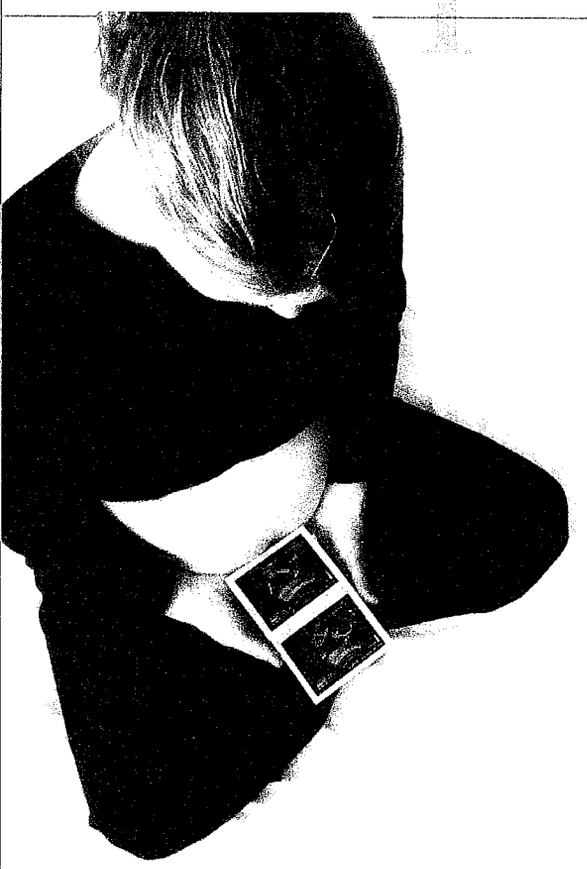
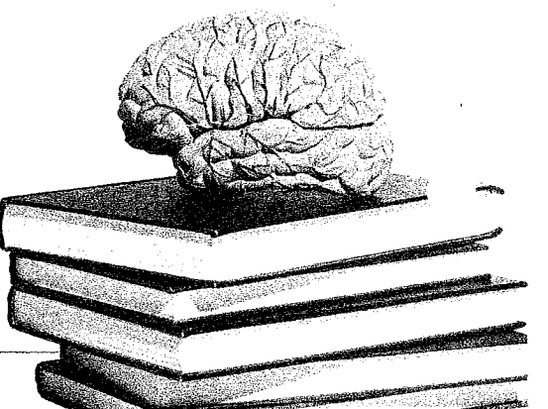
chapter eight



Thinking, Language, and Intelligence

CHAPTER OUTLINE



Unfortunately, the repressed memory debate has grown increasingly bitter, and research on both sides is hotly contested. The stakes are high because lawsuits and criminal prosecutions of sexual abuse are sometimes based on recovered memories of childhood sexual abuse. As researchers continue exploring the mechanisms underlying delayed remembering, we must be careful not to ridicule or condemn people who recover true memories of abuse. In the same spirit, we must protect innocent people from wrongful accusations that come from false memories. Hopefully, with continued research (and perhaps new technology) we may someday better protect the interests of both the victim and the accused.

RETRIEVAL PRACTICE: MEMORY DISTORTIONS

Self-Test

Completing this self-test and comparing your answers with those in Appendix B provides immediate feedback and helpful practice for exams. Additional interactive, self-tests are available at www.wiley.com/college/huffman.

1. Problems with eyewitness recollections are so well established and important that judges now _____.

a. allow expert testimony on the unreliability of eyewitness testimony
b. routinely instruct jurors on the limits and unreliability of eyewitness recollections
c. both the above
d. none of the above

2. Researchers have demonstrated that it is _____ to create false memories.

a. relatively easy
b. rarely possible
c. moderately difficult
d. never possible

3. Dave was told the same childhood story of his father saving his neighbor from a fire so many times that he is now sure it is true, but all the evidence proves it never happened. This is an example of _____.

a. a repressed memory
b. deluded childhood fantasies
c. a false memory
d. early-onset juvenile dementia

4. _____ memories are related to anxiety-provoking thoughts or events that are supposedly prevented from reaching consciousness.

a. Suppressed
b. Flashbulb
c. Flashback
d. Repressed

Think Critically

1. As an eyewitness to a crime, how could you use information in this chapter to improve your memory for specific details?
2. If you were a juror, what would you say to the other jurors about the reliability of eyewitness testimony?

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Does accuracy increase when eyewitnesses have only a few seconds to make an identification?

HINT: LOOK IN THE MARGIN FOR Q5

Summary

1 THE NATURE OF MEMORY 180

- **Memory** is an internal representation of some prior event or experience. It's also a **constructive process** that organizes and shapes information. Major perspectives on memory include the **encoding, storage,** and **retrieval (ESR) model** and the **three-stage memory model**.
- Information enters memory in three stages: **encoding**, **storage**, and **retrieval**. In contrast, the **three-stage memory model** proposes that information is stored and processed in **sensory memory**, **short-term memory (STM)**, and **long-term memory (LTM)**; these differ in purpose, duration, and capacity.
- **Chunking** and **maintenance rehearsal** improve STM's duration and capacity. Researchers think of STM as our **working memory**.
- **LTM** is an almost unlimited storehouse for information that must be kept for long periods. The two major types of LTM are **explicit/declarative memory** and **implicit/nondeclarative memory**. Organization and **elaborative rehearsal** improve encoding. **Retrieval cues** help stimulate retrieval of information from LTM. According to the **encoding-specificity principle**, retrieval is improved when conditions of recovery are similar to encoding conditions.

2 FORGETTING 188

- Researchers have proposed that we forget information through decay, **retroactive** and **proactive interference**, motivated forgetting, encoding failure, and retrieval failure.
- Early research by Ebbinghaus showed that we tend to forget newly learned information quickly, but we relearn the information more readily the second time.

PSYCHSCIENCE

DO WE "REMEMBER" WHAT WE WANT TO REMEMBER?

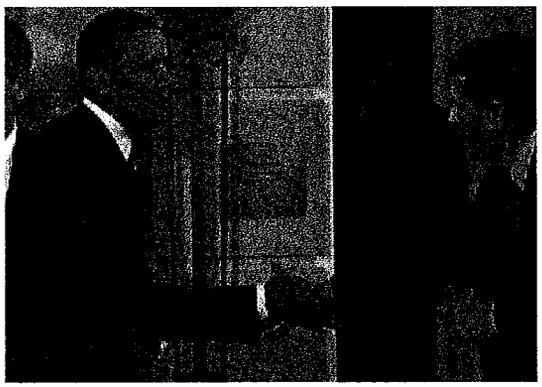


Photo left and right: Reprinted from Journal of Experimental Social Psychology Volume 49, Issue 2, Steven J. Frenda et al. False memories of fabricated political events. Copyright 2013, with permission from Elsevier

To study how false memories are formed, researchers in one recent study asked more than 5,000 participants about their memories of several political events (Frenda et al., 2013). Some of these political events had actually occurred, such as George W. Bush winning the 2000 presidential election. However, other political events had been deliberately created by the experimenters to appear as if they had occurred when in fact they had not. Each fabricated story included a photograph supposedly showing the event. Participants were then asked whether they remembered the event occurring and how they felt about it at the time.

Can you predict what these researchers found? In line with prior research on the ease with which false memories are created, approximately half the participants "remembered" that the false event happened, and about 27% "remembered" seeing it reported on the news. Interestingly, participants' political orientation influenced the formation of false memories.

For example, participants who were politically liberal were significantly more likely to create a false memory of President George W. Bush supposedly socializing with a famous baseball star during the Hurricane Katrina disaster (see the fabricated photo on the left). In contrast, participants who were politically conservative were more likely to falsely remember seeing President Barack Obama supposedly shaking hands with the President of Iran (note the fabricated photo on the right). These findings indicate that we are particularly likely to form false memories of events that fit with, and reinforce, our pre-existing attitudes.

RESEARCH CHALLENGE

1. Based on the information provided, did this study (Frenda et al., 2013) use descriptive, correlational, and/or experimental research?
2. If you chose:
   - descriptive research, is this a naturalistic observation, survey/interview, case study, or archival research?
   - correlational research, is this a positive, negative, or zero correlation?
   - experimental research, label the IV, DV, experimental group(s), and control group.

>> CHECK YOUR ANSWERS IN APPENDIX B.

NOTE: The information provided in this study is admittedly limited, but the level of detail is similar to what is presented in most textbooks and public reports of research findings. Answering these questions, and then comparing your answers to those in the Appendix, will help you become a better critical thinker and consumer of scientific research.

people from mug shots, and a week later, 8% identified innocent people in a lineup (Brown et al., 1977).

Ironically, research now suggests that the accuracy of eyewitness testimony can be improved if people are asked to make very fast judgments (Brewer et al., 2012). In fact, giving people only a few seconds to identify the culprit in a lineup increases the accuracy of such identifications by 20 to 30%, compared to allowing people to take as long as they want to make a decision. **Figure 7.18** offers further tips for improving eyewitness testimony.

left a relationship because you found a new partner, you might rearrange your memories to suit your belief that you are just a weak-willed person who can't stay faithful or that you were mismatched from the beginning. However, if you were the one left behind, you might reconstruct your memories and now believe that you're doomed to lose people you love or that your partner was a manipulative "player" from the beginning. Of course, not all memory reconstructions are so dramatic. However, it's important that we recognize and remember the fallibility of our memory processes during initial encoding, current storage, and future retrieval. To experience first-hand the constructive nature of memory, try the memory test below.

We also shape and construct our memories for the sake of *efficiency*. We summarize, augment, and tie new information in with related memories in LTM. Similarly, when we need to retrieve the stored information, we leave out seemingly unimportant elements or misremember the details.

Despite all their problems and biases, our memories are normally fairly accurate and serve us well in most situations. They have evolved to encode, store, and retrieve general and/or vital information, such as the location of various buildings on our college campus, or the importance of looking both ways when we cross the street. However, when faced with tasks that require encoding, storing, and retrieving precise details like those in a scholarly text, remembering names and faces of

TEST YOURSELF: A PERSONAL MEMORY TEST

psychology and you

Carefully read through all the words in the following list.

Sour	Chocolate	Pie	Bitter	Soda
Nice	Heart	Honey	Good	Honey
Honey	Cake	Candy	Taste	
Artichoke	Tart	Sugar	Tooth	

Now cover the list and write down all the words you remember.

Number of correctly recalled words:

15 to 18 words = excellent memory

10 to 14 words = average

5 to 9 words = below average

4 or fewer words = you might need a nap

How did you do? Do you have a good or excellent memory? Did you recall seeing the words "sour" and "honey"? Most students do, and it's a good example of the *serial-position effect*—the first and last words in the list. Did you remember the word "artichoke" and "honey"? If you recalled "artichoke," it illustrates the power of *distinctiveness*, whereas if you remembered seeing "honey" it's because it was repeated three times. Both of these examples demonstrate how distinctive and/or repeated material are more easily encoded, stored, and recalled. Finally, did you see the word "*sweet*"? Look back over the list. That word is not there, yet most students commonly report seeing it. Why? As mentioned in the introduction to this chapter, memory is not a faithful duplicate of an event; it is a *constructive process*. We actively shape and build on information as it is encoded and retrieved.

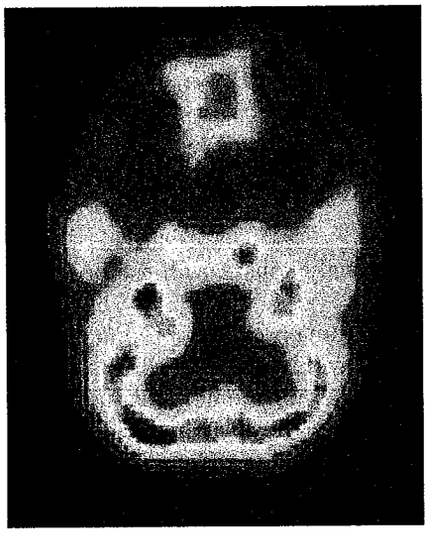
Think Critically

1. Other than this example of seeing the word "sweet," can you think of another example in which you created a false memory?
2. How might constructive memories create misunderstandings at work and in our everyday relationships?

FIGURE 7.16 THE EFFECT OF ALZHEIMER'S DISEASE ON THE BRAIN

A Normal brain
Note the high amount of red and yellow color (signs of brain activity) in the PET scans of the normal brain.

B Brain of a person with Alzheimer's disease
The reduced activity in the brain is most significant in the temporal and parietal lobes, which indicates that these areas are particularly important for storing memories.



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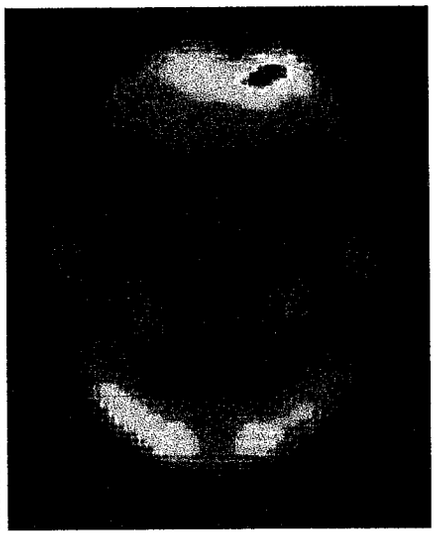

Science Source/Photo Researchers

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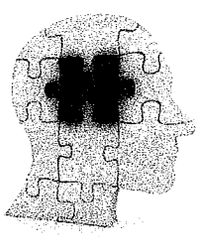
Pat Summit, coach of the Tennessee Lady Vols basketball team from 1974 until 2012 and the winningest college basketball coach of all time, announced in 2011 that she had early-stage Alzheimer's disease.

Like traumatic brain injuries, disease can alter the physiology of the brain and nervous system, affecting memory processes. For example, **Alzheimer's disease (AD)** is a progressive mental deterioration that occurs most commonly in old age **(Figure 7.16)**. The most noticeable early symptoms are disturbances in memory, which become progressively worse until, in the final stages, the person fails to recognize loved ones, needs total nursing care, and ultimately dies.

