memories of Child Sexual Abuse (Brandon et al., 1998)

- ***Memories of things happening before age 3 are unreliable.*** We cannot reliably recall happenings from our first three years. As noted earlier, this infantile amnesia happens because our brain pathways have not yet developed enough to form the kinds of memories we will form later in life. Most psychologists—including most clinical and counseling psychologists—therefore doubt "recovered" memories of abuse during infancy (Gore-Felton et al., 2000; Knapp & VandeCreek, 2000). The older a child was when suffering sexual abuse, and the more severe the abuse, the more likely it is to be remembered (Goodman et al., 2003).
- ***Memories "recovered" under hypnosis or the influence of drugs are especially unreliable.*** Under hypnosis, people will incorporate all kinds of suggestions into their memories, even memories of "past lives."
- ***Memories, whether real or false, can be emotionally upsetting.*** Both the accuser and the accused may suffer when what was born of mere suggestion becomes, like an actual trauma, a stinging memory that drives bodily stress (McNally, 2003, 2007). Some people knocked unconscious in unremembered accidents know this all too well. They have later developed stress disorders after being haunted by memories they constructed from photos, news reports, and friends' accounts (Bryant, 2001).

So, does *repression* of threatening memories ever occur? Or is this concept—the cornerstone of Freud's theory and of so much popular psychology—misleading? In Modules 55 and 56, we will return to this hotly debated issue. For now, this much appears certain: The most common response to a traumatic experience (witnessing a loved one's murder, being terrorized by a hijacker or a rapist, losing everything in a natural disaster) is not banishment of the experience into the unconscious. Rather, such experiences are typically etched on the mind as vivid, persistent, haunting memories (Porter & Peace, 2007). As Robert Kraft (2002) said of the experience of those trapped in the Nazi death camps, "Horror sears memory, leaving . . . the consuming memories of atrocity."

Before You Move On

► ASK YOURSELF

Could you be an impartial jury member in a trial of a parent accused of sexual abuse based on a recovered memory, or of a therapist being sued for creating a false memory of abuse? Why or why not?

► TEST YOURSELF

How would source amnesia affect us if we were to remember all of our waking experiences as well as all of our dreams?

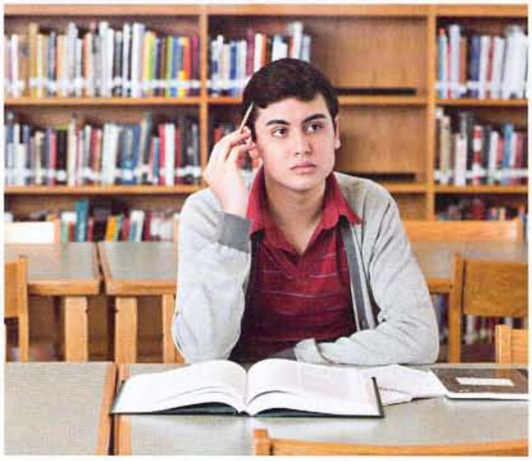
Answers to the Test Yourself questions can be found in Appendix E at the end of the book.

Improving Memory

33-4 How can you use memory research findings to do better in this and other courses?

Biology's findings benefit medicine. Botany's findings benefit agriculture. So, too, can psychology's research on memory benefit education. Here, for easy reference, is a summary of some research-based suggestions that could help you remember information when you need it. The SQ3R (*S*urvey, *Q*uestion, *R*ead, *R*etrieve, *R*eview) study technique introduced in Module 2 incorporates several of these strategies:

Rehearse repeatedly. To master material, use distributed (spaced) practice. To learn a concept, give yourself many separate study sessions. Take advantage of life's little intervals—riding a bus, walking to lunch, waiting for class to start. New memories are weak; exercise them and they will strengthen. To memorize specific facts or figures, Thomas Landauer (2001) has advised, "rehearse the name or number you are trying to memorize, wait a few seconds, rehearse again, wait a little longer, rehearse again, then wait longer still and rehearse yet again. The waits should be as long as possible without losing the information." Reading complex material with minimal rehearsal yields little retention. Rehearsal and critical reflection help more. It pays to study actively.



Thinking and memory Actively thinking as we read, by rehearsing and relating ideas, and by making the material personally meaningful, yields the best retention.

Make the material meaningful. You can build a network of retrieval cues by taking text and class notes in your own words. Apply the concepts to your own life. Form images. Understand and organize information. Relate the material to what you already know or have experienced. As William James (1890) suggested, "Knit each new thing on to some acquisition already there." Restate concepts in your own words. Mindlessly repeating someone else's words won't supply many retrieval cues. On an exam, you may find yourself stuck when a question uses phrasing different from the words you memorized.

Activate retrieval cues. Mentally re-create the situation and the mood in which your original learning occurred. Jog your memory by allowing one thought to cue the next.

Use mnemonic devices. Associate items with peg words. Make up a story that incorporates vivid images of the items. Chunk information into acronyms. Create rhythmic rhymes *("i before e, except after c")*.

Minimize interference. Study before sleep. Do not schedule back-to-back study times for topics that are likely to interfere with each other, such as Spanish and French.

Sleep more. During sleep, the brain reorganizes and consolidates information for long-term memory. Sleep deprivation disrupts this process.

Test your own knowledge, both to rehearse it and to find out what you don't yet know. Don't be lulled into overconfidence by your ability to recognize information. Test your recall using the Test Yourself items found throughout each unit, and the numbered Learning Objective Questions at the end of each module. Outline sections. Define the terms and concepts listed at each unit's end before turning back to their definitions. Try the Multiple-Choice and Practice FRQ questions at the end of each module, and take the AP® Exam Practice Questions at the end of each unit.

Before You Move On

► ASK YOURSELF

Which of the study and memory strategies suggested in this section will work best for you?

► TEST YOURSELF

What are the recommended memory strategies you just read about? (One advised rehearsing to-be-remembered material. What were the others?)

Answers to the Test Yourself questions can be found in Appendix E at the end of the book.

Module 33 Review

33-1 Why do we forget?

- *Anterograde amnesia* is an inability to form new memories.
- *Retrograde amnesia* is an inability to retrieve old memories.
- Normal forgetting happens because we have never encoded information; because the physical trace has decayed; or because we cannot retrieve what we have encoded and stored.
- Retrieval problems may result from *proactive* (forward-acting) *interference,* as prior learning interferes with recall of new information, or from *retroactive* (backward-acting) *interference,* as new learning disrupts recall of old information.
- Some believe that motivated forgetting occurs, but researchers have found little evidence of *repression.*

33-2 How do misinformation, imagination, and source amnesia influence our memory construction? How do we decide whether a memory is real or false?

- In experiments demonstrating the *misinformation effect,* people have formed false memories, by incorporating misleading details, either after receiving wrong information after an event, or after repeatedly *imagining* and rehearsing something that never happened.
- When we reassemble a memory during retrieval, we may attribute it to the wrong source *(source amnesia).* Source amnesia may help explain *déjà vu.*
- False memories feel like real memories and can be persistent but are usually limited to the gist of the event.

33-3 How reliable are young children's eyewitness descriptions, and why are reports of repressed and recovered memories so hotly debated?

- Children are susceptible to the misinformation effect, but if questioned in neutral words they understand, they can accurately recall events and people involved in them.
- The debate (between memory researchers and some well-meaning therapists) focuses on whether most memories of early childhood abuse are repressed and can be recovered during therapy using "memory work" techniques using leading questions or hypnosis.
- Psychologists now agree that (1) sexual abuse happens; (2) injustice happens; (3) forgetting happens; (4) recovered memories are commonplace; (5) memories of things that happened before age 3 are unreliable; (6) memories "recovered" under hypnosis or the influence of drugs are especially unreliable; and (7) memories, whether real or false, can be emotionally upsetting.

33-4 How can you use memory research findings to do better in this and other courses?

- Memory research findings suggest the following strategies for improving memory: Study repeatedly, make material meaningful, activate retrieval cues, use mnemonic devices, minimize interference, sleep more, and test yourself to be sure you can retrieve, as well as recognize, material.

Multiple-Choice Questions

1. Which of the following is an example of anterograde amnesia?

a. Halle has no memories of the first 10 years of her life.
b. William has lost his memory of the 2 weeks before he had surgery to remove a benign brain tumor.
c. Louis can remember his past, but has not been able to form new long-term memories since experiencing a brain infection 4 years ago.
d. Maddie can't remember the details of when she was mugged downtown 6 months ago.
e. Kalund struggles in school because he consistently misremembers what his teachers said in class.

2. Muhammad has been in his school cafeteria hundreds of times. It is a large room, and there are nine free-standing pillars that support the roof. One day, to illustrate the nature of forgetting, Muhammad's teacher asks him how many pillars there are in the cafeteria. Muhammad has difficulty answering the question, but finally replies that he thinks there are six pillars. What memory concept does this example illustrate?

a. Storage decay
b. Retrograde amnesia
c. Proactive interference
d. Retroactive interference
e. Encoding failure

3. What does Hermann Ebbinghaus' forgetting curve show about the nature of storage decay?

a. The rate of forgetting increases as time goes on.
b. The rate of forgetting decreases as time goes on.
c. The rate of forgetting does not change as time goes on.
d. The rate of forgetting varies according to the motivation of the learner.
e. The rate of forgetting varies according to the emotional state of the learner.

4. Which of the following is an example of proactive interference?

a. You can't recall your locker combination from sixth grade because your current locker combination interferes.
b. You can't recall your new cell phone number because your old number interferes.
c. You can't recall what you studied in first period because what you studied in fourth period interferes.
d. You can't recall what you studied on Monday because what you studied on Tuesday interferes.
e. You can't recall who won the state swim meet last year because the winner of this year's meet interferes.

5. The text discusses therapist-guided "recovered" memories. Which of the following statements represents an appropriate conclusion about this issue?

a. Therapists who use hypnosis are likely to help their patients retrieve repressed memories.
b. Statistics indicate that childhood sexual abuse rarely occurs; therefore, recovered memories of such abuse must be false.
c. Memories are only rarely recovered; once you are unable to retrieve a memory you will probably never be able to retrieve it.
d. One indicator of whether a recovered memory is true is the patient's emotional response; only true recovered memories are emotionally upsetting.
e. Since the brain is not sufficiently mature to store accurate memories of events before the age of 3, memories from the first 3 years of life are not reliable.

Practice FRQs

1. Tasnia feels like she encodes material well, but still forgets the material on test day. Explain how her forgetting might be related to problems with each of the following:

- Storage
- Retrieval

Answer

1 point: Forgetting may be related to the decay of stored material.

1 point: Forgetting may be related to interference during retrieval (or motivated forgetting).

2. Your younger sister has asked you for help because she feels she cannot remember class material well enough to get good grades on her tests. Provide three specific pieces of advice that she should consider, making sure that your advice is based on psychological science.

(3 points)

Module 34

Thinking, Concepts, and Creativity

Module Learning Objectives

34-1 Define *cognition*, and describe the functions of concepts.

34-2 Identify the factors associated with creativity, and describe ways of promoting creativity.

Courtesy Everett Collection

In some ways, we humans are, as we will see, dim-witted. We fear the wrong things. We allow the day's hot or cold weather to color our judgments of global climate change. We tend to be overconfident in our judgments and to persevere in clinging to discredited beliefs. Yet we also display remarkable mental powers. Our intelligence, creativity, and language mark us as "little less than the angels."

cognition all the mental activities associated with thinking, knowing, remembering, and communicating.

concept a mental grouping of similar objects, events, ideas, or people.

prototype a mental image or best example of a category. Matching new items to a prototype provides a quick and easy method for sorting items into categories (as when comparing feathered creatures to a prototypical bird, such as a robin).

Thinking and Concepts

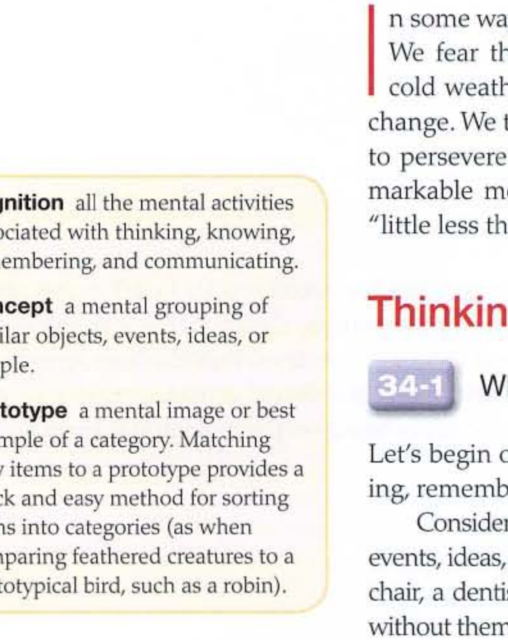
34-1 What is cognition, and what are the functions of concepts?

Let's begin our study of **cognition**—the mental activities associated with thinking, knowing, remembering, and communicating information—by appreciating our human smarts.

Consider, for example, our ability to form **concepts**—mental groupings of similar objects, events, ideas, and people. The concept *chair* includes many items—a baby's high chair, a reclining chair, a dentist's chair—all of which are for sitting. Concepts simplify our thinking. Imagine life without them. We would need a different name for every person, event, object, and idea. We could not ask a child to "throw the ball" because there would be no concept of *throw* or *ball.* Instead of saying, "They were angry," we would have to describe expressions, intensities, and words. Concepts such as *ball* and *anger* give us much information with little cognitive effort.

We often form our concepts by developing **prototypes**—a mental image or best example of a category (Rosch, 1978). People more quickly agree that "a robin is a bird" than that "a penguin is a bird." For most of us, the robin is the birdier bird; it more closely resembles our bird prototype. And the more closely something matches our prototype of a concept—bird or car—the more readily we recognize it as an example of the concept.