Alzheimer's does not attack all types of memory equally. A hallmark of the disease is an extreme decrease in *explicit/declarative memory* (Irish et al., 2011; Libon et al., 2007; Satler et al., 2007). Alzheimer's patients fail to recall facts, information, and personal life experiences, yet they still retain some *implicit/nondeclarative* memories, such as simple classically conditioned responses and procedural tasks like brushing their teeth.

Brain autopsies of people with Alzheimer's show unusual *tangles* (structures formed from degenerating cell bodies) and *plaques* (structures formed from degenerating axons and dendrites). Hereditary Alzheimer's generally strikes its victims between the ages of 45 and 55. Some experts believe the cause of Alzheimer's is primarily genetic and age related. However, like many other diseases, it undoubtedly results from a mixture of multiple factors (Bettens et al., 2013; Sillén et al., 2011; Yu et al., 2013).

Alzheimer's disease (AD) A chronic organic brain syndrome characterized by gradual loss of memory, decline in intellectual ability, and deterioration of personality.



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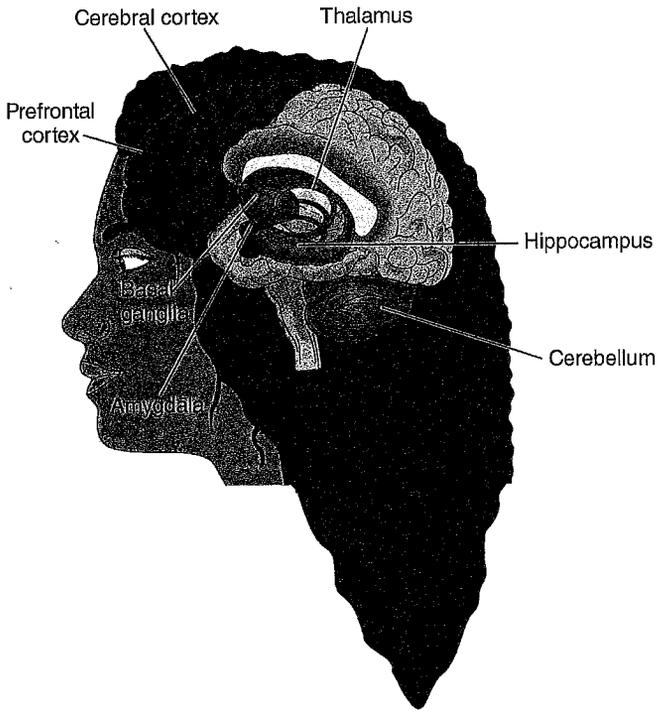
realworldpsychology A New Treatment for Alzheimer's Disease?

Researchers have recently experimented with electrical brain stimulation for patients with severe epilepsy (Suthana et al., 2012). Those who received stimulation to a particular part of the cortex, which is one of the first parts of the brain to be damaged in people with Alzheimer's disease, showed improvement in memory. This technique also may be useful in treating people with Alzheimer's and other forms of severe memory loss.

FIGURE 7.14 THE BRAIN AND MEMORY

Damage to any one of these areas can affect encoding, storage, and retrieval of memories.



Amygdala	Emotional memories (Eichenbaum, 2013; Gerber et al., 2008; Murty et al., 2011; Paz & Pare, 2013)
Basal ganglia and cerebellum	Creation and storage of basic memory and implicit (nondeclarative) memories, such as skills, habits, and simple classically conditioned responses (Braunlich & Seger, 2013; De Smet et al., 2013; Foerde & Shohamy, 2011; Stoodley, 2012)
Hippocampal formation (hippocampus and surrounding area)	Explicit/declarative and implicit/nondeclarative LTM, as well as sequences of events (Gimbel & Brewer, 2011; Glavis-Bloom et al., 2013; Murty et al., 2011; Schott et al., 2013)
Thalamus	Formation of new memories and spatial and working memory (Aggleton et al., 2010; Carlesimo et al., 2011; Eichenbaum, 2013; Pergola et al., 2012, 2013)
Cerebral cortex	Encoding of explicit (declarative) memories; storage of episodic and semantic memories, skill learning, working memory (Chao et al., 2013; Depue, 2012; Herholz et al., 2012; McAllister et al., 2013; Takahashi et al., 2013)

Think Critically

1. What effect might damage to the amygdala have on a person's relationships with others?
2. How might damage to your thalamus affect your day-to-day functioning?

Today, research techniques are so advanced that we can experimentally induce and measure memory-related brain changes as they occur—on-the-spot reporting! For example, James Brewer and his colleagues (1998) used functional magnetic resonance imaging (fMRI) to locate areas of the brain responsible for encoding memories of pictures. They showed 96 pictures of indoor and outdoor scenes to participants while scanning their brains, and then they later tested participants' ability to recall the pictures. Brewer and his colleagues identified the *right prefrontal cortex* and the *parahippocampal cortex* as being the most active during the encoding of the pictures. These are only two of several brain regions involved in memory storage.

Biological Causes of Memory Loss

The leading cause of neurological disorders—including memory loss—among young U.S. men and women between the ages of 15 and 25 is *traumatic brain injury*. These injuries most commonly result from car accidents, falls, blows, and gunshot wounds.

Traumatic brain injury happens when the skull suddenly collides with another object. Compression, twisting, and distortion of the brain inside the skull all cause serious and sometimes permanent damage to the brain. The frontal and temporal

BIOLOGICAL BASES OF MEMORY

LEARNING OBJECTIVES

RETRIEVAL PRACTICE While reading the upcoming sections, respond to each Learning Objective in your own words. Then compare your responses with those found at www.wiley.com/college/huffman.

1. **DESCRIBE** two kinds of biological changes that occur when we learn something new.
2. **EXPLAIN** the effect of hormones on memory.
3. **IDENTIFY** some brain areas involved in memory.
4. **EXPLAIN** how injury and disease can affect memory.

A number of biological changes occur when we learn something new. We discuss these changes in this section, along with the questions of where memories are located, and what causes memory loss.

Neuronal and Synaptic Changes

We know that learning modifies the brain's neural networks (Chapters 2 and 6). As you learn to play tennis, for example, repeated practice builds specific neural pathways that make it easier and easier for you to get the ball over the net. This **long-term potentiation (LTP)** happens in at least two ways.

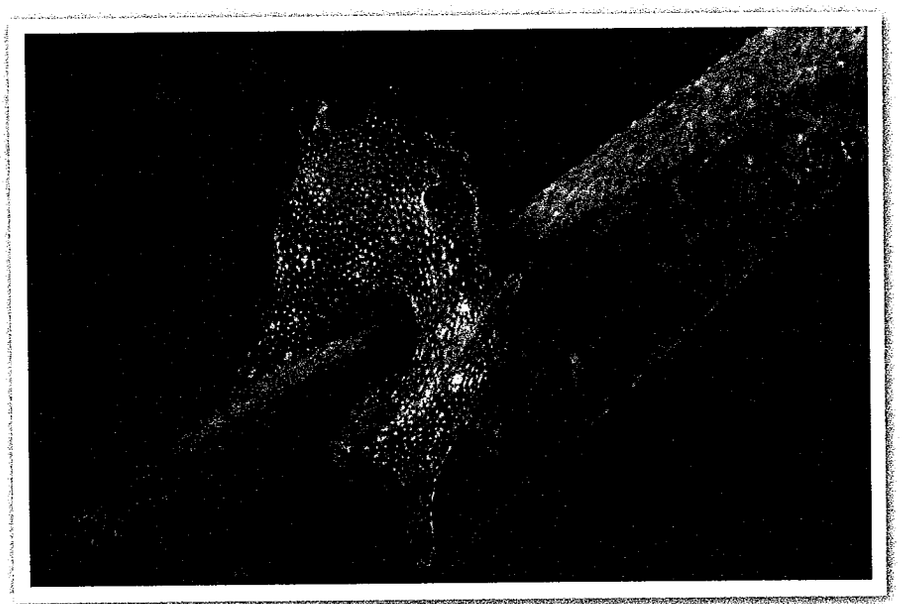
Long-term potentiation (LTP) A long-lasting increase in neural excitability, which may be a biological mechanism for learning and memory.

First, as early research with rats raised in enriched environments showed (Rosenzweig et al., 1972), repeated stimulation of a synapse can strengthen the synapse by causing the dendrites to grow more spines (Chapter 6). This results in more synapses, more receptor sites, and more sensitivity.

Second, when learning and memory occur, there is a measurable change in the amount of neurotransmitter released, which thereby increases the neuron's efficiency in message transmission. Research with *Aplysia* (sea slugs) clearly demonstrates this effect **(Figure 7.13)**.

FIGURE 7.13 HOW DOES A SEA SLUG LEARN AND REMEMBER?

After repeated squirting with water, followed by a mild shock, the sea slug, *Aplysia*, releases more neurotransmitters at certain synapses. These synapses then become more efficient at transmitting signals that allow the slug to withdraw its gills when squirted. As a critical thinker, can you explain why this ability might provide an evolutionary advantage?



experiments have created false memories by showing participants doctored photos of themselves taking a completely fictitious hot-air balloon ride or by asking participants to simply imagine an event, such as having a nurse remove a skin sample from their finger. In these and similar cases, a large number of participants later believed that the misleading information was correct and that the fictitious or imagined events actually occurred (Fazio et al., 2013; Hess et al., 2012; Wright et al., 2013).

Some research even suggests that watching someone else engage in a behavior, or merely *imagining* ourselves doing that behavior, can lead us to (falsely) believe that we've actually done that activity ourselves. For example, one study asked students to read a series of statements, such as "shake the bottle," and were then told to either imagine performing that action or to watch a video of someone else performing it. When the students were asked two weeks later to recall which actions they had performed, they "remembered" performing 23% of the actions they had seen someone else doing in the video and "remembered" performing 33% of the actions they had imagined doing themselves (Lindner et al., 2010)!

In addition to having problems with the misinformation effect, study participants who are asked to memorize lists of words remember some words better than others, depending on where they occurred in the list. This is known as the **serial-position effect**. Participants remember the words at the beginning (*primacy effect*) and the end (*recency effect*) better than those in the middle of the list, which are quite often forgotten (Bonk & Healy, 2010; Overstreet & Healy, 2011).

Serial-position effect A characteristic of memory retrieval in which information at the beginning and end of a series is remembered better than material in the middle.

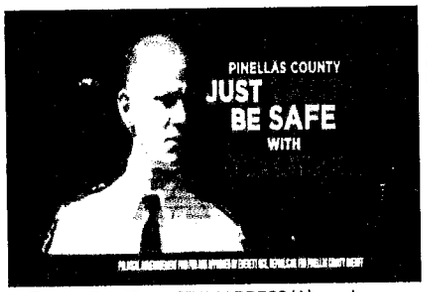
The reasons for the serial-position effect are complex, but they have interesting real-life implications. For example, a potential employer's memory of you might be enhanced if you are either the first or the last candidate interviewed.

Each day we read, hear, and process an enormous amount of information, and it's easy to get confused about who said what to whom and in what context. Forgetting the true source of a memory is known as **source amnesia** (Kleider et al., 2008; Leichtman, 2006; Paterson et al., 2011).

Source amnesia A memory error caused by forgetting the true source of a memory (also called source confusion or source misattribution).

When we first hear something from an unreliable source, we tend to disregard that information in favor of a more reliable source. However, as the source of the information is forgotten (source amnesia), the unreliable information is no longer discounted. This is called the **sleeper effect**, see the *Real World Psychology* example below (Appel & Richter, 2007; Ecker et al., 2011; Nabi & Moyer-Gusé, 2013).

Sleeper effect A memory error in which information from an unreliable source that was initially discounted later gains credibility because the source is forgotten.



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realworldpsychology The Power of Negative Political Campaigns

Think back to a recent heated political election. What type of television advertisements most readily come to mind? People are most likely to recall ads that rely on creating negative feelings about one of the candidates. These negative advertisements work because they stick with us, even if we initially have negative feelings about them (Lariscy & Tinkham, 1999). Over time, the "facts" stay in our memory, and we forget the source, illustrating both source amnesia and the sleeper effect!

If we try to memorize too much information at once (as when students "cram" before an exam), we're far less likely to learn and remember as much as we would with more distributed study (Dunn et al., 2013; Fulton et al., 2013; Karpicke & Bauernschmidt, 2011). **Distributed practice** refers to spacing your learning periods, with rest periods between sessions. Cramming is called **massed practice** because the time spent learning is massed into long, unbroken intervals. For example, researchers in one study asked musicians to practice a note sequence in three practice sessions that were separated by either 5 minutes, 6 hours, or 24 hours (Simmons, 2012). Those whose practice sessions were separated by 24 hours showed significantly greater memory of the notes than those with shorter times between practice sessions.

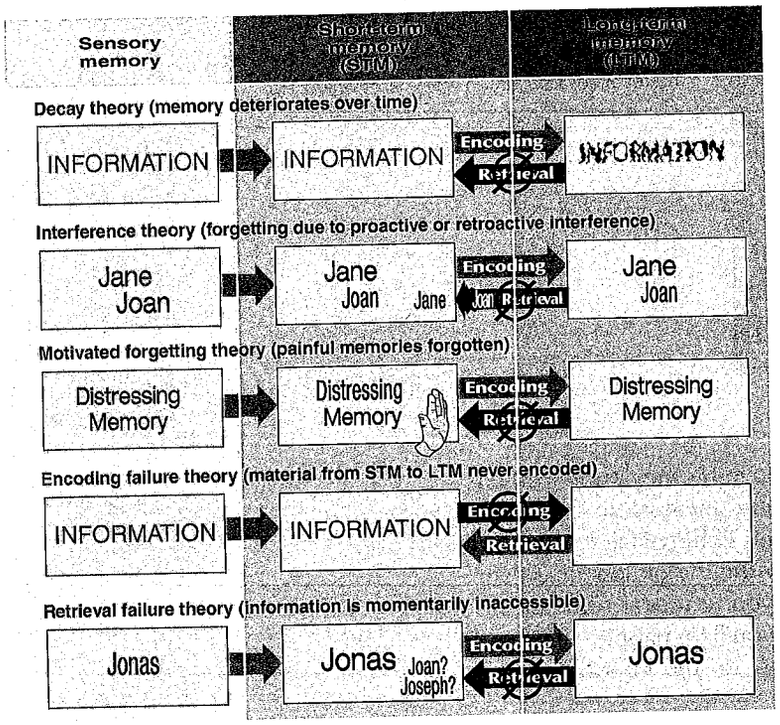
Distributed practice A study technique in which practice (or study) sessions are interspersed with rest periods.