Once we place an item in a category, our memory of it later shifts toward the category prototype, as it did for Belgian students who viewed ethnically blended faces. For example, when viewing a blended face in which 70 percent of the features were Caucasian and 30 percent were Asian, the students categorized the



"Attention, everyone! I'd like to introduce the newest member of our family."

face as Caucasian. Later, as their memory shifted toward the Caucasian prototype, they were more likely to remember an 80 percent Caucasian face than the 70 percent Caucasian they had actually seen (Corneille et al., 2004). Likewise, if shown a 70 percent Asian face, they later remembered a more prototypically Asian face. So, too, with gender: People who viewed 70 percent male faces categorized them as male (no surprise there) and then later misremembered them as even more prototypically male (Huart et al., 2005).

Move away from our prototypes, and category boundaries may blur. Is a tomato a fruit? Is a 17-year-old female a girl or a woman? Is a whale a fish or a mammal? Because a whale fails to match our "mammal" prototype, we are slower to recognize it as a mammal. Similarly, when symptoms don't fit one of our disease prototypes, we are slow to perceive an illness (Bishop, 1991). People whose heart attack symptoms (shortness of breath, exhaustion, a dull weight in the chest) don't match their heart attack prototype (sharp chest pain) may not seek help. And when behaviors don't fit our discrimination prototypes—of White against Black, male against female, young against old—we often fail to notice prejudice. People more easily detect male prejudice against females than female against males or female against females (Inman & Baron, 1996; Marti et al., 2000). Concepts speed and guide our thinking. But they don't always make us wise.

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Toying with our prototypes It takes a bit longer to conceptualize a Smart Car as an actual car, because it looks more like a toy than our mental prototype for *car*.

Creativity

34-2 What is creativity, and what fosters it?

Pierre de Fermat, a seventeenth-century mischievous genius, challenged mathematicians of his day to match his solutions to various number theory problems. His most famous challenge—*Fermat's last theorem*—baffled the greatest mathematical minds, even after a $2 million prize (in today's dollars) was offered in 1908 to whoever first created a proof.

Princeton mathematician Andrew Wiles had pondered the problem for more than 30 years and had come to the brink of a solution. One morning, out of the blue, the final "incredible revelation" struck him. "It was so indescribably beautiful; it was so simple and so elegant. I couldn't understand how I'd missed it. . . . It was the most important moment of my working life" (Singh, 1997, p. 25).

Wiles' incredible moment illustrates **creativity**—the ability to produce ideas that are both novel and valuable (Hennessey & Amabile, 2010). Studies suggest that a certain level of aptitude—a score above 120 on a standard intelligence test—supports creativity. Those who score exceptionally high in quantitative aptitude as 13-year-olds are more likely to obtain graduate science and math degrees and create published or patented work (Park et al., 2008; Robertson et al., 2010). Intelligence matters. Yet, there is more to creativity than what intelligence tests reveal. Indeed, the two kinds of thinking engage different brain areas. Intelligence tests, which typically demand a single correct answer, require **convergent thinking.** Injury to the left parietal lobe damages this ability. Creativity tests *(How many uses can you think of for a brick?)* require **divergent thinking.** Injury to certain areas of the frontal lobes can leave reading, writing, and arithmetic skills intact but destroy imagination (Kolb & Whishaw, 2006).

FYI

After picking up a Nobel Prize in Stockholm, physicist Richard Feynman stopped in Queens, New York, to look at his high school record. "My grades were not as good as I remembered," he reported, "and my IQ was [a good, though unexceptional] 124" (Faber, 1987).

Although there is no agreed-upon creativity measure—there is no Creativity Quotient (CQ) corresponding to an Intelligence Quotient (IQ) score—Robert Sternberg and his colleagues have identified five components of creativity (Sternberg, 1988, 2003; Sternberg & Lubart, 1991, 1992):

1. ***Expertise***—a well-developed base of knowledge—furnishes the ideas, images, and phrases we use as mental building blocks. "Chance favors only the prepared mind," observed Louis Pasteur. The more blocks we have, the more chances we have to combine them in novel ways. Wiles' well-developed base of knowledge put the needed theorems and methods at his disposal.

creativity the ability to produce novel and valuable ideas.

convergent thinking narrows the available problem solutions to determine the single best solution.

divergent thinking expands the number of possible problem solutions (creative thinking that diverges in different directions).

2. ***Imaginative thinking skills*** provide the ability to see things in novel ways, to recognize patterns, and to make connections. Having mastered a problem's basic elements, we redefine or explore it in a new way. Copernicus first developed expertise regarding the solar system and its planets, and then creatively defined the system as revolving around the Sun, not the Earth. Wiles' imaginative solution combined two partial solutions.
3. ***A venturesome personality*** seeks new experiences, tolerates ambiguity and risk, and perseveres in overcoming obstacles. Wiles risked much of his time in pursuit of his dream and persevered in near-isolation from the mathematics community partly to stay focused and avoid distraction.
4. ***Intrinsic motivation*** is being driven more by interest, satisfaction, and challenge than by external pressures (Amabile & Hennessey, 1992). Creative people focus less on extrinsic motivators—meeting deadlines, impressing people, or making money—than on the pleasure and stimulation of the work itself. Asked how he solved such difficult scientific problems, Isaac Newton reportedly answered, "By thinking about them all the time." Wiles concurred: "I was so obsessed by this problem that . . . I was thinking about it all the time—[from] when I woke up in the morning to when I went to sleep at night" (Singh & Riber, 1997).
5. ***A creative environment*** sparks, supports, and refines creative ideas. After studying the careers of 2026 prominent scientists and inventors, Dean Keith Simonton (1992) noted that the most eminent were mentored, challenged, and supported by their colleagues. Many had the emotional intelligence needed to network effectively with peers. Even Wiles stood on the shoulders of others and wrestled his problem with the collaboration of a former student. Creativity-fostering environments support innovation, team-building, and communication (Hülsheger et al., 2009). They also support contemplation. After Jonas Salk solved a problem that led to the polio vaccine while in a monastery, he designed the Salk Institute to provide contemplative spaces where scientists could work without interruption (Sternberg, 2006). Google has estimated that nearly half its product innovations have been sparked during the 20 percent of employee time reserved for unstructured creative thinking (Mayer, 2006).

Imaginative thinking Cartoonists often display creativity as they see things in new ways or make unusual connections.

"For the love of God, is there a doctor in the house?"

For those seeking to boost the creative process, research offers some ideas:

- *Develop your expertise.* Ask yourself what you care about and most enjoy. Follow your passion and become an expert at something.
- *Allow time for incubation.* Given sufficient knowledge available for novel connections, a period of inattention to a problem ("sleeping on it") allows for unconscious processing to form associations (Zhong et al., 2008). So think hard on a problem, then set it aside and come back to it later.
- *Set aside time for the mind to roam freely.* Take time away from attention-absorbing television, social networking, and video gaming. Jog, go for a long walk, or meditate.
- *Experience other cultures and ways of thinking.* Living abroad sets the creative juices flowing. Even after controlling for other variables, students who have spent time abroad are more adept at working out creative solutions to problems (Leung et al., 2008; Maddux et al., 2009, 2010). Multicultural experiences expose us to multiple perspectives and facilitate flexible thinking.

A creative environment

Before You Move On

▶ ASK YOURSELF

Imagine patiently waiting your turn at a store, and then having some late-arriving adults served before you. The clerk also checks inside your bag as you leave the store. What is a prototype, and what sort of "teenager" prototype does the clerk seem to have in mind?

▶ TEST YOURSELF

According to Robert Sternberg, what are the five components of creativity?

Answers to the Test Yourself questions can be found in Appendix E at the end of the book.

Module 34 Review

34-1 What is cognition, and what are the functions of concepts?

- *Cognition* refers to all the mental activities associated with thinking, knowing, remembering, and communicating.
- We use *concepts,* mental groupings of similar objects, events, ideas, or people, to simplify and order the world around us.
- We form most concepts around *prototypes,* or best examples of a category.

34-2 What is creativity, and what fosters it?

- *Creativity,* the ability to produce novel and valuable ideas, correlates somewhat with intelligence, but beyond an intelligence test score of 120, that correlation dwindles.
- Sternberg has proposed that creativity has five components: expertise, imaginative thinking skills; a venturesome personality; intrinsic motivation; and a creative environment that sparks, supports, and refines creative ideas.

Multiple-Choice Questions

1. Which of the following is the best term for mental activities associated with remembering, thinking, and knowing?

a. Cognition
b. Concepts
c. Prototypes
d. Convergent thinking
e. Divergent thinking

2. Which of the following is the best phrase for the narrowing of available problem solutions with the goal of determining the best solution?

a. Allowing for incubation
b. Divergent thinking
c. Developing expertise
d. Convergent thinking
e. Experiencing other cultures

3. Producing valuable and novel ideas best defines which of the following?

a. Prototyping
b. Cognition
c. Intrinsic motivation
d. Venturesome personality
e. Creativity

Practice FRQs

1. Compare the notions of concept and prototype.

Answer

1 point: A concept is a mental grouping of similar objects, events, ideas, and people.

1 point: A prototype is a mental image or best example of a category.

2. Identify and explain four of the five components of creativity mentioned in this module.

(4 points)

Module 35

Solving Problems and Making Decisions

Mike Cohea/Brown University

Module Learning Objectives

35-1 Describe the cognitive strategies that assist our problem solving, and identify the obstacles that hinder it.

35-2 Explain what is meant by intuition, and describe how the representativeness and availability heuristics, overconfidence, belief perseverance, and framing influence our decisions and judgments.

35-3 Describe how smart thinkers use intuition.

Problem Solving: Strategies and Obstacles

35-1 What cognitive strategies assist our problem solving, and what obstacles hinder it?

One tribute to our rationality is our problem-solving skill. What's the best route around this traffic jam? How should we handle a friend's criticism? How can we get in the house without our keys?

Some problems we solve through *trial and error.* Thomas Edison tried thousands of light bulb filaments before stumbling upon one that worked. For other problems, we use **algorithms,** step-by-step procedures that guarantee a solution. But step-by-step algorithms can be laborious and exasperating. To find a word using the 10 letters in *SPLOYOCHYG,* for example, you could try each letter in each of the 10 positions—907,200 permutations in all. Rather than give you a computing brain the size of a beach ball, nature resorts to **heuristics,** simpler thinking strategies. Thus, you might reduce the number of options in the *SPLOYOCHYG* example by grouping letters that often appear together (*CH* and *GY*) and excluding rare letter combinations (such as two Y's together). By using heuristics and then applying trial and error, you may hit on the answer. Have you guessed it?[1]

Sometimes, no problem-solving strategy seems to be at work at all, and we arrive at a solution to a problem with **insight**. Teams of researchers have identified brain activity associated with sudden flashes of insight (Kounios & Beeman, 2009; Sandkühler & Bhattacharya, 2008). They gave people a problem: Think of a word that will form a compound word or phrase with each of three other words in a set (such as *pine, crab,* and *sauce*), and press a button to sound a bell when you know the answer. (If you need a hint: The word is a fruit.[2]) EEGs or fMRIs (functional MRIs) revealed the problem solver's brain activity.

[1] Answer to SPLOYOCHYG anagram: PSYCHOLOGY.

[2] The word is apple: pineapple, crabapple, applesauce.

AP® Exam Tip

There are several sample problems for you to enjoy in this section. It can be very interesting to ask several of your friends to try to solve them, too. Have them talk through the problem out loud and you will gain some understanding of the processes they are using.

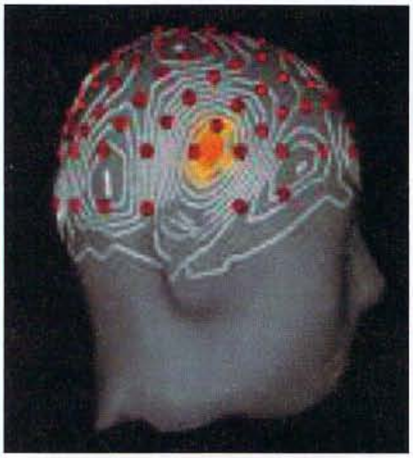
algorithm a methodical, logical rule or procedure that guarantees solving a particular problem. Contrasts with the usually speedier—but also more error-prone—use of *heuristics.*

heuristic a simple thinking strategy that often allows us to make judgments and solve problems efficiently; usually speedier but also more error-prone than *algorithms.*

insight a sudden realization of a problem's solution; contrasts with strategy-based solutions.

Fancy Collection/SuperStock

Heuristic searching To search for hot cocoa mix, you could search every supermarket aisle (an algorithm), or check the breakfast, beverage, and baking supplies sections (heuristics). The heuristics approach is often speedier, but an algorithmic search guarantees you will find it eventually.



From Mark Jung-Beeman, Northwestern University and John Kounios, Drexel University

Figure 35.1

The Aha! moment A burst of right temporal lobe activity accompanied insight solutions to word problems (Jung-Beeman et al., 2004). The red dots designate EEG electrodes. The light gray lines show the distribution of high-frequency activity accompanying insight. The insight-related activity is centered in the right temporal lobe (yellow area).

In the first experiment, about half the solutions were by a sudden Aha! insight. Before the Aha! moment, the problem solvers' frontal lobes (which are involved in focusing attention) were active, and there was a burst of activity in the right temporal lobe, just above the ear (**FIGURE 35.1**).

We are also not the only creatures to display insight, as psychologist Wolfgang Köhler (1925) demonstrated in an experiment with Sultan, a chimpanzee. Köhler placed a piece of fruit and a long stick outside Sultan's cage. Inside the cage, he placed a short stick, which Sultan grabbed, using it to try to reach the fruit. After several failed attempts, he dropped the stick and seemed to survey the situation. Then suddenly, as if thinking "Aha!" Sultan jumped up and seized the short stick again. This time, he used it to pull in the longer stick—which he then used to reach the fruit. What is more, apes will even exhibit foresight, by storing a tool they can use to retrieve food the next day (Mulcahy & Call, 2006).

Insight strikes suddenly, with no prior sense of "getting warmer" or feeling close to a solution (Knoblich & Oellinger, 2006; Metcalfe, 1986). When the answer pops into mind *(apple!)*, we feel a happy sense of satisfaction. The joy of a joke may similarly lie in our sudden comprehension of an unexpected ending or a double meaning: "You don't need a parachute to skydive. You only need a parachute to skydive twice."

Inventive as we are, other cognitive tendencies may lead us astray. For example, we more eagerly seek out and favor evidence verifying our ideas than evidence refuting them (Klayman & Ha, 1987; Skov & Sherman, 1986). Peter Wason (1960) demonstrated this tendency, known as **confirmation bias,** by giving British university students the three-number sequence 2-4-6 and asking them to guess the rule he had used to devise the series. (The rule was simple: any three ascending numbers.) Before submitting answers, students generated their own three-number sets and Wason told them whether their sets conformed to his rule. Once *certain* they had the rule, they could announce it. The result? Seldom right but never in doubt. Most students formed a wrong idea *("Maybe it's counting by twos")* and then searched only for confirming evidence (by testing 6-8-10, 100-102-104, and so forth).

confirmation bias a tendency to search for information that supports our preconceptions and to ignore or distort contradictory evidence.

"The human understanding, when any proposition has been once laid down . . . forces everything else to add fresh support and confirmation." -Francis Bacon, *Novum Organum*, 1620

"Ordinary people," said Wason (1981), "evade facts, become inconsistent, or systematically defend themselves against the threat of new information relevant to the issue." Thus, once people form a belief—that vaccines cause autism spectrum disorder, that President Barack Obama is a Kenyan-born Muslim, that gun control does (or does not) save lives—they prefer belief-confirming information. The results can be momentous. The U.S. war against Iraq was launched on the belief that Saddam Hussein possessed weapons of mass destruction (WMD) that posed an immediate threat. When that assumption turned out to be false, the bipartisan U.S. Senate Select Committee on Intelligence (2004) identified confirmation bias as partly to blame: Administration analysts "had a tendency to accept information which supported [their presumptions] . . . more readily than information which contradicted" them. Sources denying such weapons were deemed "either lying or not knowledgeable about Iraq's problems," while those sources who reported ongoing WMD activities were seen as "having provided valuable information."

Once we incorrectly represent a problem, it's hard to restructure how we approach it. If the solution to the matchstick problem in **FIGURE 35.2** eludes you, you may be experiencing *fixation*—an inability to see a problem from a fresh perspective. (For the solution, turn the page to see **FIGURE 35.3**.)

A prime example of fixation is **mental set,** our tendency to approach a problem with the mind-set of what has worked for us previously. Indeed, solutions that worked in the past often do work on new problems. Consider:

Given the sequence *O-T-T-F-?-?-?*, what are the final three letters?

Most people have difficulty recognizing that the three final letters are *F*(ive), *S*(ix), and *S*(even). But solving this problem may make the next one easier:

Given the sequence *J-F-M-A-?-?-?*, what are the final three letters? (If you don't get this one, ask yourself what month it is.)

As a perceptual set predisposes what we perceive, a mental set predisposes how we think; sometimes this can be an obstacle to problem solving, as when our mental set from our past experiences with matchsticks predisposes us to arrange them in two dimensions.

Figure 35.2
The matchstick problem How would you arrange six matches to form four equilateral triangles?

Forming Good and Bad Decisions and Judgments

35-2 What is intuition, and how can the representativeness and availability heuristics, overconfidence, belief perseverance, and framing influence our decisions and judgments?

When making each day's hundreds of judgments and decisions *(Is it worth the bother to take a jacket? Can I trust this person? Should I shoot the basketball or pass to the player who's hot?)*, we seldom take the time and effort to reason systematically. We just follow our **intuition,** our fast, automatic, unreasoned feelings and thoughts. After interviewing policy makers in government, business, and education, social psychologist Irving Janis (1986) concluded that they "often do not use a reflective problem-solving approach. How do they usually arrive at their decisions? If you ask, they are likely to tell you . . . they do it mostly by *the seat of their pants.*"

When we need to act quickly, the mental shortcuts we call *heuristics* enable snap judgments. Thanks to our mind's automatic information processing, intuitive judgments are instantaneous and usually effective. However, research by cognitive psychologists Amos Tversky and Daniel Kahneman (1974) on the *representativeness* and *availability heuristics* showed how these generally helpful shortcuts can lead even the smartest people into dumb decisions.[3]

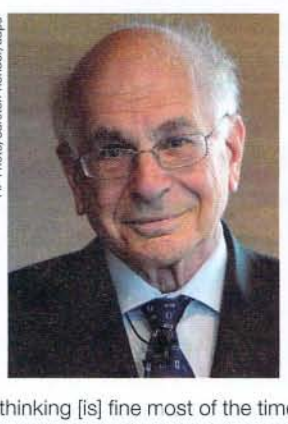
[3] Tversky and Kahneman's joint work on decision making received a 2002 Nobel Prize; sadly, only Kahneman was alive to receive the honor.

B. Veley

"The problem is I can't tell the difference between a deeply wise, intuitive nudge from the Universe and one of my own bone-headed ideas!"

"Kahneman and his colleagues and students have changed the way we think about the way people think." -American Psychological Association President, Sharon Brehm, 2007

"In creating these problems, we didn't set out to fool people. All our problems fooled us, too." Amos Tversky (1985)



AP Photo/Carsten Rehder/dapd

"Intuitive thinking [is] fine most of the time. . . . But sometimes that habit of mind gets us in trouble." Daniel Kahneman (2005)

mental set a tendency to approach a problem in one particular way, often a way that has been successful in the past.

intuition an effortless, immediate, automatic feeling or thought, as contrasted with explicit, conscious reasoning.

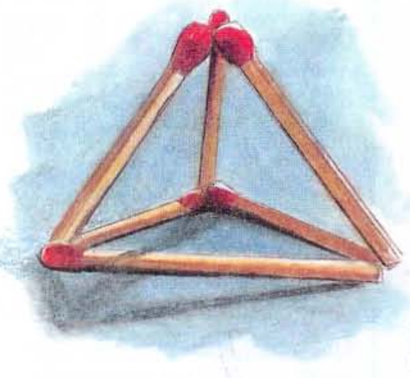


Figure 35.3
Solution to the matchstick problem To solve this problem, you must view it from a new perspective, breaking the fixation of limiting solutions to two dimensions.

The Representativeness Heuristic

To judge the likelihood of things in terms of how well they represent particular prototypes is to use the **representativeness heuristic.** To illustrate, consider:

> A stranger tells you about a person who is short, slim, and likes to read poetry, and then asks you to guess whether this person is more likely to be a professor of classics at an Ivy League university or a truck driver (adapted from Nisbett & Ross, 1980). Which would be the better guess?

Did you answer "professor"? Many people do, because the description seems more *representative* of Ivy League scholars than of truck drivers. The representativeness heuristic enabled you to make a snap judgment. But it also led you to ignore other relevant information. When I help people think through this question, the conversation goes something like this:

Question: First, let's figure out how many professors fit the description. How many Ivy League universities do you suppose there are?

Answer: Oh, about 10, I suppose.

Question: How many classics professors would you guess there are at each?

Answer: Maybe 4.

Question: Okay, that's 40 Ivy League classics professors. What fraction of these are short and slim?

Answer: Let's say half.

Question: And, of these 20, how many like to read poetry?

Answer: I'd say half—10 professors.

Question: Okay, now let's figure how many truck drivers fit the description. How many truck drivers do you suppose there are?

Answer: Maybe 400,000.

Question: What fraction are short and slim?

Answer: Not many—perhaps 1 in 8.

Question: Of these 50,000, what percentage like to read poetry?

Answer: Truck drivers who like poetry? Maybe 1 in 100—oh, oh, I get it— that leaves 500 short, slim, poetry-reading truck drivers.

Comment: Yup. So, even if we accept your stereotype that the description is more representative of classics professors than of truck drivers, the odds are 50 to 1 that this person is a truck driver.

The representativeness heuristic influences many of our daily decisions. To judge the likelihood of something, we intuitively compare it with our mental representation of that category—of, say, what truck drivers are like. If the two match, that fact usually overrides other considerations of statistics or logic.

representativeness heuristic judging the likelihood of things in terms of how well they seem to represent, or match, particular prototypes; may lead us to ignore other relevant information.

availability heuristic estimating the likelihood of events based on their availability in memory; if instances come readily to mind (perhaps because of their vividness), we presume such events are common.

The Availability Heuristic

The **availability heuristic** operates when we estimate the likelihood of events based on how mentally available they are. Casinos entice us to gamble by signaling even small wins with bells and lights—making them vividly memorable—while keeping big losses soundlessly invisible.

The availability heuristic can lead us astray in our judgments of other people, too. Anything that makes information "pop" into mind—its vividness, recency, or distinctiveness—can make it seem commonplace. If someone from a particular ethnic or religious group commits a terrorist act, as happened on September 11, 2001, when Islamic extremists killed nearly 3000 people in the United States in coordinated terrorist attacks, our readily available memory of the dramatic event may shape our impression of the whole group.

Even during that horrific year, terrorist acts claimed comparatively few lives. Yet when the statistical reality of greater dangers (see **FIGURE 35.4**) was pitted against a single vivid case, the memorable case won, as emotion-laden images of terror exacerbated our fears (Sunstein, 2007).

We often fear the wrong things. We fear flying because we play in our heads some air disaster. We fear letting our children walk to school because we play in our heads tapes of abducted and brutalized children. We fear swimming in ocean waters because we replay *Jaws* in our heads. Even just passing by a person who sneezes and coughs heightens our perceptions of various health risks (Lee et al., 2010). And so, thanks to these readily available images, we come to fear extremely rare events. (Turn the page to see Thinking Critically About: The Fear Factor—Why We Fear the Wrong Things.)

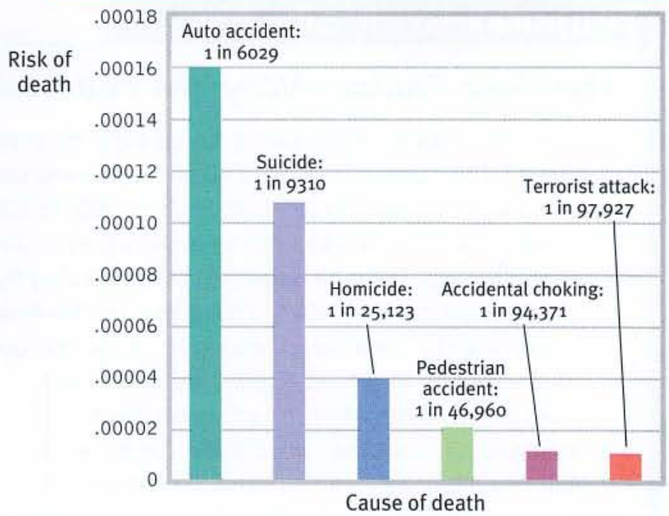


Figure 35.4
Risk of death from various causes in the United States, 2001 (Data assembled from various government sources by Randall Marshall et al., 2007.)

Meanwhile, the lack of comparably available images of global climate change—which some scientists regard as a future "Armageddon in slow motion"—has left most people little concerned (Pew, 2007). The vividness of a recent local cold day reduces their concern about long-term global warming and overwhelms less memorable scientific data (Li et al., 2011). Dramatic outcomes make us gasp; probabilities we hardly grasp. As of 2013, some 60 nations—including Canada, many in Europe, and the United States—have, however, sought to harness the positive power of vivid, memorable images by putting eye-catching warnings and graphic photos on cigarette packages (Riordan, 2013). This campaign may work, where others have failed. As psychologist Paul Slovic (2007) points out, we reason emotionally and neglect probabilities. We overfeel and underthink. In one experiment, donations to a starving 7-year-old child were greater when her image was *not* accompanied by statistical information about the millions of needy African children like her (Small et al., 2007). "If I look at the mass, I will never act," Mother Teresa reportedly said. "If I look at the one, I will." "The more who die, the less we care," noted Slovic (2010).

Overconfidence

Sometimes our judgments and decisions go awry simply because we are more confident than correct. Across various tasks, people overestimate their performance (Metcalfe, 1998). If 60 percent of people correctly answer a factual question, such as "Is absinthe a liqueur or a precious stone?," they will typically average 75 percent confidence (Fischhoff et al., 1977). (It's a licorice-flavored liqueur.) This tendency to overestimate the accuracy of our knowledge and judgments is **overconfidence.**

overconfidence the tendency to be more confident than correct—to overestimate the accuracy of our beliefs and judgments.

It was an overconfident BP that, before its exploded drilling platform spewed oil into the Gulf of Mexico, downplayed safety concerns, and then downplayed the spill's magnitude (Mohr et al., 2010; Urbina, 2010). It is overconfidence that drives stockbrokers and investment managers to market their ability to outperform stock market averages, despite overwhelming evidence to the contrary (Malkiel, 2004). A purchase of stock X, recommended by a broker who judges this to be the time to buy, is usually balanced by a sale made by someone who judges this to be the time to sell. Despite their confidence, buyer and seller cannot both be right.

History is full of leaders who were more confident than correct. And classrooms are full of overconfident students who expect to finish assignments and write papers ahead of schedule (Buehler et al., 1994). In fact, the projects generally take about twice the number of days predicted.