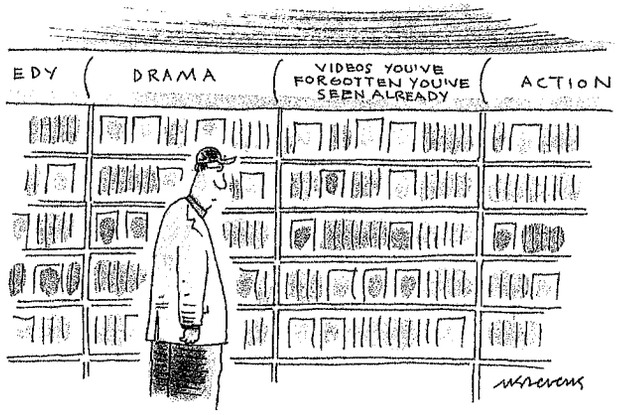
Massed practice A study technique in which time spent learning is grouped (or massed) into long, unbroken intervals; also known as cramming.

Finally, as illustrated in **Figure 7.12**, cultural factors can play a role in how well people remember what they have learned.

FIGURE 7.10 WHY WE FORGET: FIVE KEY THEORIES

Which of the five theories of forgetting best applies to this cartoon?





Mick Stevens/The New Yorker Collection/www.cartoonbank.com

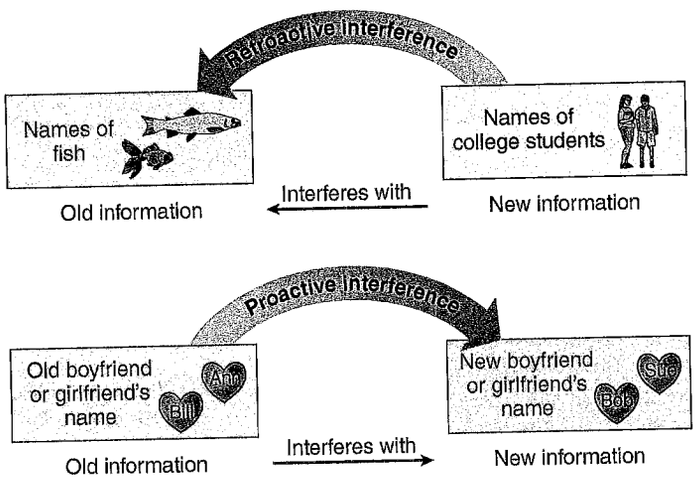
Proactive interference A memory error in which old information interferes with remembering new information; it is forward-acting interference.

"retro," information is forgotten). Conversely, when old information leads to forgetting of new information, it is called **proactive interference** (acting forward in time). Old information (like the Spanish you learned in high school) may interfere with your ability to learn and remember your new college course in French.

Motivated forgetting theory is based on the idea that we forget some information for a reason. According to Freudian theory, people forget unpleasant or anxiety-producing information, either consciously or unconsciously.

In *encoding failure theory*, our sensory memory receives the information and passes it to STM. But during STM, we may overlook precise details, and may not fully encode it, which would result in a failure to pass along a complete memory for proper storage in LTM.

FIGURE 7.11 RETROACTIVE INTERFERENCE AND PROACTIVE INTERFERENCE



A Retroactive (backward-acting) **interference** occurs when new information interferes with old information. This example comes from a story about an absent-minded ichthyology professor (fish specialist) who refused to learn the name of his college students. Asked why, he said, "Every time I learn a student's name, I forget the name of a fish!"

B Proactive (forward-acting) **interference** occurs when old information interferes with new information. Have you ever been in trouble because you used an old partner's name to refer to your new partner? You now have a guilt-free explanation—proactive interference.

more likely to remember events and circumstances from other times when you were sad (or happy or angry).

Finally, memory retrieval is most effective when we are in the same state of consciousness as we were in when the memory was formed. For example, people who are intoxicated will better remember events that happened in a previous drunken state, compared to when they are sober (Nasehi et al., 2010; Sanday et al., 2013). This is called *state-dependent retrieval.*

RETRIEVAL PRACTICE: THE NATURE OF MEMORY

Self-Test

Completing this self-test and comparing your answers with those in Appendix B provides immediate feedback and helpful practice for exams. Additional interactive, self-tests are available at www.wiley.com/college/huffman.

1. Information in _____ lasts only a few seconds or less and has a relatively large (but not unlimited) storage capacity.

a. perceptual processes
b. working memory
c. short-term storage
d. sensory memory

2. _____ is the process of grouping separate pieces of information into a single unit.

a. Chunking
b. Collecting
c. Conflation
d. Dual-coding

3. In answering this question, the correct multiple-choice option may serve as a _____ for recalling accurate information from your long-term memory.

a. specificity code
b. retrieval cue
c. priming pump
d. flashbulb stimulus

4. The encoding-specificity principle says that information retrieval is improved when _____.

a. both maintenance and elaborative rehearsal are used
b. reverberating circuits consolidate information
c. conditions of recovery are similar to encoding conditions
d. long-term potentiation is accessed

Think Critically

1. What are some of the possible advantages and disadvantages of the fact that memory is a constructive process?
2. If you were forced to lose one type of memory—sensory, short-term, or long-term—which would you select? Why?

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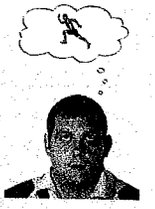


Do daydreamers actually have better working-memory skills than people who don't daydream?

How can taking a nap improve your memory?

HINT: LOOK IN THE MARGIN FOR Q1 AND Q2

FORGETTING

LEARNING OBJECTIVES

RETRIEVAL PRACTICE While reading the upcoming sections, respond to each Learning Objective in your own words. Then compare your responses with those found at www.wiley.com/college/huffman.

1. **DESCRIBE** Ebbinghaus's research on learning and forgetting.
2. **REVIEW** the five key theories about why we forget.
3. **EXPLAIN** the six most important factors that contribute to forgetting.

Psychologists have long been interested in how and why we forget. Hermann Ebbinghaus first introduced the experimental study of learning and forgetting in 1885 **(Figure 7.9)**.

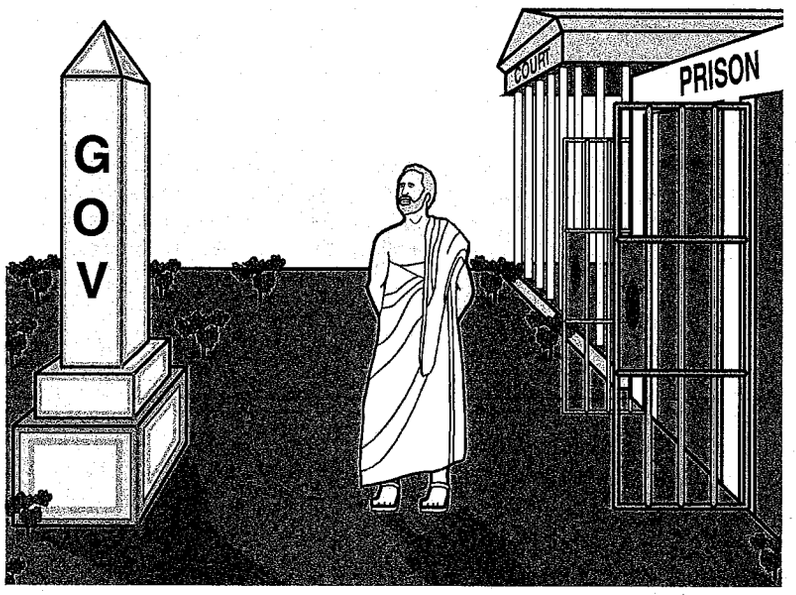
IMPROVING YOUR MEMORY USING MNEMONIC DEVICES

psychology and you

These three mnemonics improve memory by tagging information to physical locations (*method of loci*), organizing information into main and subsidiary topics (an *outline*), and using familiar information to remember the unfamiliar (*acronyms*).

Ⓐ Method of loci

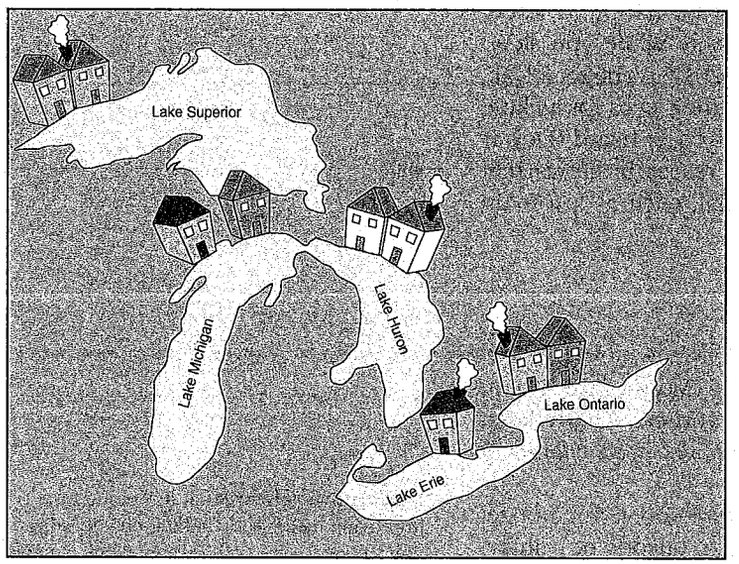
Greek and Roman orators developed the *method of loci* to keep track of the many parts of their long speeches. Orators would imagine the parts of their speeches attached to places in a courtyard. For example, if an opening point in a speech was the concept of *justice*, they might visualize a courthouse placed in the first corner of their garden. Continuing this imaginary garden walk, the second point the orator might make would be about the prison system, and the third would be the need for balance in government.



Ⓑ Outline organization

When listening to lectures and/or reading the text, draw a vertical line approximately 3 inches from the left margin of your notebook paper. Write main headings from the chapter outline to the left of the line and add specific details and examples from the lecture or text on the right, as in this example:

Outline	Details and Examples from Lecture and Text
1. Nature of Memory	_____
a. Memory Models	_____
b. Sensory Memory	_____
c. Short-Term Memory (STM)	_____



Ⓒ Acronyms

To use the *acronym method*, create a new code word from the first letters of the items you want to remember. For example, to recall the names of the Great Lakes, think of *HOMES* on a *great lake* (*H*uron, *O*ntario, *M*ichigan, *E*rie, *S*uperior). Visualizing homes on each lake also helps you remember your code word *homes*.

Think Critically

1. How could you use the method of loci to remember several items on your grocery shopping list?
2. How would you use the acronym method to remember the names of the last seven presidents of the United States?

Long-Term Memory (LTM)

Long-term memory (LTM) The third stage of memory, which stores information for long periods of time; the capacity is virtually limitless, and the duration is relatively permanent.

Once information has been transferred from STM, it is organized and integrated with other information in **long-term memory (LTM)**. LTM serves as a storehouse for information that must be kept for long periods. When we need the information, it is sent back to STM for our conscious use. Compared with sensory memory and short-term memory, long-term memory has relatively unlimited *capacity* and *duration* (Eichenbaum, 2013). But, just as with any other possession, the better we label and arrange our memories, the more readily we'll be able to retrieve them.

How do we store the vast amount of information we collect over a lifetime? Several types of LTM exist **(Figure 7.7)**.

Explicit/declarative memory A subsystem within long-term memory (LTM) that consciously stores facts, information, and personal life experiences.

Explicit/declarative memory refers to intentional learning or conscious knowledge. If asked to remember your phone number or your mother's name, you can easily state (*declare*) the answers directly (*explicitly*).

Semantic memory A subsystem of long-term memory (LTM) that stores general knowledge; a mental encyclopedia or dictionary.

Episodic memory A subsystem of long-term memory (LTM) that stores autobiographical events and the contexts in which they occurred; a mental diary of a person's life.

Explicit/declarative memory can be further subdivided into two parts. **Semantic memory** is memory for general knowledge, rules, events, facts, and specific information. It is our mental encyclopedia. In contrast, **episodic memory** is like a mental diary. It records the major events (*episodes*) in our lives. Some of our episodic memories are short-lived, whereas others can last a lifetime.

Have you ever wondered why most adults can recall almost nothing of the years before they reached age 3? Research suggests that a concept of self, sufficient language development, and growth of the frontal lobes of the cortex (along with other structures) may be necessary for us to encode and retrieve early events many years later (Bauer & Lukowski, 2010; Pathman & Bauer, 2013; Rose et al., 2011).