"Don't believe everything you think." -BUMPER STICKER

Thinking Critically About

The Fear Factor—Why We Fear the Wrong Things

After the 9/11 attacks, many people feared flying more than driving. In a 2006 Gallup survey, only 40 percent of Americans reported being "not afraid at all" to fly. Yet from 2005 to 2007 Americans were—mile for mile—170 times more likely to die in an automobile or pickup truck crash than on a scheduled flight (National Safety Council, 2010). In 2009 alone, 33,808 Americans were killed in motor vehicle accidents—that's 650 dead people each week. Meanwhile, in 2009 (as in 2007 and 2008) zero died from airline accidents on scheduled flights.

In a late 2001 essay, I calculated that if—because of 9/11—we flew 20 percent less and instead drove half those unflown miles, about 800 more people would die in the year after 9/11 (Myers, 2001). German psychologist Gerd Gigerenzer (2004, 2006) later checked this estimate against actual accident data. (Why didn't I think of that?) U.S. traffic deaths did indeed increase significantly in the last three months of 2001 (**FIGURE 35.5**). By the end of 2002, Gigerenzer estimated, 1600 Americans had "lost their lives on the road by trying to avoid the risk of flying." Despite our greater fear of flying, flying's greatest danger is, for most people, the drive to the airport.

Why do we fear the wrong things? Why do we judge terrorism to be a greater risk than accidents? Psychologists have identified four influences that feed fear and cause us to ignore higher risks.

1. *We fear what our ancestral history has prepared us to fear.* Human emotions were road tested in the Stone Age. Our old brain prepares us to fear yesterday's risks: snakes, lizards, and spiders (which combined now kill a tiny fraction of the number killed by modern-day threats, such as cars and cigarettes). Yesterday's risks also prepare us to fear confinement and heights, and therefore flying.
2. *We fear what we cannot control.* Driving we control; flying we do not.
3. *We fear what is immediate.* The dangers of flying are mostly telescoped into the moments of takeoff and landing. The dangers of driving are diffused across many moments to come, each trivially dangerous.
4. *Thanks to the availability heuristic, we fear what is most readily available in memory.* Powerful, vivid images, like that of United Flight 175 slicing into the World Trade Center, feed our judgments of risk. Thousands of safe car trips have extinguished our anxieties about driving. Similarly, we remember (and fear) widespread disasters (hurricanes, tornadoes, earthquakes) that kill people dramatically, in bunches. But we fear too little the less dramatic threats that claim lives quietly, one by one, continuing into the distant future. Bill Gates has noted that each year a half-million children worldwide die from rotavirus. This is the equivalent of four 747s full of children *every day,* and we hear nothing of it (Glass, 2004).

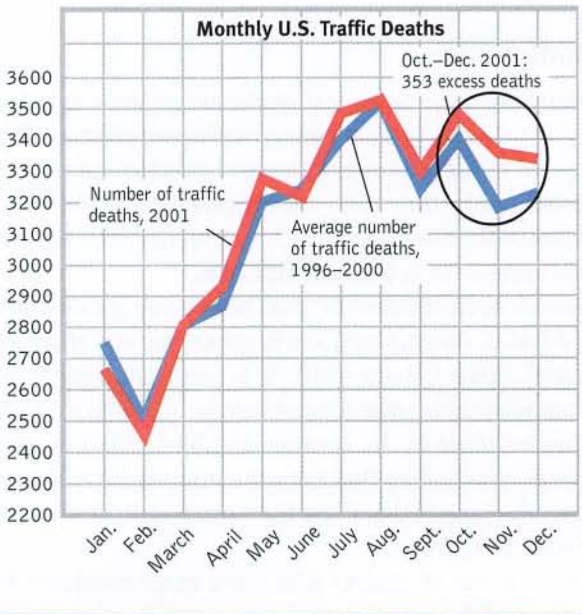


Figure 35.5
Scared onto deadly highways Images of 9/11 etched a sharper image in American minds than did the millions of fatality-free flights on U.S. airlines during 2002 and after. Dramatic events are readily available to memory, and they shape our perceptions of risk. In the three months after 9/11, those faulty perceptions led more Americans to travel, and some to die, by car. (Adapted from Gigerenzer, 2004.)

Thinking Critically About *(continued)*

Dramatic deaths in bunches breed concern and fear The memorable Haitian earthquake that killed some 250,000 people stirred an outpouring of justified concern. Meanwhile, according to the World Health Organization, a silent earthquake of poverty-related malaria was killing about that many people, mostly in Africa, every four months.

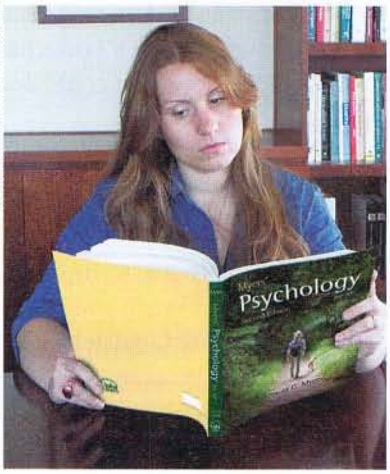
Ian Berry/Magnum Photos

The news, and our own memorable experiences, can make us disproportionately fearful of infinitesimal risks. As one risk analyst explained, "If it's in the news, don't worry about it. The very definition of *news* is 'something that hardly ever happens'" (Schneier, 2007). Despite people's fear of dying in a terrorist attack on an airplane, the last decade produced one terrorist attempt for every 10.4 million flights—less than one-twentieth the chance of any one of us being struck by lightning (Silver, 2009).

"Fearful people are more dependent, more easily manipulated and controlled, more susceptible to deceptively simple, strong, tough measures and hard-line postures." -Media researcher George Gerbner to U.S. Congressional Subcommittee on Communications, 1981

The point to remember: It is perfectly normal to fear purposeful violence from those who wish us harm. When terrorists strike again, we will all recoil in horror. But smart thinkers will check their fears against the facts and resist those who aim to create a culture of fear. By so doing, we take away the terrorists' most omnipresent weapon: exaggerated fear.

Anticipating how much we will accomplish, we also overestimate our future leisure time (Zauberman & Lynch, 2005). Believing we will have more time next month than we do today, we happily accept invitations and assignments, only to discover we're just as busy when the day rolls around. Failing to appreciate our potential for error and believing we will have more money next year, we take out loans or buy on credit. Despite our painful underestimates, we remain overly confident of our next prediction.



Bianca Moscatelli/Worth Publishers

Predict your own behavior When will you finish reading this module?

Overconfidence can have adaptive value. People who err on the side of overconfidence live more happily. They make tough decisions more easily, and they seem more credible than others (Baumeister, 1989; Taylor, 1989). Moreover, given prompt and clear feedback, as weather forecasters receive after each day's predictions, people can learn to be more realistic about the accuracy of their judgments (Fischhoff, 1982). The wisdom to know when we know a thing and when we do not is born of experience.

belief perseverance clinging to one's initial conceptions after the basis on which they were formed has been discredited.

Belief Perseverance

Our overconfidence in our judgments is startling; equally startling is our tendency to cling to our beliefs in the face of contrary evidence. **Belief perseverance** often fuels social conflict, as it did in a classic study of people with opposing views of capital punishment (Lord et al., 1979). Each side studied two supposedly new research findings, one supporting and the other refuting the claim that the death penalty deters crime. Each side was more impressed by the study supporting its own beliefs, and each readily disputed the other study. Thus, showing the pro- and anti-capital-punishment groups the *same* mixed evidence actually *increased* their disagreement.

"When you know a thing, to hold that you know it; and when you do not know a thing, to allow that you do not know it; this is knowledge." -Confucius (551–479 B.C.E.), *Analects*

If you want to rein in the belief perseverance phenomenon, a simple remedy exists: *Consider the opposite.* When the same researchers repeated the capital-punishment study, they asked some participants to be "as *objective* and *unbiased* as possible" (Lord et al., 1984). The plea did nothing to reduce biased evaluations of evidence. They asked another group to consider "whether you would have made the same high or low evaluations had exactly the same study produced results on the *other* side of the issue." Having imagined and pondered *opposite* findings, these people became much less biased in their evaluations of the evidence.

The more we come to appreciate why our beliefs might be true, the more tightly we cling to them. Once we have explained to ourselves why we believe a child is "gifted" or has a "specific learning disorder," or why candidate X or Y will be a better commander-in-chief, or why company Z makes a product worth owning, we tend to ignore evidence undermining our belief. Prejudice persists. As we will see in Unit XIV, once beliefs form and are justified, it takes more compelling evidence to change them than it did to create them.

"I'm happy to say that my final judgment of a case is almost always consistent with my prejudgment of the case."

The Effects of Framing

Framing, the way we present an issue, sways our decisions and judgments. Imagine two surgeons explaining a surgery risk. One tells patients that 10 percent of people die during this surgery. The other tells patients that 90 percent will survive. The information is the same. The effect is not. In surveys, both patients and physicians said the risk seems greater when they hear that 10 percent will *die* (Marteau, 1989; McNeil et al., 1988; Rothman & Salovey, 1997). Similarly, 9 in 10 college students rated a condom as effective if told it had a supposed "95 percent success rate" in stopping the HIV virus. Only 4 in 10 judged it effective when told it had a "5 percent failure rate" (Linville et al., 1992). To scare people, frame risks as numbers, not percentages. People told that a chemical exposure is projected to kill 10 of every 10 million people (imagine 10 dead people!) feel more frightened than if told the fatality risk is an infinitesimal .000001 (Kraus et al., 1992).

framing the way an issue is posed; how an issue is framed can significantly affect decisions and judgments.

Framing can be a powerful persuasion tool. Carefully posed options can nudge people toward decisions that could benefit them or society as a whole (Thaler & Sunstein, 2008).

- *Why choosing to be an organ donor depends on where you live.* In many European countries as well as the United States, people can decide whether they want to be organ donors when renewing their driver's license. In some countries, the default option is *Yes,* but people can opt out. Nearly 100 percent of the people in opt-out countries agree to be donors. In the United States, Britain, and Germany, the default option is *No,* but people can "opt in." There, only about 25 percent agree to be donors (Johnson & Goldstein, 2003).
- *How to help employees decide to save for their retirement.* A 2006 U.S. pension law recognized the framing effect. Before that law, employees who wanted to contribute to a 401(k) retirement plan typically had to choose a lower take-home pay, which few people will do. Companies can now automatically enroll their employees in the plan but allow them to opt out (which would raise the employees' take-home pay). In both plans, the decision to contribute is the employee's. But under the new "opt-out" arrangement, enrollments in one analysis of 3.4 million workers soared from 59 to 86 percent (Rosenberg, 2010).
- *How to help save the planet.* Some psychologists are asking: With the climate warming, but concerns lessening among the British and Americans, are there better ways to frame these issues (Krosnick, 2010; Rosenthal, 2010)? For example, although a "carbon tax" may be the most effective way to curb greenhouse gases, many people oppose new taxes. But they are more supportive of funding energy development or carbon capture with a "carbon offset" fee (Hardisty et al., 2010).

The point to remember: Those who understand the power of framing can use it to influence our decisions.

The Perils and Powers of Intuition

35-3 How do smart thinkers use intuition?

We have seen how our irrational thinking can plague our efforts to see problems clearly, make wise decisions, form valid judgments, and reason logically. Moreover, these perils of intuition feed gut fears and prejudices. And they persist even when people are offered extra pay for thinking smart, even when they are asked to justify their answers, and even when they are expert physicians or clinicians (Shafir & LeBoeuf, 2002). So, are our heads indeed filled with straw?

Good news: Cognitive scientists are also revealing intuition's powers. Here is a summary of some of the high points:

- *Intuition is huge.* Recall from Module 16 that through *selective attention,* we can focus our conscious awareness on a particular aspect of all we experience. Our mind's unconscious track, however, makes good use intuitively of what we are not consciously processing. Today's cognitive science offers many examples of unconscious influences on our judgments (Custers & Aarts, 2010). Consider: Most people guess that the more complex the choice, the smarter it is to make decisions rationally rather than intuitively (Inbar et al., 2010). Actually, Dutch psychologists have shown that in making complex decisions, we benefit by letting our brain work on a problem without thinking about it (Strick et al., 2010). In one series of experiments, they showed three groups of people complex information (about apartments or roommates or art posters or soccer football matches). They invited one group to state their preference immediately after reading information about each of four options. A second group, given several minutes to analyze the information, made slightly smarter decisions. But wisest of all, in study after study, was the third group, whose attention was distracted for a time, enabling their minds to process the complex information unconsciously. Critics of this research remind us that deliberate, conscious thought also is part of smart thinking (Gonzáles-Vallejo et al., 2008; Lassiter et al., 2009; Newell et al., 2008; Payne et al., 2008). Nevertheless, letting a problem "incubate" while we attend to other things can pay dividends (Sio & Ormerod, 2009). Facing a difficult decision involving lots of facts, we're wise to gather all the information we can, and then say, "Give me some time *not* to think about this." By taking time to sleep on it, we let our unconscious mental machinery work on, and await, the intuitive result of our unconscious processing.
- *Intuition is usually adaptive.* Our instant, intuitive reactions enable us to react quickly. Our fast and frugal heuristics, for example, enable us to intuitively assume that fuzzy looking objects are far away—which they usually are, except on foggy mornings. Our learned associations surface as gut feelings, the intuitions of our two-track mind. If a stranger looks like someone who previously harmed or threatened us, we may—without consciously recalling the earlier experience—react warily. People's automatic, unconscious associations with a political position can even predict their future decisions *before* they consciously make up their minds (Galdi et al., 2008).
- *Intuition is recognition born of experience.* It is implicit knowledge—what we've learned but can't fully explain, such as how to ride a bike. We see this tacit expertise in chess masters playing "blitz chess," where every move is made after barely more than a glance. They can look at a board and intuitively know the right move (Burns, 2004). We see it in experienced nurses, firefighters, art critics, car mechanics, and hockey players. And in you, too, for anything in which you have developed a special skill. In each case, what feels like instant intuition is an acquired ability to size up a situation in an eyeblink. As Nobel laureate psychologist Herbert Simon (2001) observed, intuition is analysis "frozen into habit."