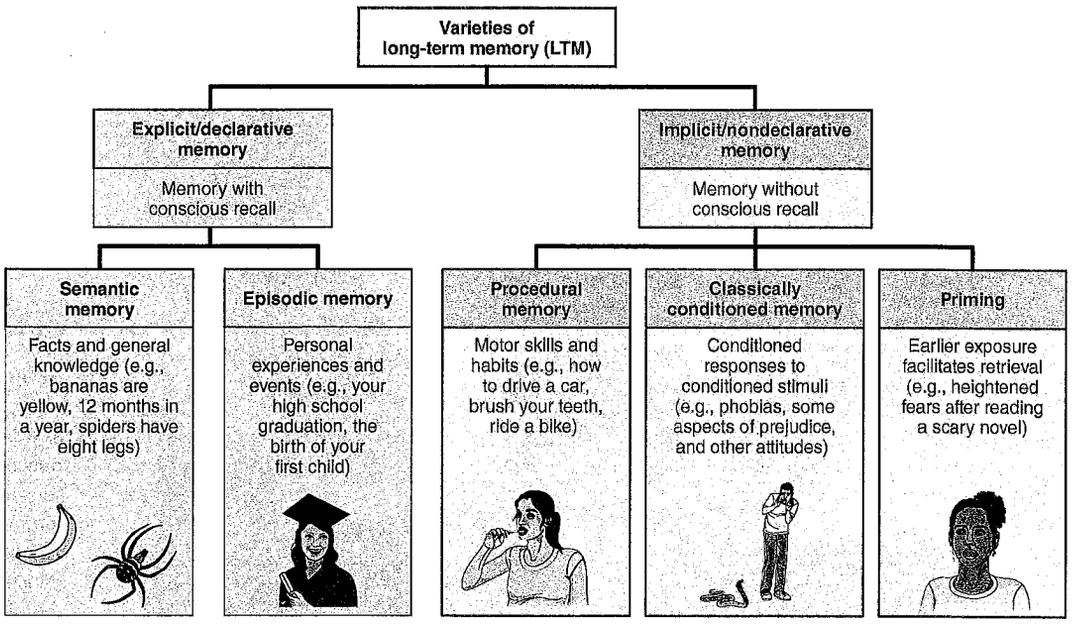
Implicit/nondeclarative memory A subsystem within long-term memory (LTM) that unconsciously stores procedural skills and simple classically conditioned responses.

Implicit/nondeclarative memory refers to unintentional learning or unconscious knowledge. Try telling someone else how you tie your shoelaces without demonstrating the actual behavior. Because your memory of this skill is unconscious and hard to describe (*declare*) in words, this type of memory is sometimes referred to as *nondeclarative*.

Implicit/nondeclarative memory consists of *procedural* motor skills, like tying your shoes or riding a bike, as well as *classically conditioned emotional* responses, such as fears and prejudices (Chapter 6).

FIGURE 7.7 TYPES OF LONG-TERM MEMORY (LTM)

LTM is divided and subdivided into various types.



Sensory Memory

Sensory memory The initial memory stage, which holds sensory information; it has relatively large capacity but the duration is only a few seconds.

Everything we see, hear, touch, taste, and smell must first enter our **sensory memory**. Once it's entered, the information remains in sensory memory just long enough for our brain to locate relevant bits of data and transfer it on to the next stage of memory. For visual information, known as *iconic memory*, the visual image (icon) stays in sensory memory only about one-half a second before it rapidly fades away.

In an early study of iconic sensory memory, George Sperling (1960) flashed an arrangement of 12 letters like the ones in **Figure 7.3** for 1/20 of a second. Most people, he found, could recall only 4 or 5 of the letters. But when instructed to report just the top, middle, or bottom row, depending on whether they heard a high, medium, or low tone, they reported almost all the letters correctly. Apparently, all 12 letters are held in sensory memory right after they are viewed, but only those that are immediately attended to are noted and processed.

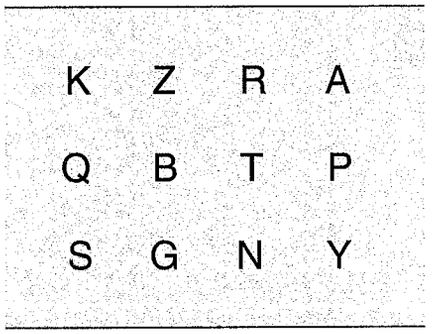


FIGURE 7.3 SPERLING'S TEST FOR ICONIC MEMORY

Like the fleeting visual images in iconic memory, auditory stimuli (what we hear) is also temporary, but a weaker "echo," or *echoic memory*, of this auditory input lingers for up to four seconds (Inui et al., 2010; Neisser, 1967; Radvansky, 2011). Why are iconic and auditory memories so fleeting? We cannot process all incoming stimuli, so lower brain centers need only a few seconds to "decide" if the information is important enough to promote to conscious awareness **(Figure 7.4).**

Early researchers believed that sensory memory had an unlimited capacity. However, later research suggests that sensory memory does have limits and that stored images are fuzzier than once thought (Franconeri et al., 2013; Goldstein, 2010; Moulin, 2011).

Short-Term Memory (STM)

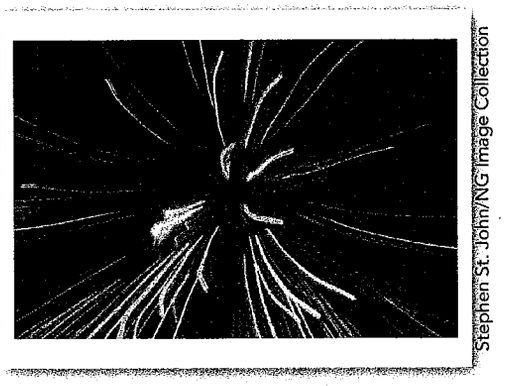
Short-term memory (STM) The second memory stage, which temporarily stores sensory information and decides whether to send it on to long-term memory (LTM); its capacity is limited to five to nine items and it has a duration of about 30 seconds.

Chunking The process of grouping separate pieces of information into a single unit (or chunk) on the basis of similarity or some other organizing principle.

The second stage of memory processing, **short-term memory (STM)**, temporarily stores and processes sensory stimuli. If the information is important, STM organizes and sends this information along to long-term (LTM)—otherwise, information decays and is lost. STM also retrieves stored memories from LTM.

The capacity and duration of STM are limited (Bankó & Vidnyánsky, 2010; Nairne & Neath, 2013). To extend the *capacity* of STM, you can use a technique called **chunking** (Glicksohn & Cohen, 2011; Miller, 1956; Oberauer et al., 2013; Thornton & Conway, 2013). Have you noticed that your credit card, Social Security, and telephone numbers are almost always grouped into three or four units separated

FIGURE 7.4 DEMONSTRATING ICONIC AND ECHOIC MEMORIES psychology and you



(A) Visual Images—Iconic Memory
To demonstrate the duration of visual memory, or *iconic memory*, swing a flashlight in a dark room. Because the image, or icon, lingers for a fraction of a second after the flashlight is moved, you see the light as a continuous stream, as in this photo, rather than as a succession of individual points.

(B) Auditory Stimuli—Echoic Memory
Think back to a time when someone asked you a question while you were deeply absorbed in a task. Did you ask "What?" and then immediately find you could answer them without hearing their repeated response? Now you know why. A weaker "echo" (echoic memory) of auditory information is available for up to four seconds.

chapteroverview

When H.M. was 27, he underwent brain surgery to correct his severe epileptic seizures. Although the surgery improved his medical problem, now something was clearly wrong with H.M.'s long-term memory. When his uncle died, he grieved in a normal way. But soon after, he began to ask why his uncle never visited him. H.M. had to be repeatedly reminded of his uncle's death, and each reminder would begin a new mourning process.

H.M. lived another 55 years not recognizing the people who cared for him daily. Each time he met his caregivers, read a book, or ate a meal, it was as if for the first time (Barbeau, Puel, & Pariente, 2010; Carey, 2008; Corkin, 2002). Sadly, H.M. died in 2008—never having regained his long-term memory.

What should we make of this true, real-life example? What would it be like to be H.M.—existing only in the present moment, unable to learn and form new memories? How can we remember our second-grade teacher's name, but forget the name of someone we just met? In this chapter, you'll discover answers to these and other fascinating questions about memory.

THE NATURE OF MEMORY

LEARNING OBJECTIVES

RETRIEVAL PRACTICE While reading the upcoming sections, respond to each Learning Objective in your own words. Then compare your responses with those found at www.wiley.com/college/huffman.

1. **REVIEW** the core principles of the major memory models.
2. **DESCRIBE** the purpose of sensory memory.
3. **EXPLAIN** the function of short-term memory (STM) and how it operates as our working memory.
4. **DESCRIBE** the functions and various types of long-term memory (LTM).
5. **EXPLAIN** how organization, elaborative rehearsal, and retrieval cues improve long-term memory.

Memory The internal record or representation of some prior event or experience; the mental capacity to encode, store, and retrieve information.

Constructive process The process of organizing and shaping information during processing, storage, and retrieval of memories.

Memory allows us to learn from our experiences and to adapt to ever-changing environments. Without it, we would have no past or future. Yet our memories are also highly fallible. Although some people think of **memory** as a gigantic library or an automatic video recorder, our memories are not exact recordings of events. Instead, memory is a **constructive process** through which we actively organize and shape information as it is being processed, stored, and retrieved. As expected, this construction often leads to serious errors and biases, which we'll discuss throughout the chapter.

Memory Models

To understand memory (and its constructive nature), you need a model of how it operates. Over the years, psychologists have developed numerous models for memory, and we'll focus on the two most important ones.

Encoding, Storage, and Retrieval (ESR) Model

Encoding, storage, and retrieval (ESR) model A memory model which suggests that memory is formed through three processes: *encoding* (getting information in), *storage* (retaining information for future use), and *retrieval* (recovering information).

Encoding The process by which a mental representation is formed in memory.

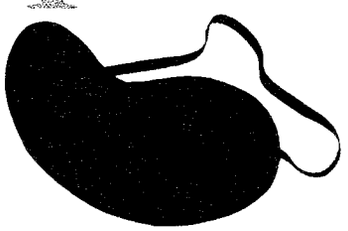
Storage The retention of encoded information over time.

According to the **encoding**, **storage**, and **retrieval (ESR) model**, the barrage of information that we encounter every day goes through three basic operations: *encoding*, *storage*, and *retrieval*. Each of these processes represents a different function that is closely analogous to the parts and functions of a computer **(Figure 7.1)**.

To input data into a computer, you begin by typing letters and numbers on the keyboard. The computer then translates these keystrokes into its own electronic language. In a roughly similar fashion, your brain **encodes** sensory information (sound, visual images, and other senses) into a neural code (language) it can understand and use.

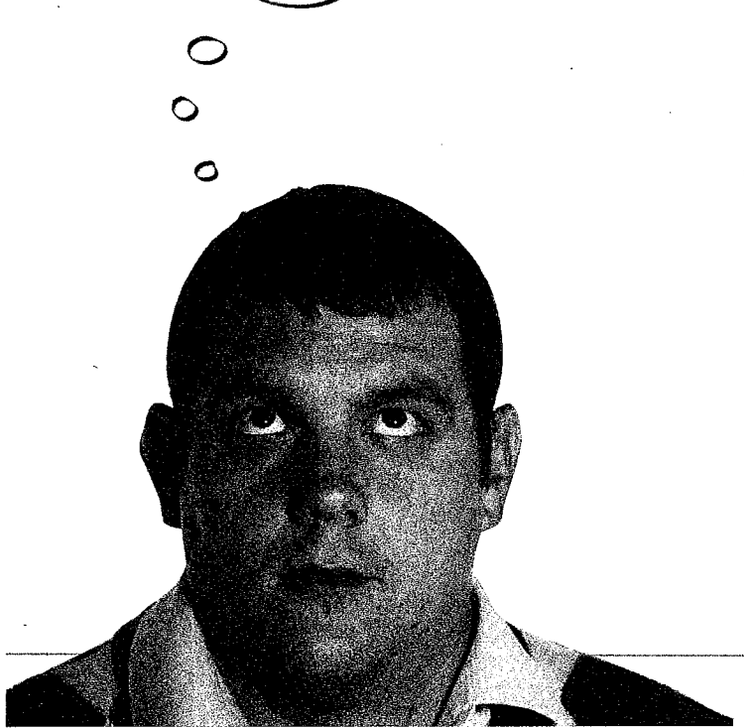
Once information is *encoded*, it must be **stored**. Computer information is normally stored on a flash drive or hard drive, whereas human information is stored in the brain.

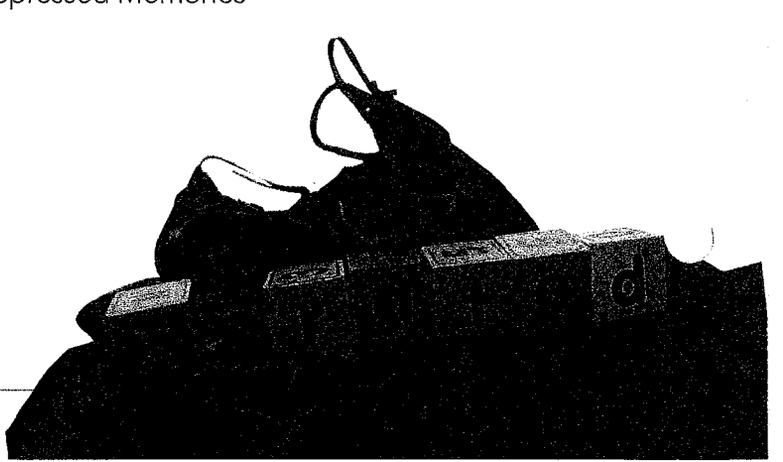
chapter seven



Memory

CHAPTER OUTLINE





Summary

1 CLASSICAL CONDITIONING 152

- **Learning** is a relatively permanent change in behavior or mental processes caused by experience. Pavlov discovered a fundamental form of **conditioning** (learning) called **classical conditioning**, a type of learning that develops through involuntarily paired associations. A previously **neutral stimulus (NS)** becomes associated with an **unconditioned stimulus (US)** to elicit a **conditioned response (CR)**.
- In the "Little Albert" study, Watson and Rayner demonstrated how many of our likes, dislikes, prejudices, and fears are examples of a **conditioned emotional response (CER)**, which develops in response to a previously neutral stimulus (NS).
- **Acquisition**, the first of six key principles of classical conditioning, occurs when the **conditioned stimulus (CS)** leads to a CR. **Stimulus generalization** occurs when an event similar to the originally conditioned stimulus triggers the same conditioned response. With experience, animals learn to distinguish between an original conditioned stimulus and similar stimuli—**stimulus discrimination**. **Extinction** is a gradual weakening or suppression of a previously conditioned response. However, if a conditioned stimulus is reintroduced after extinction, an extinguished response may **spontaneously recover**. **Higher-order conditioning** occurs when the NS becomes a CS through repeated pairings with a previous CS.