Hmm . . . male or female? When acquired expertise becomes an automatic habit, as it is for experienced chicken sexers, it feels like intuition. At a glance, they just know the sex of the chick, yet cannot easily tell you how they know.

Jean-Philippe Ksiazek/AFP

The bottom line: Intuition can be perilous, especially when we overfeel and underthink, as we do when judging risks. Today's psychological science reminds us to check our intuitions against reality, but also enhances our appreciation for intuition. Our two-track mind makes sweet harmony as smart, critical thinking listens to the creative whispers of our vast unseen mind, and then evaluates evidence, tests conclusions, and plans for the future.

Try This

What time is it now? When I asked you (in the section on overconfidence) to estimate how quickly you would finish this module, did you underestimate or overestimate?

Before You Move On

▶ ASK YOURSELF

People's perceptions of risk, often biased by vivid images from movies or the news, are surprisingly unrelated to actual risks. (People may hide in the basement during thunderstorms but fail to buckle their seat belts in the car.) What are the things you fear? Are some of those fears out of proportion to statistical risk? Are you failing, in other areas of your life, to take reasonable precautions?

▶ TEST YOURSELF

The availability heuristic is a quick-and-easy but sometimes misleading guide to judging reality. What is the availability heuristic?

Answers to the Test Yourself questions can be found in Appendix E at the end of the book.

Module 35 Review

35-1 What cognitive strategies assist our problem solving, and what obstacles hinder it?

- An *algorithm* is a methodical, logical rule or procedure (such as a step-by-step description for evacuating a building during a fire) that guarantees a solution to a problem.
- A *heuristic* is a simpler strategy (such as running for an exit if you smell smoke) that is usually speedier than an algorithm but is also more error-prone.
- *Insight* is not a strategy-based solution, but rather a sudden flash of inspiration that solves a problem.
- Obstacles to problem solving include *confirmation bias,* which predisposes us to verify rather than challenge our hypotheses, and fixation, such as *mental set,* which may prevent us from taking the fresh perspective that would lead to a solution.

35-2 What is intuition, and how can the representativeness and availability heuristics, overconfidence, belief perseverance, and framing influence our decisions and judgments?

- *Intuition* is the effortless, immediate, automatic feeling or thoughts we often use instead of systematic reasoning.
- Heuristics enable snap judgments. *The representativeness heuristic* leads us to judge the likelihood of things in terms of how they represent our prototype for a group of items. Using the *availability heuristic,* we judge the likelihood of things based on how readily they come to mind, which often leads us to fear the wrong things.
- *Overconfidence* can lead us to overestimate the accuracy of our beliefs.

- When a belief we have formed and explained has been discredited, belief perseverance may cause us to cling to that belief. A remedy for *belief perseverance* is to consider how we might have explained an opposite result.
- *Framing* is the way a question or statement is worded. Subtle wording differences can dramatically alter our responses.

35-3 How do smart thinkers use intuition?

- Smart thinkers welcome their intuitions (which are usually adaptive), but when making complex decisions they gather as much information as possible and then take time to let their two-track mind process all available information.
- As people gain expertise, they grow adept at making quick, shrewd judgments.

Multiple-Choice Questions

1. What is another term for a methodical, logical rule that guarantees solving a particular problem?

a. Heuristic
b. Algorithm
c. Insight
d. Mental set
e. Confirmation bias

2. Which of the following is the tendency to search for supportive information of preconceptions while ignoring contradictory evidence?

a. Confirmation bias
b. Intuition
c. Mental set
d. Availability heuristic
e. Overconfidence

3. What is another word for the way an issue is presented to you?

a. Intuition
b. Insight
c. Framing
d. Overconfidence
e. Perseverance

4. When instances come readily to mind, we often presume such events are common. What of the following is the term for this phenomenon?

a. Intuition insight
b. Confirmation bias
c. Belief perseverance
d. Mental set
e. Availability heuristic

Practice FRQs

1. Name and define two problem-solving strategies. Next, explain an advantage each has over the other.

Answer

1 point: An algorithm is a step-by-step procedure that guarantees a solution.

1 point: A heuristic is a simple thinking strategy that often allows us to make quick judgments.

1 point: Algorithm advantage: More likely to produce a correct solution.

1 point: Heuristic advantage: Often faster than using an algorithm.

2. Explain how each of the following can lead to inaccurate judgments: overconfidence, mental set, and confirmation bias.

(3 points)

Module 36

Thinking and Language

Vladimir Mucibabic/Shutterstock

Module Learning Objectives

36-1 Describe the structural components of a language.

36-2 Identify the milestones in language development.

36-3 Describe how we acquire language.

36-4 Identify the brain areas involved in language processing and speech.

36-5 Describe the relationship between language and thinking, and discuss the value of thinking in images.

Imagine an alien species that could pass thoughts from one head to another merely by pulsating air molecules in the space between them. Perhaps these weird creatures could inhabit a future science fiction movie?

Actually, we are those creatures. When we speak, our brain and voice apparatus conjure up air pressure waves that we send banging against another's eardrum—enabling us to transfer thoughts from our brain into theirs. As cognitive scientist Steven Pinker (1998) has noted, we sometimes sit for hours "listening to other people make noise as they exhale, because those hisses and squeaks contain *information*." And thanks to all those funny sounds created in our heads from the air pressure waves we send out, we get people's attention, we get them to do things, and we maintain relationships (Guerin, 2003). Depending on how you vibrate the air after opening your mouth, you may get slapped or kissed.

language our spoken, written, or signed words and the ways we combine them to communicate meaning.

But **language** is more than vibrating air. As I create this paragraph, my fingers on a keyboard generate electronic binary numbers that are translated into squiggles of dried carbon pressed onto the page in front of you. When transmitted by reflected light rays into your retina, the printed squiggles trigger formless nerve impulses that project to several areas of your brain, which integrate the information, compare it with stored information, and decode meaning. Thanks to language, information is moving from my mind to yours. Monkeys mostly know what they see. Thanks to language (spoken, written, or signed) we comprehend much that we've never seen and that our distant ancestors never knew.

AP Photo/M. Spencer Green

Language transmits knowledge Whether spoken, written, or signed, language—the original wireless communication—enables mind-to-mind information transfer, and with it the transmission of civilization's accumulated knowledge across generations.

Today, notes Daniel Gilbert (2006), "The average newspaper boy in Pittsburgh knows more about the universe than did Galileo, Aristotle, Leonardo, or any of those other guys who were so smart they only needed one name."

To Pinker (1990), language is "the jewel in the crown of cognition." If you were able to retain one cognitive ability, make it language, suggests researcher Lera Boroditsky (2009). Without sight or hearing, you could still have friends, family, and a job. But without language, could you have these things? "Language is so fundamental to our experience, so deeply a part of being human, that it's hard to imagine life without it."

phoneme in a language, the smallest distinctive sound unit.

morpheme in a language, the smallest unit that carries meaning; may be a word or a part of a word (such as a prefix).

grammar in a language, a system of rules that enables us to communicate with and understand others. In a given language, *semantics* is the set of rules for deriving meaning from sounds, and *syntax* is the set of rules for combining words into grammatically sensible sentences.

Language Structure

36-1 What are the structural components of a language?

Consider how we might go about inventing a language. For a spoken language, we would need three building blocks:

- **Phonemes** are the smallest distinctive sound units in a language. To say *bat,* English speakers utter the phonemes *b, a,* and *t.* (Phonemes aren't the same as letters. *Chat* also has three phonemes—*ch, a,* and *t.*) Linguists surveying nearly 500 languages have identified 869 different phonemes in human speech, but no language uses all of them (Holt, 2002; Maddieson, 1984). English uses about 40; other languages use anywhere from half to more than twice that many. As a general rule, consonant phonemes carry more information than do vowel phonemes. *The treth ef thes stetement shed be evedent frem thes bref demenstretien.*
- **Morphemes** are the smallest units that carry meaning in a given language. In English, a few morphemes are also phonemes—the personal pronoun *I* and the *s* that indicates plural, for instance. But most morphemes combine two or more phonemes. Some, like *bat* or *gentle,* are words. Others—like the prefix *pre-* in *preview* or the suffix *-ed* in *adapted*—are parts of words.
- **Grammar** is the system of rules that enables us to communicate with one another. Grammatical rules guide us in deriving meaning from sounds *(semantics)* and in ordering words into sentences *(syntax).*

AP® Exam Tip

It is sometimes challenging to keep these building blocks straight. Phonemes are sounds. It may help to remember that phones carry sounds. Morphemes have meaning, and both words begin with the letter *m.*

Language becomes increasingly complex as we move from one level to the next. In English, for example, 40 or so phonemes can be combined to form more than 100,000 morphemes, which alone or in combination produce the 616,500 word forms in the *Oxford English Dictionary.* Using those words, we can then create an infinite number of sentences, most of which (like this one) are original. Like life constructed from the genetic code's simple alphabet, language is complexity built of simplicity. I know that you can know why I worry that you think this sentence is starting to get too complex, but that complexity—and our capacity to communicate and comprehend it—is what distinguishes human language capacity (Hauser et al., 2002; Premack, 2007).

From The Wall Street Journal—permission Cartoon Features Syndicate.

"Let me get this straight now. Is what you want to build a jean factory or a gene factory?"

Language Development

Make a quick guess: How many words will you have learned during the years between your first birthday and your high school graduation? Although you use only 150 words for about half of what you say, you will have learned about 60,000 words in your native language during those years (Bloom, 2000; McMurray, 2007). That averages (after age 2) to nearly 3500 words each year, or nearly 10 each day! How you do it—how those 3500 words so far outnumber the roughly 200 words your schoolteachers are consciously teaching you each year—is one of the great human wonders.


Jaimie Duplass/Shutterstock

Could you even state all your language's rules of syntax (the correct way to string words together to form sentences)? Most of us cannot. Yet, before you were able to add 2 + 2, you were creating your own original and grammatically appropriate sentences. As a preschooler, you comprehended and spoke with a facility that puts to shame college students struggling to learn a foreign language.

We humans have an astonishing facility for language. With remarkable efficiency, we sample tens of thousands of words in our memory, effortlessly assemble them with near-perfect syntax, and spew them out, three words a second (Vigliocco & Hartsuiker, 2002). Seldom do we form sentences in our minds before speaking them. Rather we organize them on the fly as we speak. And while doing all this, we also adapt our utterances to our social and cultural context, following rules for speaking *(How far apart should we stand?)* and listening *(Is it OK to interrupt?)*. Given how many ways there are to mess up, it's amazing that we can master this social dance. So when and how does it happen?

When Do We Learn Language?

36-2 What are the milestones in language development?

RECEPTIVE LANGUAGE

Children's language development moves from simplicity to complexity. Infants start without language (*in fantis* means "not speaking"). Yet by 4 months of age, babies can recognize differences in speech sounds (Stager & Werker, 1997). They can also read lips: They prefer to look at a face that matches a sound, so we know they can recognize that *ah* comes from wide open lips and *ee* from a mouth with corners pulled back (Kuhl & Meltzoff, 1982). This marks the beginning of the development of babies' *receptive language,* their ability to understand what is said to and about them. At 7 months and beyond, babies grow in their power to do what you and I find difficult when listening to an unfamiliar language: to segment spoken sounds into individual words. Moreover, their adeptness at this task, as judged by their listening patterns, predicts their language abilities at ages 2 and 5 (Newman et al., 2006).

PRODUCTIVE LANGUAGE

Babies' *productive language,* their ability to produce words, matures after their receptive language. They recognize noun-verb differences—as shown by their responses to a misplaced noun or verb—earlier than they utter sentences with nouns and verbs (Bernal et al., 2010).

babbling stage beginning at about 4 months, the stage of speech development in which the infant spontaneously utters various sounds at first unrelated to the household language.

Before nurture molds babies' speech, nature enables a wide range of possible sounds in the **babbling stage,** beginning around 4 months of age. Many of these spontaneously uttered sounds are consonant-vowel pairs formed by simply bunching the tongue in the front of the mouth *(da-da, na-na, ta-ta)* or by opening and closing the lips *(ma-ma),* both of which babies do naturally for feeding (MacNeilage & Davis, 2000). Babbling is not an imitation of adult speech—it includes sounds from various languages, including those not spoken in the household. From this early babbling, a listener could not identify an infant as being, say, French, Korean, or Ethiopian. Deaf infants who observe their deaf parents signing begin to babble more with their hands (Petitto & Marentette, 1991).

By the time infants are about 10 months old, their babbling has changed so that a trained ear can identify the household language (de Boysson-Bardies et al., 1989). Without exposure to other languages, babies lose their ability to hear and produce sounds and tones found outside their native language (Meltzoff et al., 2009; Pallier et al., 2001). Thus, by adulthood, those who speak only English cannot discriminate certain sounds in Japanese speech.

Nor can Japanese adults with no training in English hear the difference between the English *r* and *l*. For a Japanese-speaking adult, *la-la-ra-ra* may sound like the same syllable repeated. (Does this astonish you as it does me?) A Japanese-speaking person told that the train station is "just after the next light" may wonder, "The next what? After the street veering right, or farther down, after the light?"

Around their first birthday, most children enter the **one-word stage.** They have already learned that sounds carry meanings, and if repeatedly trained to associate, say, *fish* with a picture of a fish, 1-year-olds will look at a fish when a researcher says, "Fish, fish! Look at the fish!" (Schafer, 2005). They now begin to use sounds—usually only one barely recognizable syllable, such as *ma* or *da*—to communicate meaning. But family members quickly learn to understand, and gradually the infant's language conforms more to the family's language. Across the world, baby's first words are often nouns that label objects or people (Tardif et al., 2008). At this one-word stage, a single inflected word ("Doggy!") may equal a sentence. ("Look at the dog out there!")