2 OPERANT CONDITIONING 159

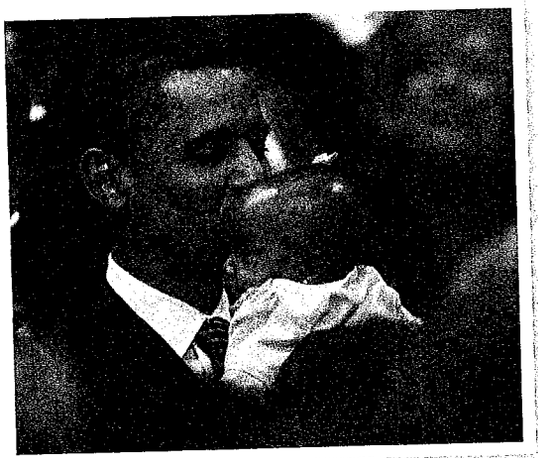
- In **operant conditioning**, an organism learns as a result of voluntary behavior and its subsequent consequences. **Reinforcement** strengthens the response, while **punishment** weakens the response.
- Thorndike developed the **law of effect**, in which responses that produce a satisfying effect are more likely to recur, whereas those that produce a discomforting effect become less likely to recur. Skinner extended Thorndike's law of effect to more complex behaviors.
- **Primary reinforcers** and **primary punishers** are innate, whereas **secondary reinforcers** and **secondary punishers** are learned. Each type of reinforcer can produce **positive reinforcement** or **negative reinforcement,** and both of these forms of reinforcement strengthen the response they follow. Negative reinforcement is NOT punishment. Both **positive punishment** and **negative punishment** weaken a response.
- Punishment can have serious side effects: passive aggressiveness, avoidance behavior, inappropriate modeling, temporary suppression, learned helplessness, rewarded aggression, and perpetuated aggression.
- Organisms learn complex behaviors through **shaping**, in which reinforcement is delivered for successive approximations of the desired response.
- **Schedules of reinforcement** refers to the rate or interval at which responses are reinforced. Most behavior is rewarded and maintained through one of four partial schedules of reinforcement: **fixed ratio (FR)**, **variable ratio (VR)**, **fixed interval (FI)**, or **variable interval (VI)**.

3 COGNITIVE-SOCIAL LEARNING 168

- **Cognitive-social learning theory** emphasizes cognitive and social aspects of learning. Köhler discovered that animals sometimes learn through sudden **insight**, rather than through trial and error. Tolman provided evidence of hidden, **latent learning** and internal **cognitive maps**.
- Bandura's research found that children who watched an adult behave aggressively toward an inflated Bobo doll were later more aggressive than those who had not seen the aggression. According to Bandura, **observational learning** requires attention, retention, reproduction, and motivation.

4 BIOLOGY OF LEARNING 172

- Learning creates structural changes in the brain. Early evidence for such changes came from research on animals raised in enriched environments versus deprived environments.
- **Mirror neurons** fire when an action is performed, as well as when observing the actions or emotions of another.
- Learning is an evolutionary adaptation that enables organisms to survive and prosper in a constantly changing world. Researchers have identified biological constraints that limit the generality of conditioning principles: **biological preparedness** and **instinctive drift**.



Chris Fitzgerald/CandidatePhotos/NewsCom

applyingrealworldpsychology

We began this chapter with five intriguing Real World Psychology questions, and you were asked to revisit these questions at the end of each section. Questions like these have an important and lasting impact on all of our lives. See if you can answer these additional critical thinking questions related to real world examples.

1. What principles of learning best explain why politicians kiss babies?
2. What other stimuli or symbols do politicians use in their campaigns that are based on learning principles?
3. Have you ever used learning principles to get others to do what you want? Was it ethical?
4. How could the media be used to promote desirable traits and behaviors in the viewing public?
5. Imagine if someone developed a secret pill that could make alcohol, tobacco, and fatty foods an immediate taste aversion for everyone. Would that be a good or bad thing? Assuming that it was safe, would you take the pill? Why or why not?

Mirror neuron A type of neuron that fires (or activates) when an action is performed, as well as when observing the actions or emotions of another; believed to be responsible for empathy, imitation, language, and the deficits of some mental disorders.

researchers have identified specific **mirror neurons** believed to be responsible for human empathy and imitation (Ahlsén, 2008; Baird et al., 2011; Caggiano et al., 2011; Haker et al., 2013). These neurons are found in several key areas of the brain, and are believed to be responsible for how we identify with what others are feeling and imitate their actions. When we see another person in pain, one reason we empathize and "share their pain" may be that our mirror neurons are firing. Similarly, if we watch others who are smiling, our mirror neurons make it harder for us to frown.

Mirror neurons were first discovered by neuroscientists who implanted wires in the brains of monkeys to monitor areas involved in planning and carrying out movement (Ferrari et al., 2005; Rizzolatti et al., 2002, 2006). When these monkeys moved and grasped an object, specific neurons fired, but they also fired when the monkeys simply observed another monkey performing the same or similar tasks.

Carlos E. Santa Maria/Shutterstock

realworldpsychology **Mirror Neurons** Have you noticed how spectators at an athletic event sometimes slightly move their arms or legs in synchrony with the athletes? Mirror neurons may be the underlying biological mechanism for this imitation. Deficiencies in these neurons also might help explain the emotional deficits of children and adults with autism or schizophrenia, who often misunderstand the verbal and nonverbal cues of others (Enticott et al., 2012; Kana et al., 2011; Rizzolatti, 2012).

Although scientists are excited about the promising links between mirror neurons and human emotions, imitation, language, learning, and learning disabilities, we do not yet know how they develop. In addition, other researchers have suggested that more research is needed to justify the claims for the role of mirror neurons (Baird et al., 2011; Thomas, 2012). Stay tuned.

Evolution and Learning

Humans and other animals are born with various innate reflexes and instincts. Although these biological tendencies help ensure evolutionary survival, they are inherently inflexible. Learning allows us to more flexibly respond to complex environmental cues, such as spoken words and written symbols, which in turn enables us to survive and prosper in a constantly changing world.

Because animals can be classically conditioned to salivate to tones and operantly conditioned to perform a variety of novel behaviors, such as a seal balancing a ball on its nose, learning theorists initially believed that the fundamental laws of conditioning would apply to almost all species and all behaviors. However, researchers have discovered that some associations are much more readily learned than others.

For example, when a food or drink is associated with nausea or vomiting, that particular food or drink more readily becomes a conditioned stimulus (CS) that triggers a conditioned **taste aversion**. Like other classically conditioned responses, taste aversions develop involuntarily.

Taste aversion A classically conditioned dislike for, and avoidance of, a specific food whose ingestion is followed by illness.

© robtek/IStockphoto

psychology and you **Taste Aversion** Years ago, a young woman named Rebecca unsuspectingly bit into a Butterfinger candy bar filled with small, wiggling maggots. Horrified, she ran gagging and screaming to the bathroom. Many years later, Rebecca still feels nauseated when she sees a Butterfinger candy bar. Can you see how stimulus discrimination explains why she doesn't feel similarly nauseated by the sight of her boyfriend, who bought her the candy?

Rebecca's graphic (and true!) story illustrates an important evolutionary process. Being biologically prepared to quickly associate nausea with food or drink is obviously adaptive because it helps us avoid that specific food or drink, and similar ones, in the future (Domjan, 2005; Garcia, 2003; Lotem & Halpern, 2012; Swami, 2011).

Further evidence comes from John Garcia and his colleague Robert Koelling (1966) who produced a taste aversion in lab rats by pairing sweetened water (NS) and a shock (US), which produced nausea (UR). After being conditioned and then

RETRIEVAL PRACTICE: COGNITIVE-SOCIAL LEARNING

Self-Test

Completing this self-test and comparing your answers with those in Appendix B provides immediate feedback and helpful practice for exams. Additional interactive, self-tests are available at www.wiley.com/college/huffman.

1. Insight is _____.

a. based on unconscious classical conditioning
b. an innate human reflex
c. a sudden flash of understanding
d. an artifact of operant conditioning

2. When walking to your psychology class, you note that the path you normally take is blocked for construction, so you quickly choose an alternate route. This demonstrates that you've developed _____ of your campus.

a. a hidden, latent mastery
b. insight into the layout
c. a cognitive map
d. none of these options

3. Latent learning occurs without being rewarded and _____.

a. remains hidden until a future time when it is needed
b. is easily extinguished
c. serves as a discriminative stimuli
d. has been found only in nonhuman species

4. Bandura's observational learning studies focused on how _____.

a. rats learn cognitive maps through exploration
b. children learn aggressive behaviors by observing aggressive models
c. cats learn problem solving through trial and error
d. chimpanzees learn problem solving through reasoning

Think Critically

1. What are some examples of how insight learning has benefited you in your life?
2. Are there instances in which observational learning has worked to your advantage?

realworldpsychology

Does watching sex on TV increase the risk of teen pregnancies?

HINT: LOOK IN THE MARGIN FOR Q4

BIOLOGY OF LEARNING

LEARNING OBJECTIVES

RETRIEVAL PRACTICE While reading the upcoming sections, respond to each Learning Objective in your own words. Then compare your responses with those found at www.wiley.com/college/huffman.

1. **EXPLAIN** how learning changes the brain.
2. **DESCRIBE** the biological foundation for empathy.
3. **SUMMARIZE** the role of evolution in learning.

So far in this chapter, we have considered how external forces—from reinforcing events to our observations of others—affect learning. But we also know that for changes in behavior to persist over time, lasting biological changes must occur within the organism. In this section, we will examine neurological and evolutionary influences on learning.

Neuroscience and Learning

Each time we learn something, either consciously or unconsciously, that experience creates new synaptic connections and alterations in a wide network of our brain

Albert Bandura

Albert Bandura

FIGURE 6.14 BANDURA'S BOBO DOLL STUDY

biological, psychological, and social survival (the *biopsychosocial model*). Watching others helps us avoid dangerous stimuli in our environment, teaches us how to think and feel, and shows us how to act and interact socially (Hora & Klassen, 2012; Kalat, 2013).

Unfortunately, watching others also may lead to negative outcomes. For example, one correlational study found that teenagers who watched high levels of televised sexual content were twice as likely to become pregnant or get a partner pregnant within the next three years compared to teens who watched low levels of such behaviors (Chandra et al., 2008). Further research suggests that these unintended pregnancies may reflect the fact that mainstream media focuses on glamorized, casual sex, while ignoring its risks and consequences (Strasburger, 2010).

Much of our knowledge about the power of observational learning initially came from the work of Albert Bandura and his colleagues (Bandura, 2007; Bandura, Ross, & Ross, 1961; Bandura & Walters, 1963). Wanting to know whether children learn to be aggressive by watching others be aggressive, Bandura and his colleagues set up several experiments. They allowed children to watch a live or televised adult model punch, throw, and hit a large inflated Bobo doll **(Figure 6.14 top)**. Later, the children were allowed to play in the same room with the same Bobo doll. As Bandura hypothesized, children who had seen the live or televised aggressive model were much more aggressive with the Bobo doll than children who had not seen the modeled aggression **(Figure 6.14 bottom)**. In other words, "Monkey see, monkey do."

Thanks to the Bobo doll studies and his other experiments, Bandura established that observational learning requires at least four separate processes: *attention*, *retention*, *reproduction*, and *motivation* **(Figure 6.15)**.

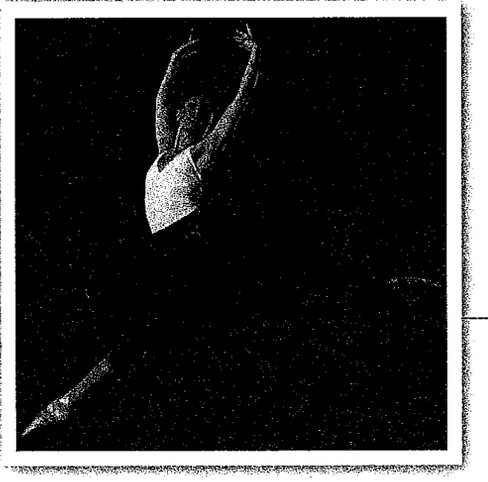
FIGURE 6.15 BANDURA'S FOUR KEY FACTORS IN OBSERVATIONAL LEARNING

A child wanting to become a premier ballerina would need to incorporate these four factors to maximize learning.

A Attention
Observational learning requires attention. This is why teachers insist on having students watch their demonstrations.

B Retention
To learn new behaviors, we need to carefully note and remember the model's directions and demonstrations.

Erik Isakson/Getty Images, Inc.



C Reproduction
Observational learning requires that we imitate the model.

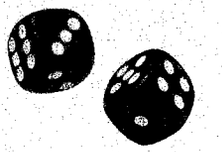
D Motivation
We are more likely to repeat a modeled behavior if the model is reinforced for the behavior (for example, with applause or other recognition).

Think Critically

1. You observe a parent yelling "No!" to his or her child who is screaming for candy in a supermarket. Given what you've learned about operant conditioning, can you predict how both the parent and the child will respond in similar future situations?
2. Can you think of a better alternative to yelling "No!"?

realworldpsychology

How can decreasing the cost of fruit and vegetables lead to healthier eating?



Why do gamblers have such trouble quitting, even when they continue to lose money?

HINT: LOOK IN THE MARGIN FOR Q2 AND Q3

COGNITIVE-SOCIAL LEARNING

LEARNING OBJECTIVES

RETRIEVAL PRACTICE While reading the upcoming sections, respond to each Learning Objective in your own words. Then compare your responses with those found at www.wiley.com/college/huffman.

1. **SUMMARIZE** the cognitive-social theory of learning.
2. **DESCRIBE** insight learning and latent learning.
3. **EXPLAIN** the principles of observational learning.

So far, we have examined learning processes that involve associations between a stimulus and an observable behavior. Although some behaviorists believe that almost all learning can be explained in such stimulus–response terms, other psychologists feel that all of learning can not be explained solely by operant and classical conditioning. **Cognitive-social learning theory** (also called cognitive-social learning or cognitive-behavioral theory) incorporates the general concepts of conditioning, but rather than relying on a simple S–R (stimulus and response) model, this theory emphasizes the interpretation or thinking that occurs within the organism: S–O–R (stimulus–organism–response).

Cognitive-social learning theory A theory that emphasizes the roles of thinking and social learning.

According to this view, humans have attitudes, beliefs, expectations, motivations, and emotions that affect learning. Furthermore, humans and many nonhuman animals also are social creatures that are capable of learning new behaviors through the observation and imitation of others. For example, children with at least one physically active parent are much more likely to be physically active themselves (Voss & Sandercock, 2013).

Insight and Latent Learning

Early behaviorists likened the mind to a "black box" whose workings could not be observed directly. German psychologist Wolfgang Köhler (1887-1967) wanted to look inside the box. He believed that there was more to learning—especially learning to solve a complex problem—than responding to stimuli in a trial-and-error fashion.

In one of a series of experiments, Köhler placed a banana just outside the reach of a caged chimpanzee. To reach the banana, the chimp had to use a stick placed near the cage to extend its reach. Köhler noticed that the chimp did not solve the problem in a random trial-and-error fashion. Instead, he seemed to sit and think about the situation for a while. Then, in a flash of **insight**, the chimp

Insight A sudden understanding or realization of how a problem can be solved.

TABLE 6.4 FOUR SCHEDULES OF PARTIAL (INTERMITTENT) REINFORCEMENT | realworldpsychology

		Definitions	Response rates	Example
Ratio schedules (response based)	**Fixed ratio (FR)**	Reinforcement occurs after a predetermined number of responses	High rate of response, but a brief drop-off just after reinforcement	You receive a free flight from your frequent flyer program after accumulating a given number of flight miles.
	Variable ratio (VR)	Reinforcement occurs after a varying number of responses	High response rate, no pause after reinforcement, and very resistant to extinction	Slot machines are designed to pay out after an average number of responses (maybe every 10 times), but any one machine may pay out on the first responses, then seventh, then the twentieth.
Interval schedules (time based)	**Fixed Interval (FI)**	Rainforcement occurs after the first response, following a fixed period of time	Responses tend to increase as the time for the next reinforcement is near, but drop off after reinforcement and during interval	You receive a monthly paycheck. Rat's behavior is reinforced with a food pellet when (or if) it presses a bar after 20 seconds have elapsed.
	Variable interval (VI)	Reinforcement occurs after the first response, following varying periods of time	Relatively low, but steady, response rates because respondents cannot predict when reward will come	Your professor gives pop quizzes at random times throughout the course. Rat's behavior is reinforced with a food pellet after a response and a variable unpredictable interval of time.

FIGURE 6.11 OPERANT CONDITIONING IN EVERYDAY LIFE | realworldpsychology

Reinforcement and punishment shape behavior in many aspects of our lives.

A Prejudice and discrimination
Although prejudice and discrimination show up early in life, children are not born believing others are inferior. What reinforcement might these boys receive for teasing this boy? Can you see how operant conditioning, beginning at an early age, can promote prejudice and discrimination?

B Superstition
Like prejudice and discrimination, we are not born being superstitious, these attitudes are learned—partly through operant conditioning. Knocking on wood for good fortune, a bride wearing "something old" at her wedding, or this baseball player placing gum on his helmet are all superstitious behaviors that generally develop from accidental reinforcement. For example, the baseball player might have once placed his gum on his helmet and then hit a home run. He then associated the gum with winning and continued the practice for all later games.

C Biofeedback
Biofeedback relies on operant conditioning to treat ailments such as anxiety and chronic pain. For example, chronic pain patients are sometimes connected to electrodes and watch a monitor screen with a series of flashing lights, or listen to different beeps, which display changes in their internal bodily functions. The patients then use the machine's "feedback," flashing lights or beeps, to gauge their progress as they try various relaxation strategies to receive corresponding relief from the pain of muscle tension.

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Duane Burleson/AP

Photo Researchers, Inc.

Is this positive or negative punishment?

Answer: It depends. If the child's behavior decreases, it would be negative punishment. Forcing him or her to sit in a chair away from other people and activities removes, or takes away (–), the opportunity to be near and interact with caregivers and/or playmates.

In sum, reinforcement and punishment can change behavior in laboratory settings, but evidence from real life suggests that these two approaches are not equal in their ease of application or effectiveness. Also, reinforcement is generally more ethical than punishment. However, punishment is sometimes necessary. If you decide to use it in cases of serious and potentially dangerous situations, keep in mind that punishment has at least seven important drawbacks:

1. **Passive aggressiveness** For the recipient, punishment often leads to frustration, anger, and possible aggression. But most of us have learned from experience that retaliatory aggression toward a punisher (especially one who is bigger and more powerful) is usually followed by more punishment. So instead, we may resort to subtle techniques, called *passive aggressiveness*, in which we deliberately show up late, "forget" to do an assigned chore, or complete the chore in a half-hearted way (Hopwood & Wright, 2012; Johnson, 2008).
2. **Avoidance behavior** No one likes to be punished, so we naturally try to avoid the punisher. If every time you come home a parent or spouse starts yelling at you, you will delay coming home—or will find another place to go.
3. **Inappropriate modeling** Have you ever seen a parent spank or hit his or her child for hitting another child? Ironically, the punishing parent may unintentionally serve as a "model" for the same behavior he or she is attempting to stop.
4. **Temporary suppression versus elimination** Punishment generally suppresses the behavior only temporarily, while the punisher is nearby.
5. **Learned helplessness** Research shows that nonhuman animals will fail to learn an escape response after experiencing inescapable aversive events (Jones et al., 2013; Maier, 1970; Seligman & Maier, 1967). Can you see how this phenomenon, known as *learned helplessness*, might explain, in part, why some people stay in abusive relationships (Miller et al., 2012)? Or why some students, who've experienced many failures in academic settings, might passively accept punishingly low grades, and/or engage in self-defeating behaviors, such as procrastination or minimal effort responses?
6. **Rewarded aggression** Because punishment often produces a decrease in undesired behavior, at least for the moment, the punisher is in effect rewarded for applying punishment.
7. **Perpetuated aggression** A vicious cycle may be established in which both the punisher and recipient are reinforced for inappropriate behavior—the punisher for punishing and the recipient for being fearful and submissive. This side effect partially explains the escalation of violence in family abuse and bullying (Anderson et al., 2008; Hamby & Grych, 2013; Miller et al., 2012).

Using this list of punishment's seven drawbacks, see if you can explain the following questions: Why do you think roommates, children, and spouses refuse to load the dishwasher despite repeated nagging? Why do drivers quickly slow down when they see a police car following behind and then quickly resume speeding once the police officer is out of sight? Given all the problems associated with punishment, why is it so often used?

The best answer to the dishwasher question may be item number 1—*passive aggressiveness*. The driver speeding up after the police officer leaves may be an example of number 4—*temporary suppression*. And the continued use of punishment, despite its drawbacks, may be best explained by the sixth and seventh points—*rewarded and perpetuated aggression*!

Premack principle The use of a naturally occurring high-frequency response to reinforce and increase low-frequency responses.

Primary punishers Any stimuli that decrease the probability of a response because of their innate, biological value, such as hunger and thirst.

Secondary punishers Any stimuli that decrease the probability of a response because of their learned value, such as poor grades or a parking ticket.

Positive punishment The addition (or presenting) of a stimulus, thereby weakening a response and making it less likely to recur.

Negative punishment The taking away (or removing) of a stimulus, thereby weakening a response and making it less likely to recur.

Interestingly, when you make yourself do some necessary but tedious task—say, paying bills—before letting yourself go to the movies, you are not only using positive reinforcement, you're also using the **Premack principle**. This principle is named after psychologist David Premack, who found that any naturally occurring, high-frequency response can be used to reinforce and increase low-frequency responses (Goldfield, 2012; Poling, 2010). Recognizing that you love to go to movies, you intuitively tie your less desirable, low-frequency activity (paying bills) to your high-frequency or highly desirable behavior (going to the movies).

It's very important to note that negative reinforcement is NOT punishment. The two concepts are actually completely opposite. Reinforcement (both positive and negative) *strengthens* a behavior, whereas punishment (both positive and negative) *weakens* a behavior. Knowing that this terminology is confusing, we encourage you to think of positive and negative in a *mathematical* sense. Instead of automatically assuming that positive means something "good" and negative means something "bad," recognize that, as in mathematics, positive is adding something [+], and negative is taking something away [–].

As with reinforcement, there are two kinds of punishers—primary and secondary, and two kinds of punishment—positive and negative.

Primary punishers are unmet innate, biological needs (e.g., hunger, thirst, discomfort). **Secondary punishers** are unmet learned needs (e.g., poor grades, bad hair day, loss of an election). In turn, **positive punishment** is the addition (+) of a stimulus that decreases (or weakens) the likelihood of the response occurring again. **Negative punishment** is the taking away (–) of a reinforcing stimulus, which decreases (or weakens) the likelihood of the response occurring again **(Table 6.3)**. (To check your understanding of the principles of reinforcement and punishment, see **Figure 6.9**.)

Keep in mind that punishment is a difficult, and tricky, concept that's difficult to use appropriately and effectively. We often think we're punishing, yet the behaviors continue. Similarly, we too often mistakenly think we're reinforcing when we're actually punishing. The key thing to remember is that punishment, by definition, is a process that adds or takes away something and causes a behavior to decrease. If

TABLE 6.3 HOW PUNISHMENT DECREASES (OR WEAKENS) BEHAVIOR | *psychology and you*

	POSITIVE PUNISHMENT **Stimulus added (+) and behavior decreases (or weakens)**	NEGATIVE PUNISHMENT **Stimulus taken away (–) and behavior decreases (or weakens)**
PRIMARY PUNISHERS *Unlearned, biological needs are not met*	A rat receives an electric shock when it crosses an electric grid. The addition of the shock decreases the likelihood that the rat will cross the electric grid in the future. You must run four extra laps on a hot day because you were late to your gym class. Adding the four extra laps makes it less likely that you'll be late for gym class in the future.	A hungry child is denied dessert because she refused to eat her dinner. The removal of the dessert option decreases the likelihood of the child refusing to eat her dinner in the future. You lose sleep for several nights because you didn't study ahead of time in order to prepare for your final exams. The loss of sleep makes it less likely that you'll be unprepared for future final exams.
SECONDARY PUNISHERS *Learned needs are not met*	A parent adds extra chores following a child's bad report card. The addition of the extra chores decreases the likelihood that the child will get a bad report card in the future. You study hard and still receive a low grade on your psychology exam. The addition of the low grade after studying hard decreases the likelihood that you will study hard the future.	A child's favorite toy is taken away because he/she disobeyed. The removal of the toy decreases the likelihood that the child will disobey in the future. Your bonus is taken away because of poor performance on your job. Removing the bonus makes it less likely that you'll turn in a poor performance in the future.


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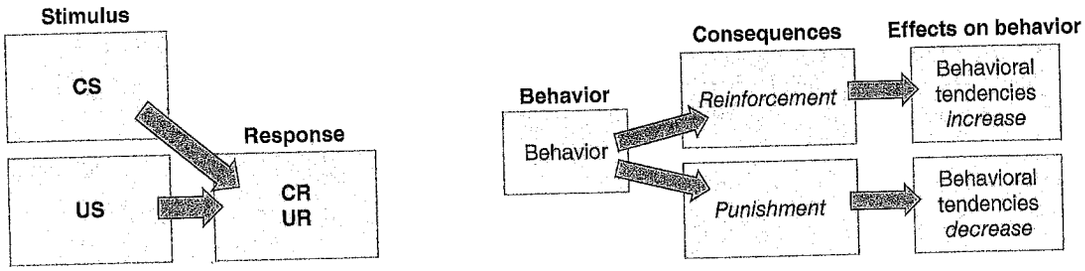
FIGURE 6.7 CLASSICAL VERSUS OPERANT CONDITIONING

Classical conditioning is based on involuntary behavior, whereas operant conditioning is based on voluntary behavior.



A Classical conditioning
The subject is passive and involuntarily pairs the originally neutral stimulus (NS) with an unconditioned stimulus (US), which produces a conditioned stimulus (CS) that leads to a learned, conditioned response (CR).

B Operant conditioning
The subject is active and voluntarily "operates" on the environment. The consequences (reinforcement or punishment) affect whether the behavior will increase or decrease.

Thankfully, operant conditioning principles can be used to change our negative health-related behaviors by reinforcing healthy choices and punishing unhealthy ones. For example, only allowing yourself to watch TV while exercising will improve your general physical health. And, several studies have shown that decreasing the cost of fruits and vegetables, while increasing the price of soda, can lead people to make healthier food and drink choices (Eyles et al., 2012). Similarly, increasing the cost of smoking—often by increasing taxes on cigarettes—reduces smoking rates (Cavazos-Rehg et al., 2012; Wilson et al., 2012). The effect of increased taxes on cigarettes is particularly true for heavy smokers, who pay considerably more due to their higher consumption, and for teenagers, who tend to have less discretionary income.