"Got idea. Talk better. Combine words. Make sentences."

At about 18 months, children's word learning explodes from about a word per week to a word per day. By their second birthday, most have entered the **two-word stage (TABLE 36.1)**. They start uttering two-word sentences in **telegraphic speech.** Like today's text messages or yesterday's telegrams that charged by the word (TERMS ACCEPTED. SEND MONEY), a 2-year-old's speech contains mostly nouns and verbs *(Want juice)*. Also like telegrams, it follows rules of syntax: The words are in a sensible order. English-speaking children typically place adjectives before nouns—*white house* rather than *house white*. Spanish reverses this order, as in *casa blanca*.

one-word stage the stage in speech development, from about age 1 to 2, during which a child speaks mostly in single words.

two-word stage beginning about age 2, the stage in speech development during which a child speaks mostly in two-word statements.

telegraphic speech early speech stage in which a child speaks like a telegram—"go car"—using mostly nouns and verbs.

Table 36.1 Summary of Language Development

Month (approximate)	Stage
4	Infant babbles many speech sounds ("Ah-goo").
10	Babbling resembles household language ("Ma-ma").
12	Child enters one-word stage ("Kitty!").
24	Child engages in two-word, telegraphic speech ("Get ball.").
24+	Language develops rapidly into complete sentences.

Moving out of the two-word stage, children quickly begin uttering longer phrases (Fromkin & Rodman, 1983). If they get a late start on learning a particular language, such as after receiving a cochlear implant or being adopted by a family in another country, their language development still proceeds through the same sequence, although usually at a faster pace (Ertmer et al., 2007; Snedeker et al., 2007). By early elementary school, children understand complex sentences and begin to enjoy the humor conveyed by double meanings: "You never starve in the desert because of all the sand-which-is there."

Explaining Language Development

36-3 How do we acquire language?

The world's 7000 or so languages are structurally very diverse (Evans & Levinson, 2009). Linguist Noam Chomsky has nonetheless argued that all languages do share some basic elements, which he calls *universal grammar*. All human languages, for example, have nouns, verbs, and adjectives as grammatical building blocks. Moreover, said Chomsky, we humans are born with a built-in predisposition to learn grammar rules, which helps explain why preschoolers pick up language so readily and use grammar so well. It happens so naturally—as naturally as birds learn to fly—that training hardly helps.

Creating a language Brought together as if on a desert island (actually a school), Nicaragua's young deaf children over time drew upon sign gestures from home to create their own Nicaraguan Sign Language, complete with words and intricate grammar. Our biological predisposition for language does not create language in a vacuum. But activated by a social context, nature and nurture work creatively together (Osborne, 1999; Sandler et al., 2005; Senghas & Coppola, 2001).

Susan Meiselas/Magnum Photos

We are not, however, born with a built-in *specific* language. Europeans and Native Australia–New Zealand populations, though geographically separated for 50,000 years, can readily learn each others' languages (Chater et al., 2009). And whatever language we experience as children, whether spoken or signed, we all readily learn its specific grammar and vocabulary (Bavelier et al., 2003). But no matter what language we learn, we start speaking it mostly in nouns *(kitty, da-da)* rather than in verbs and adjectives (Bornstein et al., 2004). Biology and experience work together.

STATISTICAL LEARNING

When adults listen to an unfamiliar language, the syllables all run together. A young Sudanese couple new to North America and unfamiliar with English might, for example, hear *United Nations* as "Uneye Tednay Shuns." Their 7-month-old daughter would not have this problem. Human infants display a remarkable ability to learn statistical aspects of human speech. Their brains not only discern word breaks, they statistically analyze which syllables, as in "hap-py-ba-by," most often go together. After just two minutes of exposure to a computer voice speaking an unbroken, monotone string of nonsense syllables *(bidakupadotigolabubidaku . . .),* 8-month-old infants were able to recognize (as indicated by their attention) three-syllable sequences that appeared repeatedly (Saffran et al., 1996, 2009).

In further testimony to infants' surprising knack for soaking up language, research shows that 7-month-olds can learn simple sentence structures. After repeatedly hearing syllable sequences that follow one rule (an ABA pattern, such as *ga-ti-ga* and *li-na-li*), infants listened longer to syllables in a different sequence (an ABB pattern, such as *wo-fe-fe,* rather than *wo-fe-wo*). Their detecting the difference between the two patterns supports the idea that babies come with a built-in readiness to learn grammatical rules (Marcus et al., 1999).

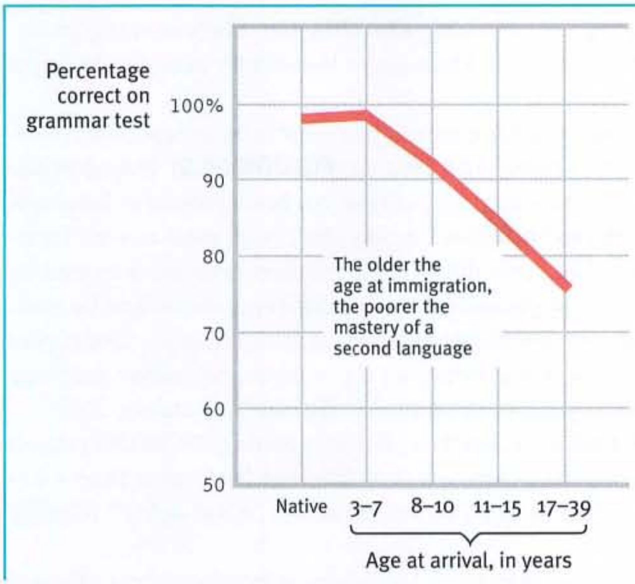
CRITICAL PERIODS

Could we train adults to perform this same feat of statistical analysis later in the human life span? Many researchers believe not. Childhood seems to represent a *critical* (or "sensitive") *period* for mastering certain aspects of language before the language-learning window closes (Hernandez & Li, 2007). People who learn a second language as adults usually speak it with the accent of their native language, and they also have difficulty mastering the new grammar. In one experiment, Korean and Chinese immigrants considered 276 English sentences *("Yesterday the hunter shoots a deer")* and decided whether they were grammatically correct or incorrect (Johnson & Newport, 1991). All had been in the United States for approximately 10 years: Some had arrived in early childhood, others as adults. As **FIGURE 36.1** reveals, those who learned their second language early learned it best. The older one is when moving to a new country, the harder it will be to learn its language and to absorb its culture (Cheung et al., 2011; Hakuta et al., 2003).

A natural talent We humans come with a remarkable capacity to soak up language. But the particular language we learn reflects our unique interactions with others.

©Roy Morsch/CORBIS

The window on language learning closes gradually in early childhood. Later-than-usual exposure to language (at age 2 or 3) unleashes the idle language capacity of a child's brain, producing a rush of language. But



Don Smetzer/Photo Edit

Figure 36.1

Our ability to learn a new language diminishes with age Ten years after coming to the United States, Asian immigrants took an English grammar test. Although there is no sharply defined critical period for second language learning, those who arrived before age 8 understood American English grammar as well as native speakers did. Those who arrived later did not. (From Johnson & Newport, 1991.)

by about age 7, those who have not been exposed to either a spoken or a signed language gradually lose their ability to master *any* language.

The impact of early experiences is evident in language learning in the 90+ percent of prelingually deaf children born to hearing-nonsigning parents. These children typically do not experience language during their early years. Natively deaf children who learn sign language after age 9 never learn it as well as those who lose their hearing at age 9 after learning English. They also never learn English as well as other natively deaf children who learned sign in infancy (Mayberry et al., 2002). Those who learn to sign as teens or adults are like immigrants who learn English after childhood: They can master basic words and learn to order them, but they never become as fluent as native signers in producing and comprehending subtle grammatical differences (Newport, 1990). As a flower's growth will be stunted without nourishment, so, too, children will typically become linguistically stunted if isolated from language during the critical period for its acquisition.

George Ancona

***No* means *No*—no matter how you say it!** Deaf children of deaf-signing parents and hearing children of hearing parents have much in common. They develop language skills at about the same rate, and they are equally effective at opposing parental wishes and demanding their way.

The Brain and Language

36-4 What brain areas are involved in language processing and speech?

We think of speaking and reading, or writing and reading, or singing and speaking as merely different examples of the same general ability—language. But consider this curious finding: **Aphasia,** an impairment of language, can result from damage to any of several cortical areas. Even more curious, some people with aphasia can speak fluently but cannot read (despite good vision), while others can comprehend what they read but cannot speak. Still others can write but not read, read but not write, read numbers but not letters, or sing but not speak. These cases suggest that language is complex, and that different brain areas must serve different language functions.

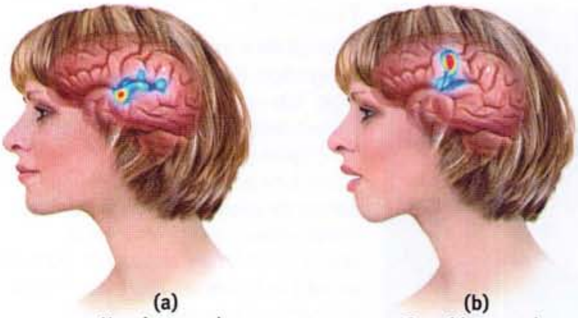
Indeed, in 1865, French physician Paul Broca reported that after damage to an area of the left frontal lobe (later called **Broca's area**) a person would struggle to *speak* words while still being able to sing familiar songs and comprehend speech.

In 1874, German investigator Carl Wernicke discovered that after damage to an area of the left temporal lobe (**Wernicke's area**) people could speak only meaningless words. Asked to describe a picture that showed two boys stealing cookies behind a woman's back, one patient responded: "Mother is away her working her work to get her better, but when

aphasia impairment of language, usually caused by left-hemisphere damage either to Broca's area (impairing speaking) or to Wernicke's area (impairing understanding).

Broca's area controls language expression—an area of the frontal lobe, usually in the left hemisphere, that directs the muscle movements involved in speech.

Wernicke's area controls language reception—a brain area involved in language comprehension and expression; usually in the left temporal lobe.



(a)
Hearing words
(auditory cortex and Wernicke's area)

(b)
Speaking words
(Broca's area and the motor cortex)

Figure 36.2
Brain activity when hearing and speaking words

she's looking the two boys looking the other part. She's working another time" (Geschwind, 1979). Damage to Wernicke's area also disrupts understanding.

Today's neuroscience has confirmed brain activity in Broca's and Wernicke's areas during language processing (**FIGURE 36.2**). But neuroscience is refining our understanding of how our brain processes language. Language functions are distributed across other brain areas as well. Functional MRI scans show that different neural networks are activated by nouns and verbs, or objects and actions; by different vowels; and by reading stories of visual versus motor experiences (Shapiro et al., 2006; Speer et al., 2009). Different neural networks also enable one's native language and a second language learned later in life (Perani & Abutalebi, 2005).

And here's another funny fMRI finding. Jokes that play on meaning *("Why don't sharks bite lawyers? . . . Professional courtesy")* are processed in a different brain area than jokes that play on words *("What kind of lights did Noah use on the ark? . . . Flood lights")* (Goel & Dolan, 2001).

"It is the way systems interact and have a dynamic interdependence that is—unless one has lost all sense of wonder—quite awe-inspiring." -Simon Conway Morris, "The Boyle Lecture," 2005

The big point to remember is this: In processing language, as in other forms of information processing, *the brain operates by dividing its mental functions—speaking, perceiving, thinking, remembering—into subfunctions.* Your conscious experience of reading this page *seems* indivisible, but your brain is computing each word's form, sound, and meaning using different neural networks (Posner & Carr, 1992). We saw this also in Module 18's discussion of vision, for which the brain engages specialized subtasks, such as discerning depth, movement, form, and color. And in vision as in language, a localized trauma that destroys one of these neural work teams may cause people to lose just one aspect of processing. In visual processing, a stroke may destroy the ability to perceive movement but not color. In language processing, a stroke may impair the ability to speak distinctly without harming the ability to read.

AP® Exam Tip

You'll notice that even though the brain was one of the major topics in Unit III, it keeps coming up. Each time it does provides you with an opportunity to go back and review what you learned previously about the brain. Rehearse frequently, and you will not have much to relearn before the AP® exam.

Think about it: What you experience as a continuous, indivisible stream of experience is actually but the visible tip of a subdivided information-processing iceberg.

* * *

Returning to our debate about how deserving we humans are of our name *Homo sapiens,* let's pause to issue an interim report card. On decision making and risk assessment, our error-prone species might rate a C+. On problem solving, where humans are inventive yet vulnerable to fixation, we would probably receive a better mark, perhaps a B. On cognitive efficiency, our fallible but quick heuristics earn us an A. And when it comes to our creativity, and our learning and using language, the awestruck experts would surely award the human species an A+.

Before You Move On

▶ ASK YOURSELF

There has been controversy at some universities about allowing fluency in sign language to fulfill a second-language requirement for an undergraduate degree. As you start planning for your own college years, what is your opinion?

▶ TEST YOURSELF

If children are not yet speaking, is there any reason to think they would benefit from parents and other caregivers reading to them?

Answers to the Test Yourself questions can be found in Appendix E at the end of the book.

Language and Thought

36-5 What is the relationship between language and thinking, and what is the value of thinking in images?

Thinking and language intricately intertwine. Asking which comes first is one of psychology's chicken-and-egg questions. Do our ideas come first and we wait for words to name them? Or are our thoughts conceived in words and therefore unthinkable without them?

Try This

To find out what we have learned about thinking and language in other animals, see Module 85.

Language Influences Thinking

Linguist Benjamin Lee Whorf (1956) contended that language determines the way we think: "Language itself shapes a [person's] basic ideas." The Hopi, who have no past tense for their verbs, could not readily *think* about the past, said Whorf.

Whorf's **linguistic determinism** hypothesis is too extreme. We all think about things for which we have no words. (Can you think of a shade of blue you cannot name?) And we routinely have *unsymbolized* (wordless, imageless) thoughts, as when someone, while watching two men carry a load of bricks, wondered whether the men would drop them (Heavey & Hurlburt, 2008; Hurlburt & Akhter, 2008).

Nevertheless, to those who speak two dissimilar languages, such as English and Japanese, it seems obvious that a person may think differently in different languages (Brown, 1986). Unlike English, which has a rich vocabulary for self-focused emotions such as anger, Japanese has more words for interpersonal emotions such as sympathy (Markus & Kitayama, 1991). Many bilingual individuals report that they have different senses of self, depending on which language they are using (Matsumoto, 1994). In one series of studies with bilingual Israeli Arabs (who speak both Arabic and Hebrew), participants thought differently about their social world, with differing automatic associations with Arabs and Jews, depending on which language the testing session used (Danziger & Ward, 2010).

Bilingual individuals may even reveal different personality profiles when taking the same test in their two languages (Dinges & Hull, 1992). This happened when China-born, bilingual students at the University of Waterloo in Ontario were asked to describe themselves in English or Chinese (Ross et al., 2002). The English-language self-descriptions fit typical Canadian profiles: Students expressed mostly positive self-statements and moods. Responding in Chinese, the same students gave typically Chinese self-descriptions: They reported more agreement with Chinese values and roughly equal positive and negative self-statements and moods. "Learn a new language and get a new soul," says a Czech proverb. Similar personality changes have been shown when bicultural, bilingual Americans and Mexicans shifted between the cultural frames associated with English and Spanish (Ramírez-Esparza et al., 2006).

So our words may not *determine* what we think, but they do *influence* our thinking (Boroditsky, 2011). We use our language in forming categories. In Brazil, the isolated Piraha tribespeople have words for the numbers 1 and 2, but numbers above that are simply "many." Thus, if shown 7 nuts in a row, they find it very difficult to lay out the same number from their own pile (Gordon, 2004).

Words also influence our thinking about colors. Whether we live in New Mexico, New South Wales, or New Guinea, we *see* colors much the same, but we use our native language to *classify* and *remember* colors (Davidoff, 2004; Roberson et al., 2004, 2005). If your language is English, you might view three colors and call two of them "yellow" and one of them "blue." Later you would likely see and recall the yellows as being more similar. But if you are a member of Papua New Guinea's Berinmo tribe, which has words for two different shades of yellow, you would more speedily perceive and better recall the distinctions between the two yellows. And if your language is Russian, which has distinct names for different shades of blue, such as *goluboy* and *sinly,* you might remember the blue better. Words matter.

Try This

Before reading on, use a pen or pencil to sketch this idea: "The girl pushes the boy." Now see the inverted comment below.

How did you illustrate "the girl pushes the boy"? Anne Maass and Aurore Russo (2003) report that people whose language reads from left to right mostly position the pushing girl on the left. Those who read and write Arabic, a right-to-left language, mostly place her on the right. This spatial bias appears only in those old enough to have learned their culture's writing system (Dobel et al., 2007).

linguistic determinism
Whorf's hypothesis that language determines the way we think.

Culture and color
In Papua New Guinea, Berinmo children have words for different shades of "yellow," so they might more quickly spot and recall yellow variations. Here and everywhere, "the languages we speak profoundly shape the way we think, the way we see the world, the way we live our lives," notes psychologist Lera Boroditsky (2009).

Prisma Bildagentur AG/Alamy

Perceived differences grow when we assign different names to colors. On the color spectrum, blue blends into green—until we draw a dividing line between the portions we call "blue" and "green." Although equally different on the color spectrum, two different items that share the same color name (as the two "blues" do in **FIGURE 36.3**, contrast B) are harder to distinguish than two items with different names ("blue" and "green," as in Figure 36.3, contrast A) (Özgen, 2004).

Given words' subtle influence on thinking, we do well to choose our words carefully. Does it make any difference whether I write, "A child learns language as *he* interacts with *his* caregivers" or "Children learn language as *they* interact with *their* caregivers"? Many studies have found that it does. When hearing the generic *he* (as in "the artist and his work"), people are more likely to picture a male (Henley, 1989; Ng, 1990). If *he* and *his* were truly gender free, we shouldn't skip a beat when hearing that "man, like other mammals, nurses his young."

"All words are pegs to hang ideas on." -Henry Ward Beecher, *Proverbs From Plymouth Pulpit*, 1887

To expand language is to expand the ability to think. As Unit IX points out, young children's thinking develops hand in hand with their language (Gopnik & Meltzoff, 1986). Indeed, it is very difficult to think about or conceptualize certain abstract ideas (commitment, freedom, or rhyming) without language! And what is true for preschoolers is true for everyone: *It pays to increase your word power.* That's why most textbooks, including this one, introduce new words—to teach new ideas and new ways of thinking. And that's also why psychologist Steven Pinker (2007) titled his book on language *The Stuff of Thought.*

Increased word power helps explain what McGill University researcher Wallace Lambert (1992; Lambert et al., 1993) calls the *bilingual advantage.* Although their vocabulary in each language is somewhat smaller than that of people speaking a single language, bilingual people are skilled at inhibiting one language while using the other. And thanks to their well-practiced "executive control" over language, they also are better at inhibiting their attention to irrelevant information (Bialystock & Craik, 2010). This superior attentional control is evident from 7 months of age into adulthood (Emmorey et al., 2008; Kovacs & Mehler, 2009).

FYI
Perceived distances between cities also grow when two cities are in different countries or states rather than in the same (Burris & Branscombe, 2005; Mishra & Mishra, 2010).

Lambert helped devise a Canadian program that immerses English-speaking children in French. (The number of non-Quebec children enrolled rose from 65,000 in 1981 to 300,000 in 2007 [Statistics Canada, 2010].) For most of their first three years in school, the English-speaking children are taught entirely in French, and thereafter gradually shift to classes mostly in English. Not surprisingly, the children attain a natural French fluency unrivaled by other methods of language teaching. Moreover, compared with similarly capable children in control groups, they do so without detriment to their English fluency, and with increased aptitude scores, creativity, and appreciation for French-Canadian culture (Genesee & Gándara, 1999; Lazaruk, 2007).

Whether we are in the linguistic minority or majority, language links us to one another. Language also connects us to the past and the future. "To destroy a people, destroy their language," observed poet Joy Harjo.

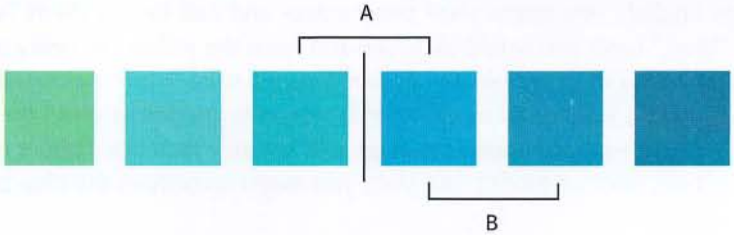


Figure 36.3
Language and perception When people view blocks of equally different colors, they perceive those with different names as more different. Thus the "green" and "blue" in contrast A may appear to differ more than the two similarly different blues in contrast B (Özgen, 2004).

Thinking in Images

When you are alone, do you talk to yourself? Is "thinking" simply conversing with yourself? Without a doubt, words convey ideas. But aren't there times when ideas precede words? To turn on the cold water in your bathroom, in which direction do you turn the handle? To answer, you probably thought not in words but with *implicit* (nondeclarative, procedural) memory—a mental picture of how you do it (see Module 31).

Indeed, we often think in images. Artists think in images. So do composers, poets, mathematicians, athletes, and scientists. Albert Einstein reported that he achieved some of his greatest insights through visual images and later put them into words. Pianist Liu Chi Kung showed the value of thinking in images. One year after placing second in the 1958 Tschaikovsky piano competition, Liu was imprisoned during China's cultural revolution. Soon after his release, after seven years without touching a piano, he was back on tour, the critics judging his musicianship better than ever. How did he continue to develop without practice? "I did practice," said Liu, "every day. I rehearsed every piece I had ever played, note by note, in my mind" (Garfield, 1986).

For someone who has learned a skill, such as ballet dancing, even *watching* the activity will activate the brain's internal simulation of it, reported one British research team after collecting fMRIs as people watched videos (Calvo-Merino et al., 2004). So, too, will imagining a physical experience, which activates some of the same neural networks that are active during the actual experience (Grèzes & Decety, 2001). Small wonder, then, that mental practice has become a standard part of training for Olympic athletes (Suinn, 1997).

One experiment on mental practice and basketball foul shooting tracked the University of Tennessee women's team over 35 games (Savoy & Beitel, 1996). During that time, the team's free-throw shooting increased from approximately 52 percent in games following standard physical practice to some 65 percent after mental practice. Players had repeatedly imagined making foul shots under various conditions, including being "trash-talked" by their opposition. In a dramatic conclusion, Tennessee won the national championship game in overtime, thanks in part to their foul shooting.

Mental rehearsal can also help you achieve an academic goal, as researchers demonstrated with two groups of introductory psychology students facing a midterm exam 1 week later (Taylor et al., 1998). (Scores of other students formed a control group, not engaging in any mental simulation.) The first group spent 5 minutes each day visualizing themselves scanning the posted grade list, seeing their A, beaming with joy, and feeling proud. This *outcome simulation* had little effect, adding only 2 points to their exam-scores average. Another group spent 5 minutes each day visualizing themselves effectively studying—reading the textbook, going over notes, eliminating distractions, declining an offer to go out. This *process simulation* paid off: This second group began studying sooner, spent more time at it, and beat the others' average by 8 points. *The point to remember:* It's better to spend your fantasy time planning how to get somewhere than to dwell on the imagined destination.

* * *

What, then, should we say about the relationship between thinking and language? As we have seen, language influences our thinking. But if thinking did not also affect language, there would never be any new words. And new words and new combinations of old words express new ideas. The basketball term *slam dunk* was coined after the act itself had become fairly common. So, let us say that *thinking affects our language, which then affects our thought* (**FIGURE 36.4**).

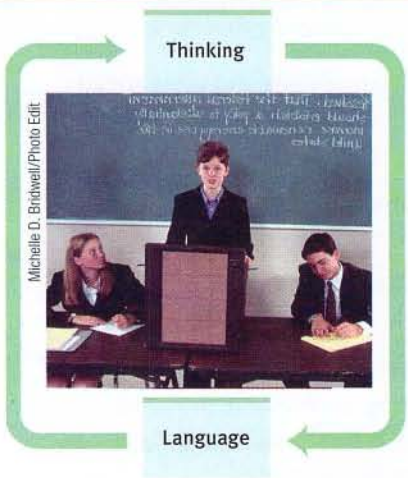


Figure 36.4
The interplay of thought and language The traffic runs both ways between thinking and language. Thinking affects our language, which affects our thought.

Psychological research on thinking and language mirrors the mixed views of our species by those in fields such as literature and religion. The human mind is simultaneously capable of striking intellectual failures and of striking intellectual power. Misjudgments are common and can have disastrous consequences. So we do well to appreciate our capacity for error. Yet our efficient heuristics often serve us well. Moreover, our ingenuity at problem solving and our extraordinary power of language mark humankind as almost "infinite in faculties."

Before You Move On

▶ ASK YOURSELF

Do you use certain words or gestures that only your family or closest circle of friends would understand? Can you envision using these words or gestures to construct a language, as the Nicaraguan children did in building their version of sign language?

▶ TEST YOURSELF

To say that "words are the mother of ideas" assumes the truth of what concept?

Answers to the Test Yourself questions can be found in Appendix E at the end of the book.

Module 36 Review

36-1 What are the structural components of a language?

- *Phonemes* are a *language's* basic units of sound.
- *Morphemes* are the elementary units of meaning.
- *Grammar*—the system of rules that enables us to communicate—includes semantics (rules for deriving meaning) and syntax (rules for ordering words into sentences).

36-2 What are the milestones in language development?

- Language development's timing varies, but all children follow the same sequence.
- Receptive language (the ability to understand what is said to or about you) develops before productive language (the ability to produce words).
- At about 4 months of age, infants *babble,* making sounds found in languages from all over the world.
- By about 10 months, their babbling contains only the sounds found in their household language.
- Around 12 months of age, children begin to speak in single words. This *one-word stage* evolves into *two-word (telegraphic)* utterances before their second birthday, after which they begin speaking in full sentences.

36-3 How do we acquire language?

- Linguist Noam Chomsky has proposed that all human languages share a universal grammar—the basic building blocks of language—and that humans are born with a predisposition to learn language.
- We acquire specific language through learning as our biology and experience interact.
- Childhood is a critical period for learning to speak or sign fluently.

36-4 What brain areas are involved in language processing and speech?

- Two important language- and speech-processing areas are *Broca's area,* a region of the frontal lobe that controls language expression, and *Wernicke's area,* a region in the left temporal lobe that controls language reception (and also assists with expression).
- Language processing is spread across other brain areas as well, where different neural networks handle specific linguistic subtasks.

36-5 What is the relationship between language and thinking, and what is the value of thinking in images?

- Although Benjamin Lee Whorf's *linguistic determinism* hypothesis suggested that language determines thought, it is more accurate to say that language influences thought.
- Different languages embody different ways of thinking, and immersion in bilingual education can enhance thinking.
- We often think in images when we use nondeclarative (procedural) memory (our automatic memory system for motor and cognitive skills and classically conditioned associations).
- Thinking in images can increase our skills when we mentally practice upcoming events.