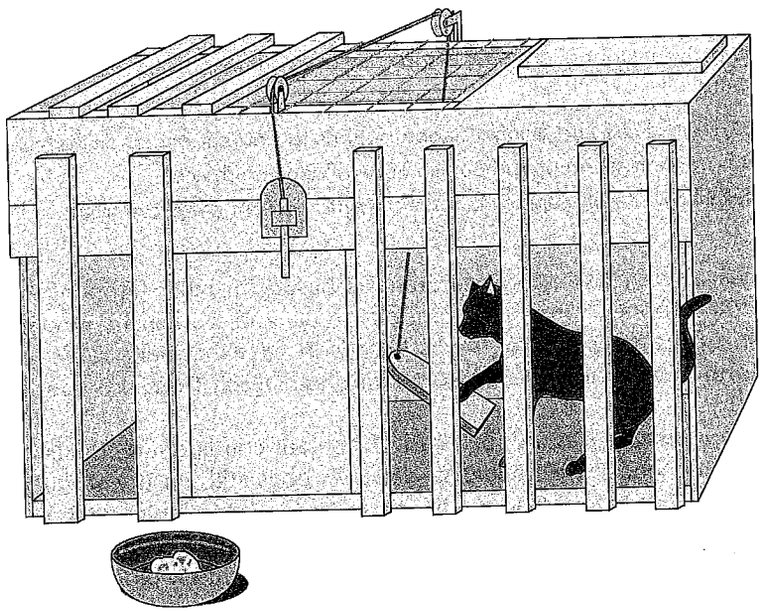
Beginnings of Operant Conditioning

Law of effect Thorndike's rule that responses that produce a satisfying effect are more likely to occur again, whereas those that produce a discomforting effect become less likely to occur again.

Edward Thorndike (1874–1949), a pioneer of operant conditioning, determined that the frequency of a behavior is modified by its consequences (Thorndike, 1911). Thorndike's **law of effect** was an important first step in understanding how consequences can modify active, voluntary behaviors **(Figure 6.8)**.

FIGURE 6.8 THORNDIKE'S LAW OF EFFECT

In his most famous experiment, Thorndike put a cat inside a specially built puzzle box. When the cat stepped on a pedal inside the box (at first, through trial and error), the door opened, and the cat could get out and eat. With each additional success, the cat's actions became more purposeful, and it soon learned to open the door immediately (Thorndike, 1898).

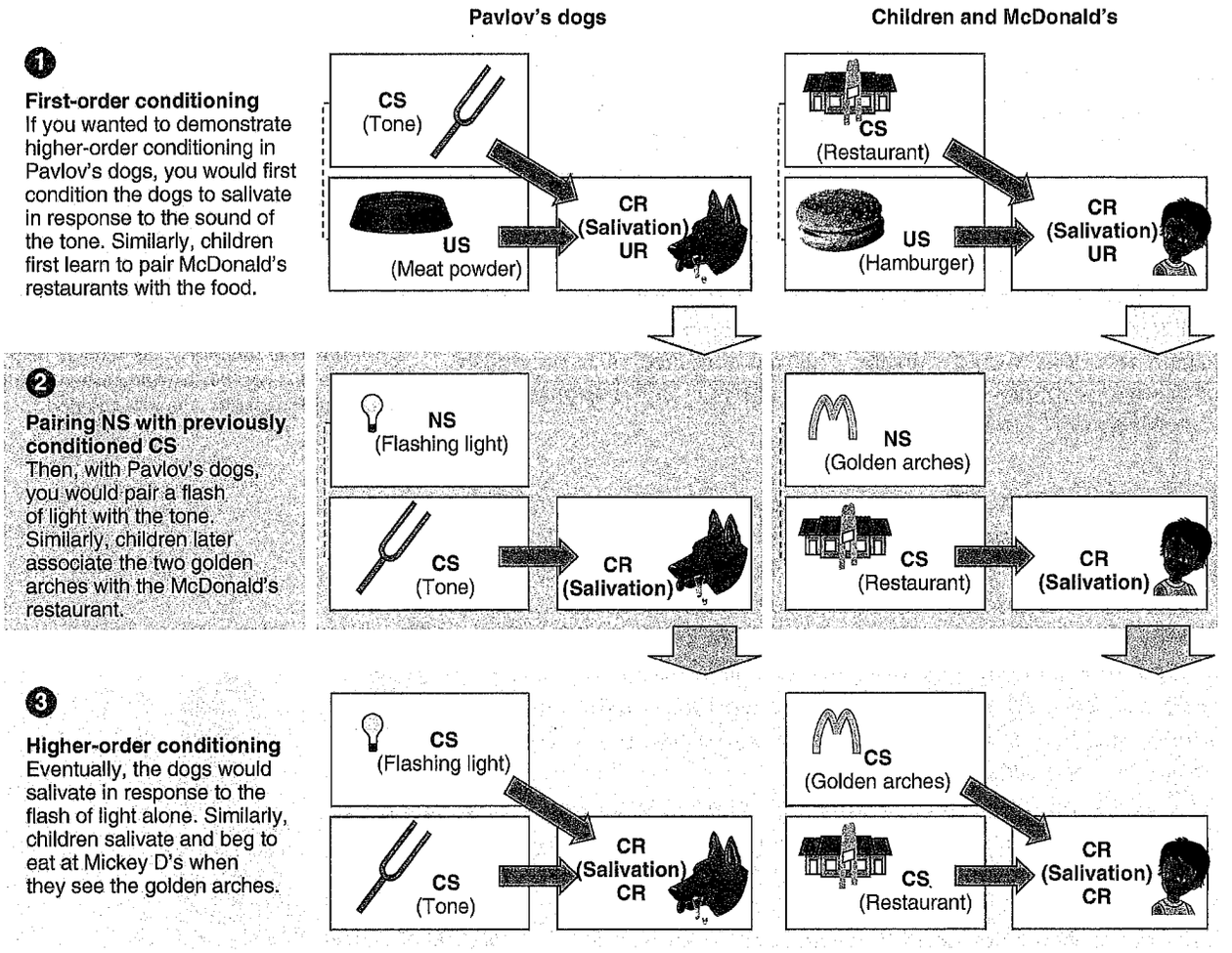


Higher-order conditioning A process in which a neutral stimulus (NS) becomes a conditioned stimulus (CS) through repeated pairings with a previously conditioned stimulus (CS).

Both spontaneous recovery and reconditioning help underscore why it can be so difficult for us to break bad habits (such as eating too much chocolate cake) or internalize new beliefs (such as egalitarian gender or racial beliefs). The phenomenon of **higher-order conditioning (Figure 6.6)** further expands our understanding of complex learned habits and associations.

FIGURE 6.6 THE POWER OF HIGHER-ORDER CONDITIONING | realworldpsychology

Children are not born salivating to the sight of McDonald's golden arches. So why do they beg adults to take them to "Mickey D's" after simply seeing an ad showing the golden arches? It's because of higher-order conditioning, which occurs when a neutral stimulus (NS) becomes a conditioned stimulus (CS) through repeated pairings with a previously conditioned stimulus (CS).



Voices from the Classroom

Cats and Classical Conditioning To review the major principles of classical conditioning, I use several examples based on a cat's eating behavior. *Basic, initial classical conditioning* = cat meows to the sound of a spoon banging on the side of a food bowl. *Higher-order conditioning* = meowing occurs when the spoon drawer is opened. *Generalization* = meowing occurs when any kitchen drawer is opened. *Discrimination* = meowing occurs when just the spoon drawer is opened. *Extinction* = cat slowly stops meowing because canned cat food is banned due to cat's health issues. *Spontaneous recovery* = one day cat suddenly meows after hearing a spoon bang the side of the food bowl or when the spoon drawer is opened.

Professor Jeffrey Henriques
University of Wisconsin
Madison, Wisconsin

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Are you afraid of dentists?

Principles of Classical Conditioning

Fear and avoidance of dental work is very common. How did it develop? Imagine being seated in a dental chair, and, even though the drill is nowhere near you, its sound can make you feel anxious. Your anxiety is obviously not innate. Little babies don't cringe at the sound of a dental drill. Your fear of the drill, and maybe dentistry in general, involves one or more of the six principles summarized in **Table 6.1**, and discussed in detail below. As you'll discover in Chapters 12 and 13, the good news is that even people with serious dental phobias can learn to overcome them (Elsesser et al., 2013). Q1

Acquisition, Stimulus Generalization, and Stimulus Discrimination

After Pavlov's original (accidental) discovery of classical conditioning, he conducted numerous experiments beyond the basic **acquisition** phase, a general term for the initial stage in classical conditioning in which the conditioned response (CR) is first elicited by the conditioned stimulus (CS).

One of his most interesting findings was that stimuli similar to the original conditioned stimulus (CS) also can elicit the conditioned response (CR). For example, after first conditioning dogs to salivate to the sound of low-pitched tones, Pavlov later demonstrated that the dogs would also salivate in response to higher-pitched tones. Similarly, after conditioning, the infant in Watson and Rayner's experiment ("Little Albert") feared not only rats but also a rabbit, a dog, and a bearded Santa Claus mask. This spreading or *generalizing* of the CR to similar stimuli, even though they have never been paired with the US, is called **stimulus generalization**.

In contrast, just as Pavlov's dogs learned to generalize and respond to similar stimuli, they also learned how to *discriminate* between similar stimuli. For example, when he gave the dogs food following a high-pitched tone, but not when he used a low-pitched tone, he found that they learned the difference between the two tones and only salivated to the high-pitched one. Likewise, Albert learned to recognize differences between rats and other stimuli, and presumably overcame his fear of Santa Claus. This ability to distinguish or discriminate between stimuli is known as **stimulus discrimination**.

Acquisition The initial stage in a classical conditioning experiment during which the conditioned stimulus (CS) elicits the conditioned response (CR).

Stimulus generalization The conditioned response (CR) is elicited not only by the conditioned stimulus (CS) but also by stimuli similar to the conditioned stimulus (CS).

Stimulus discrimination A conditioning process in which an organism learns to respond differently to stimuli that differ from the conditioned stimulus on some dimension.

TABLE 6.1 SIX PRINCIPLES AND APPLICATIONS OF CLASSICAL CONDITIONING | psychology and you

Process	Description	Example
Acquisition of basic classical conditioning	Process of learning a new response, in which the neutral stimulus (NS) and unconditioned stimulus (US) are first paired to produce the unconditioned response (UR); then the neutral stimulus (NS) becomes a conditioned stimulus (CS), eliciting a conditioned response (CR)	You learn to fear (CR) a dentist's drill (CS) because you associate it with the pain of your tooth extraction (US).
Stimulus generalization	Conditioned response (CR) is elicited not only by the conditioned stimulus (CS) but also by stimuli similar to the conditioned stimulus (CS)	You generalize your fear of the dentist's drill to your dentist's office and other dentists' offices.
Stimulus discrimination	Stimuli similar to the conditioned stimulus (CS) do not elicit the conditioned response (CR)	You are not afraid of your physician's office because you've learned to differentiate it from your dentist's office.
Extinction	Conditioned stimulus (CS) is presented alone, without the unconditioned stimulus (US); eventually the conditioned stimulus (CS) no longer elicits the conditioned response (CR)	You return several times to your dentist's office for routine checkups, with no dental drill; your fear (CR) gradually diminishes.
Spontaneous recovery	Sudden reappearance of a previously extinguished conditioned response (CR)	While watching a movie depicting dental drilling, your previous fear (CR) suddenly returns.
Higher-order conditioning	Neutral stimulus (NS) becomes a conditioned stimulus (CS) through repeated pairing with a previously conditioned stimulus (CS)	You fear just the sight of the sign outside your dentist's office, an originally neutral stimulus (NS). Why? It has become a conditioned stimulus (CS), associated with the previous conditioned stimulus (CS) of the dental drill.

Neutral stimulus (NS) A stimulus that, before conditioning, does not naturally bring about the response of interest.

Unconditioned stimulus (US) In classical conditioning, a stimulus that elicits an unconditioned response (UR) without previous conditioning.

Unconditioned response (UR) In classical conditioning, a learned reaction to an unconditioned stimulus (US) that occurs without previous conditioning.

Conditioned stimulus (CS) In classical conditioning, a previously neutral stimulus (NS) becomes conditioned through repeated pairings with an unconditioned stimulus (US), and it now elicits a conditioned response (CR).

Conditioned response (CR) In classical conditioning, a learned reaction to a conditioned stimulus (CS) that occurs because of previous repeated pairings with an unconditioned stimulus (US).

Conditioned emotional response (CER) Through classical conditioning, an emotion, such as fear, becomes a conditioned response to a previously neutral stimulus (NS).

STEP 1 Before conditioning, the sound of the tone does NOT lead to salivation, which makes the tone a **neutral stimulus (NS)**. Conversely, food naturally brings about salivation, which makes food an *unlearned*, **unconditioned stimulus (US)**. The initial reflex of salivation also is *unlearned*, so it is called an **unconditioned response (UR)**.

STEP 2 During conditioning, the tuning fork is repeatedly sounded right before the presentation of the meat (US).

STEP 3 After conditioning, the tone alone will bring about salivation. At this point, we can say that the dog is *classically conditioned*. The previously neutral stimulus (NS) (the tone) has now become a *learned*, **conditioned stimulus (CS)**, that produced a *learned*, **conditioned response (CR)** (the dog's salivation). (Note that the "R" in UR in Step 1 and the CR in this Step 3 refers to both "reflex" and "response.")

In sum, the overall goal of Pavlov's classical conditioning was for the dog to learn to associate the tone with the unconditioned stimulus (meat), and then to show the same response (salivation) to the tone as to the meat.

So what does a salivating dog have to do with your everyday life? Classical conditioning is a fundamental way that all animals, including humans, learn. The human feelings of excitement and/or compulsion to gamble, your love for your parents (or significant other), drooling at the sight of chocolate cake or pizza, and the almost universal fear of public speaking all largely result from classical conditioning.

How do we learn to be afraid of public speaking or of typically harmless things like mice and elevators? In a now-famous experiment, John Watson and Rosalie Rayner (1920) demonstrated how a fear of rats could be classically conditioned.