Multiple-Choice Questions

1. What do we call the smallest distinctive sound units in language?

a. Structure
b. Morphemes
c. Grammar
d. Phonemes
e. Thoughts

2. Which of the following best identifies the early speech stage in which a child speaks using mostly nouns and verbs?

a. Two-word stage
b. Babbling stage
c. One-word stage
d. Telegraphic speech
e. Grammar

3. The prefix "pre" in "preview" or the suffix "ed" in "adapted" are examples of

a. phonemes.
b. morphemes.
c. babbling.
d. grammar.
e. intuition.

4. Evidence of words' subtle influence on thinking best supports the notion of

a. Wernicke's area.
b. Broca's area.
c. linguistic determinism.
d. babbling.
e. aphasia.

Practice FRQs

1. Name and define the three building blocks of spoken language.

Answer

1 point: Phoneme: the smallest distinctive sound unit.

1 point: Morpheme: the smallest unit carrying meaning in language.

1 point: Grammar: the system of rules that enable communication.

2. What is aphasia, and how does it relate to Broca's and Wernicke's areas?

(3 points)

Unit VII Review

Key Terms and Concepts to Remember

memory, p. 318
encoding, p. 319
storage, p. 319
retrieval, p. 319
parallel processing, p. 319
sensory memory, p. 319
short-term memory, p. 319
long-term memory, p. 319
working memory, 320
explicit memory, p. 320
effortful processing, p. 320
automatic processing, p. 320
implicit memory, p. 320
iconic memory, p. 322
echoic memory, p. 322
chunking, p. 323
mnemonics [nih-MON-iks], p. 323
spacing effect, p. 324
testing effect, p. 324
shallow processing, p. 324
deep processing, p. 325
hippocampus, p. 330
flashbulb memory, p. 332
long-term potentiation (LTP), p. 333
recall, p. 334
recognition, p. 334
relearning, p. 334
priming, p. 336
mood-congruent memory, p. 337
serial position effect, p. 337
anterograde amnesia, p. 342
retrograde amnesia, p. 342
proactive interference, p. 345
retroactive interference, p. 345
repression, p. 346
misinformation effect, p. 347
source amnesia, p. 349
déjà vu, p. 349
cognition, p. 356
concept, p. 356
prototype, p. 356
creativity, p. 357
convergent thinking, p. 357
divergent thinking, p. 357
algorithm, p. 361
heuristic, p. 361
insight, p. 361
confirmation bias, p. 362
mental set, p. 363
intuition, p. 363
representativeness heuristic, p. 364
availability heuristic, p. 364
overconfidence, p. 365
belief perseverance, p. 367
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phoneme, p. 373
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babbling stage, p. 374
one-word stage, p. 375
two-word stage, p. 375
telegraphic speech, p. 375
aphasia, p. 377
Broca's area, p. 377
Wernicke's area, p. 377
linguistic determinism, p. 379

Key Contributors to Remember

Richard Atkinson, p. 319
Richard Shiffrin, p. 319
George A. Miller, p. 322
Hermann Ebbinghaus, p. 324
Eric Kandel, p. 332
Elizabeth Loftus, p. 347
Robert Sternberg, p. 357
Wolfgang Köhler, p. 362
Amos Tversky, p. 363
Daniel Kahneman, p. 363
Steven Pinker, p. 372
Noam Chomsky, p. 375
Paul Broca, p. 377
Carl Wernicke, p. 377
Benjamin Lee Whorf, p. 379

AP® Exam Practice Questions

Multiple-Choice Questions

1. What does the "magical number seven, plus or minus two" refer to?
   a. The ideal number of times to rehearse information in the first encoding session
   b. The number of seconds information stays in short-term memory without rehearsal
   c. The capacity of short-term memory
   d. The number of seconds information stays in echoic storage
   e. The number of years most long-term memories last

2. Which of the following describes long-term potentiation (LTP)?
   a. When attempting to retrieve information, it is easier to recognize than to recall.
   b. Constructed memories have the potential to be either accurate or inaccurate.
   c. Changes in synapses allow for more efficient transfer of information.
   d. Implicit memories are processed by the cerebellum instead of by the hippocampus.
   e. Information is transferred from working memory to long-term memory.

3. Which of the following abilities is an example of implicit memory?
   a. Riding a bicycle while talking to your friend about something that happened in class
   b. Retrieving from memory the details of an assignment that is due tomorrow
   c. Vividly recalling significant events like the 9/11 attacks on New York City and Washington, D.C.
   d. Remembering the details of your last birthday party
   e. Recognizing names and pictures of your classmates many years after they have graduated

4. Which of the following statements concerning memory is true?
   a. Hypnosis, when used as a component of therapy, usually improves the accuracy of memory.
   b. One aspect of memory that is usually accurate is the source of the remembered information.
   c. Children's memories of abuse are more accurate than other childhood memories.
   d. Memories we are more certain of are more likely to be accurate.
   e. Memories are often a blend of correct and incorrect information.

5. The basketball players could remember the main points of their coach's halftime talk, but not her exact words. This is because they encoded the information
   a. semantically.
   b. iconically.
   c. implicitly.
   d. shallowly.
   e. automatically.

6. When someone provides his phone number to another person, he usually pauses after the area code and again after the next three numbers. This pattern underscores the importance of which memory principle?
   a. Chunking
   b. The serial position effect
   c. Semantic encoding
   d. Auditory encoding
   e. Recognition

7. Which of the following is true regarding the role of the amygdala in memory?
   a. The amygdala help process implicit memories.
   b. The amygdala support Freud's ideas about memory because they allow us to repress memories of trauma.
   c. The amygdala produce long-term potentiation in the brain.
   d. The amygdala help make sure we remember events that trigger strong emotional responses.
   e. The amygdala are active when the retrieval of a long-term memory is primed.

8. Which of the following illustrates the serial position effect?
   a. The only name Kensie remembers from the people she met at the party is Spencer because she thought he was particularly good looking.
   b. Kimia has trouble remembering information from the book's first unit when she reviews for semester finals.
   c. It's easy for Brittney to remember that carbon's atomic number is 6 because her birthday is on December 6.
   d. Kyle was not able to remember the names of all of his new co-workers after one week on the job, but he could remember them after two weeks.
   e. Alp is unable to remember the middle of a list of vocabulary words as well as he remembers the first or last words on the list.

9. Mnemonic devices are *least* likely to be dependent upon which of the following?
 a. Imagery
 b. Acronyms
 c. Rhymes
 d. Chunking
 e. Massed rehearsal

10. You are more likely to remember psychology information in your psychology classroom than in other environments because of what memory principle?
 a. Mood congruence
 b. Context effects
 c. State-dependency
 d. Proactive interference
 e. Retroactive interference

11. Which of the following kinds of information is *not* likely to be automatically processed?
 a. Space information
 b. Time information
 c. Frequency information
 d. New information
 e. Rehearsed information

12. Which of the following is an example of source amnesia?
 a. Iva can't remember the details of a horrifying event because she has repressed them.
 b. Mary has entirely forgotten about an incident in grade school until her friend reminds her of the event.
 c. Michael can't remember this year's locker combination because he confuses it with last year's combination.
 d. Stephen misremembers a dream as something that really happened.
 e. Anna, who is trying to lose weight, is unable to remember several of the between-meal snacks she had yesterday.

13. Which of the following is an accurate conclusion based on Hermann Ebbinghaus' forgetting curve research?
 a. Most forgetting occurs early on and then levels off
 b. We forget more rapidly as time passes
 c. Forgetting is relatively constant over time
 d. Forgetting is related to many factors, but time is not one of them
 e. We are more likely to forget items in the middle of a list than at the beginning or the end

14. "Chair," "freedom," and "ball" are all examples of what?
 a. Phonemes
 b. Heuristics
 c. Concepts
 d. Telegraphic utterances
 e. Prototypes

15. People are more concerned about a medical procedure when told it has a 10 percent death rate than they are when told it has a 90 percent survival rate. Which psychological concept explains this difference in concern?
 a. Belief perseverance
 b. Insight
 c. Intuition
 d. Framing
 e. Confirmation bias

16. Which of the following illustrates a heuristic?
 a. Calculating the area of a rectangle by multiplying the length times the width
 b. Using news reports of corporate fraud to estimate how much business fraud occurs in American business
 c. Looking in each room of your home to find your sleeping cat
 d. Following a new recipe to bake a cake for your friend
 e. Trying every key on your mom's key ring until you find the one that unlocks the seldom-used storeroom in the basement

17. Which of the following most likely represents a prototype for the concept indicated in parentheses?
 a. A whale (mammal)
 b. An ostrich (bird)
 c. A beanbag chair (chair)
 d. An igloo (house)
 e. A golden retriever (dog)

18. The inability to see a problem from a fresh perspective is called what?
 a. Confirmation bias
 b. Insight
 c. Representativeness
 d. Fixation
 e. Availability

19. Which phrase best describes the concept of phonemes?
 a. Units of meaning in a language
 b. A form of syntax
 c. The basis of grammar
 d. Units of sound in a language
 e. A form of telegraphic speech

20. Which concept best explains why people often underestimate the amount of time it will take to complete a project?
 a. Belief perseverance
 b. Framing
 c. Intuition
 d. The availability heuristic
 e. Overconfidence

21. Which of the following is not one of Robert Sternberg's components of creativity?
   a. A venturesome personality
   b. Imaginative thinking skills
   c. A creative environment
   d. A position of ignorance
   e. Intrinsic motivation

22. Which of the following demonstrates the representativeness heuristic?
   a. Deciding that a new kid in school is a nerd because he looks like a nerd
   b. Fearing air travel because of memories of plane crashes
   c. Checking in every drawer to find some matches because matches are usually in drawers
   d. Having the solution to a word problem pop into your head because you have just successfully solved a similar problem
   e. Applying for jobs in several local grocery stores because your best friend just got a job in a grocery store

23. Benjamin Lee Whorf's linguistic determinism hypothesis relates to what aspect of the power of language?
   a. How thinking influences language
   b. How language influences thinking
   c. The role of the language acquisition device
   d. The importance of critical periods in language development
   e. The development of language in nonhuman animals

24. According to Noam Chomsky, what is the most essential environmental stimulus necessary for language acquisition?
   a. Exposure to language in early childhood
   b. Instruction in grammar
   c. Reinforcement for babbling and other early verbal behaviors
   d. Imitation and drill
   e. Linguistic determinism

Free-Response Questions

1. Jacque learned to speak Italian when she was in the first grade and was able to speak, read, and write Italian fairly well by the fourth grade. She moved to a new school system that did not have Italian as a choice for World Languages, so she decided to take Spanish. Sometimes she found herself saying and writing words in Italian as she completed her Spanish assignments. Often, she remembered the vocabulary in Italian before she said the word in Spanish. Sometimes she felt like knowing Italian helped her learn Spanish, but sometimes she thought it just confused her! When Jacque was in her Spanish classroom, she felt more at ease with the Spanish language. When she went to an Italian restaurant, she enjoyed being able to read the menu to her friends if it was written in Italian.

Briefly define each concept and use an example to show how each concept is related to Jacque's experiences.

- Working memory
- Explicit memory
- Effortful processing
- Context-dependent memory
- Proactive interference

Explain how these brain structures play a role in Jacque's memory processing.

- Hippocampus
- Amygdala

Rubric for Free Response Question 1

1 point: Working memory is a newer understanding of short-term memory that focuses on conscious, active processing of incoming auditory and visual-spatial information, and of information retrieved from long-term memory. Possible example: Jacque has to focus on what the teacher is saying and recall the correct vocabulary word when she is asked a question. Page 319

1 point: Explicit memory is memory of facts and experiences that one can consciously know and "declare." (Also called *declarative memory*.) Possible example: Defining vocabulary words in any language relies on explicit memory. Page 321

1 point: Effortful processing is encoding that requires attention and conscious effort. Possible example: When reading, Jacque has to pay attention to the words and sentence construction to understand what is being conveyed. Page 321

1 point: Context-dependent memory refers to the need to put yourself back in the context where you experienced something to prime your memory retrieval. Possible example: Jacque seems to be able to remember her Spanish best when in her Spanish classroom. Page 336

1 point: Proactive interference is the disruptive effect of prior learning on the recall of new information. Possible example: Jacque learned Italian before she learned Spanish, and so sometimes her prior knowledge of Italian interferes with her recall of Spanish words. Page 345

1 point: The hippocampus is a brain area important to the storage of new learning. Possible example: Since the left hippocampus is important to storage and recall of verbal information—new terms, vocabulary, and so on—Jacque's hippocampus must be very active during her language classes. Page 330

1 point: The amygdala is involved in intense emotional experiences, which affect related memory formation. Possible example: When Jacque is stressed about mixing up her Spanish with Italian words, the stress may cause her to have trouble recalling the information because of hormones that are released. Her positive emotions, experienced in the Italian restaurant, may also be related to the amygdala. Pages 331–332

2. Our cognitive processes can enhance or inhibit memory, decision making, problem solving, and communication. Explain how each of the following may both help and hurt cognitive functioning.

- Mental set
- Availability heuristic
- Prototypes
- Critical (or sensitive) period for language development
- Stress effects on memory

(10 points)

3. George, a senior in high school, was reminiscing with his friends about their first homecoming dance.

A. Explain how each of the following psychological terms could *help* George's recollection or memory of his freshman-year homecoming dance.

- Flashbulb memory
- Mood-congruent effect

B. Explain how each of the following psychological terms could *hinder* George's recollection or memory of his freshman-year homecoming dance.

- Serial position effect
- Retroactive interference
- Misinformation effect

(5 points)

Multiple-choice self-tests and more may be found at www.worthpublishers.com/MyersAP2e