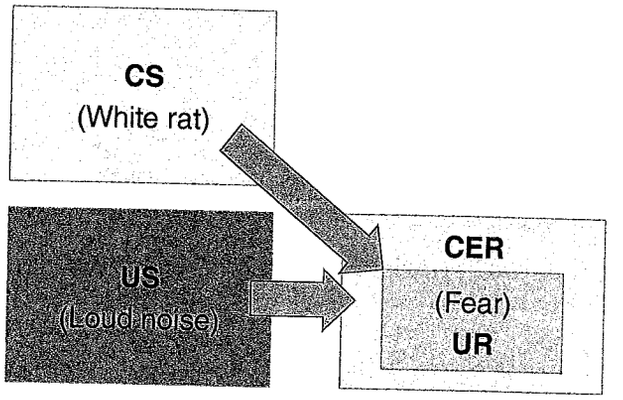
In this study, a healthy 11-month-old child, later known as "Little Albert," was first allowed to play with a white laboratory rat **(Figure 6.3)**. Like most other infants, Albert was curious and reached for the rat, showing no fear. Knowing that infants are naturally frightened by loud noises, Watson stood behind Albert and when he reached for the rat, Watson banged a steel bar with a hammer. The loud noise obviously frightened the child and made him cry. The rat was paired with the loud noise only seven times before Albert became classically conditioned and demonstrated fear of the rat even without the noise. The rat had become a CS that brought about the CR (fear).

Although this deliberate experimental creation of what's now called a **conditioned emotional response (CER)** remains a classic in psychology, it has been heavily criticized and would never be allowed under today's experimental guidelines

FIGURE 6.3 LITTLE ALBERT'S FEARS

Benjamin Harris

Ⓐ Watson and Rayner's famous "Little Albert" study demonstrated how some fears can originate through conditioning.



Ⓑ Using classical conditioning terms, we would say that the white rat (a neutral stimulus/NS) was paired with the loud noise (an unconditioned stimulus/US) to produce a conditioned emotional response (CER) in Albert, fear of the rat.

chapteroverview

Imagine yourself in the following situations:

On your way to campus, you note a bad traffic jam up ahead and quickly decide to try a new shortcut someone mentioned several weeks ago.

Later, in your general psychology class, you watch a video on service dogs for the blind, and are amazed by these dogs opening and closing doors, helping their owners dress and undress, carrying items in a backpack, and even differentiating between classrooms, bathrooms, escalators, and elevators.

While leaving campus, you note that the pitcher on your college's baseball team ritualistically kicks the dirt twice with each foot, then spits in his glove, and finally taps the top of his ball cap three times before throwing each pitch.

Now ask yourself, how did you manage that new shortcut to campus? How did those guide dogs perform such amazing acts? Why did the baseball pitcher engage in such strange, superstitious rituals? All three of these sets of behavior are clearly not genetic or present at the moment of birth. Instead, they result from *learning*.

We usually think of learning as classroom activities, such as math and reading, or as motor skills, like riding a bike or playing the piano. But for psychologists, learning is an all-encompassing process allowing us to adapt to our ever-changing environment. We learn that certain objects or events, such as food or pain, are associated with our survival (classical conditioning). We also learn to avoid punishing situations, and to repeat acts that bring rewards (operant conditioning). Finally, we learn through personal insights and from watching others (cognitive-social learning). Without the ability to learn, we simply could not exist.

In this chapter, we will study these three forms of learning, followed by the biology of learning, which explains how our brain and nervous system change when we learn.

CLASSICAL CONDITIONING

LEARNING OBJECTIVES

RETRIEVAL PRACTICE While reading the upcoming sections, respond to each Learning Objective in your own words. Then compare your responses with those found at www.wiley.com/college/huffman.

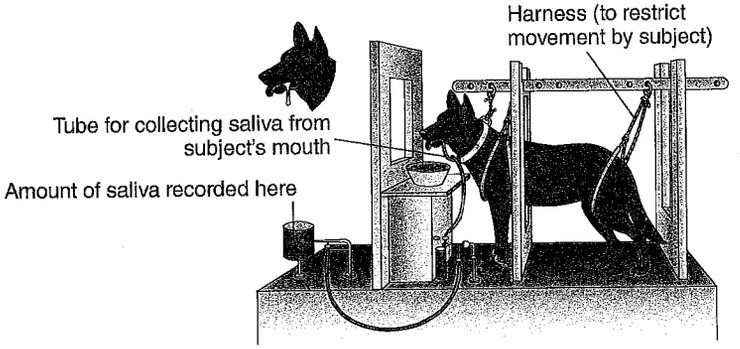
1. **DESCRIBE** Pavlov and Watson's contributions to our understanding of learning.
2. **EXPLAIN** the three steps in classical conditioning.
3. **SUMMARIZE** the six principles of classical conditioning.

Learning A relatively permanent change in behavior or mental processes caused by experience.

Before we go on, we need to operationally define **learning** *as a relatively permanent change in behavior or mental processes caused by experience.* This relative permanence applies not only to bad habits, like texting while driving or procrastinating, but also to useful behaviors and emotions, such as training guide dogs for the blind or falling in love.

We begin this chapter with a study of one of the earliest forms of learning, *classical conditioning*, made famous by Pavlov's salivating dogs.

FIGURE 6.1 PAVLOV'S EXPERIMENTAL SETUP

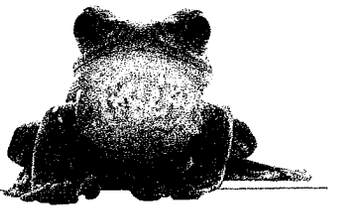


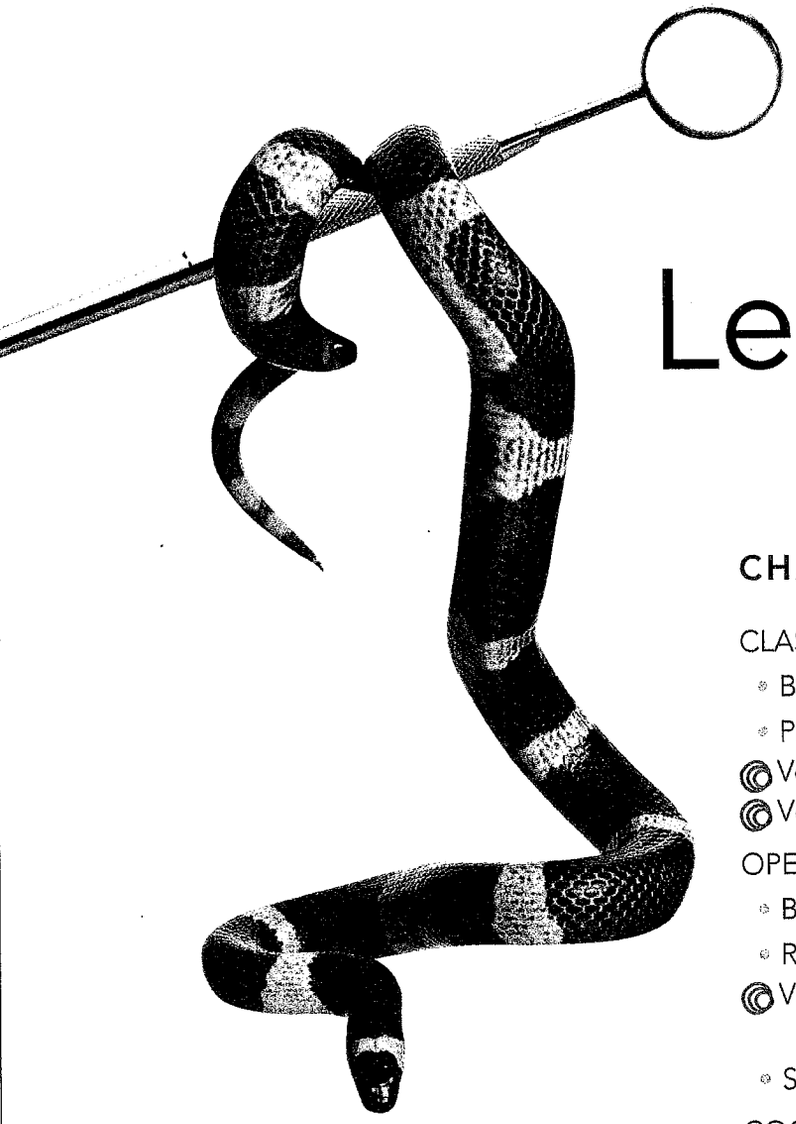
Beginnings of Classical Conditioning

Why does your mouth water when you stare at a large slice of delicious cake or a juicy steak? The answer to this question was accidentally discovered in the laboratory of Russian physiologist Ivan Pavlov (1849–1936). Pavlov's initial plan was to study the role of saliva in digestion by using a tube attached to dogs' salivary glands **(Figure 6.1)**.

During these experiments, one of Pavlov's students noticed that even before receiving the actual food, many dogs began salivating at the mere sight of the food, the food dish, the smell of the food, or even just the sight of the person who normally delivered the food! Pavlov's genius was in recognizing the importance of this

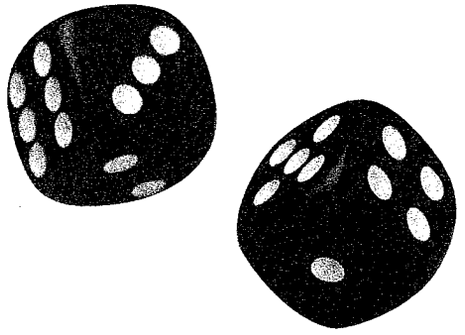
chapter six

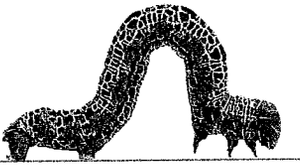




Learning

CHAPTER OUTLINE





Summary

1 CONSCIOUSNESS, SLEEP, AND DREAMING 124

- **Consciousness**, an organism's awareness of internal events and the external environment, varies in its depth and exists along a continuum. We spend most of our time in waking consciousness, but also in various **alternate states of consciousness (ASCs)**, such as sleep and dreaming.
- Many physiological functions follow 24-hour **circadian rhythms**. Disruptions in these rhythms, as well as long-term sleep deprivation, lead to increased fatigue, cognitive and mood disruptions, and other health problems.
- During a normal night's sleep, we progress through four distinct stages of **non-rapid-eye-movement (NREM) sleep**, with periods of **rapid-eye-movement (REM) sleep** generally occurring at the end of each sleep cycle. Both REM and NREM sleep are important for our biological functioning.
- There are four major theories about why we sleep. **Adaptation/protection theory** proposes that sleep evolved to conserve energy and to provide protection from predators. The **repair/restoration theory** suggests that sleep helps us recuperate from the day's events. The **growth/development theory** argues that we use sleep for growth. The **learning/memory theory** says that we use sleep for consolidation, storage, and maintenance of memories.
- Three major theories about why we dream are Freud's **wish-fulfillment view**, the **activation–synthesis hypothesis**, and the **cognitive view**.
- Sleep–wake disorders include **insomnia**, **narcolepsy**, **sleep apnea**, **nightmares**, and **sleep terrors**. Natural sleep aids, based on behavior therapy, are helpful ways to treat sleep-wake disorders and avoid problems associated with medication.

2 PSYCHOACTIVE DRUGS 136

- **Psychoactive drugs** influence the nervous system in a variety of ways. Alcohol affects neural membranes throughout the entire nervous system. Most psychoactive drugs act in a more specific way, by either enhancing a particular neurotransmitter's effect—an **agonist drug**—or inhibiting it—an **antagonist drug**.
- The term **drug abuse** refers to drug-taking behavior that causes emotional or physical harm to oneself or others. **Addiction** refers to a condition in which a person feels compelled to use a specific drug. **Psychological dependence** refers to the mental desire or craving to achieve a drug's effects. **Physical dependence** refers to biological changes that make a drug necessary for minimum daily functioning, and **withdrawal** symptoms. Repeated use of a drug can produce decreased sensitivity, or **tolerance**. Sometimes, using one drug increases tolerance for another (**cross-tolerance**).
- Psychologists divide psychoactive drugs into four categories: **depressants** (such as alcohol, barbiturates, Rohypnol, and Ketamine), **stimulants** (such as caffeine, nicotine, cocaine, and amphetamines), **opiates** (such as morphine, heroin, and codeine), and **hallucinogens** (such as marijuana and LSD). Almost all psychoactive drugs may cause serious health problems and, in some cases, even death.

3 MEDITATION AND HYPNOSIS 144

- **Meditation** refers to techniques designed to focus attention, block out distractions, and produce an alternate state of consciousness. Researchers have verified that it can produce dramatic changes in basic physiological processes.
- Modern research has removed the mystery surrounding **hypnosis**, a trance-like state of heightened suggestibility, deep relaxation, and intense focus. It is used in psychotherapy and medicine, and it is especially useful for those with a high degree of anxiety, fear, and misinformation.

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applyingrealworldpsychology

We began this chapter with five intriguing Real World Psychology questions, and you were asked to revisit these questions at the end of each section. Questions like these have an important and lasting impact on all of our lives. See if you can answer these additional critical thinking questions related to real world examples.

1. In which stage of sleep is the kitten in each photo, and how do you know?
2. Why might REM sleep serve an important adaptive function for cats?
3. Imagine that someone marketed a drug that allowed you to get complete rest and recuperation from only one hour of sleep, but it stopped you from dreaming. Would you take the drug? Why or why not?
4. Why do you think Freud's dream theory remains so popular, despite serious scientific questions and alternative modern theories?
5. Why do you think alcohol is more popular and culturally acceptable than the other drugs discussed in this chapter?
6. What are some possible ethical considerations of using hypnosis?

Hypnosis

Relax . . . your eyelids are so very heavy . . . your muscles are becoming more and more relaxed . . . your breathing is becoming deeper and deeper . . . relax . . . your eyes are closing . . . let go . . . relax.

Hypnosis An alternate state of consciousness characterized by deep relaxation and a trance-like state of heightened suggestibility and intense focus.

Hypnotists use suggestions like these to begin **hypnosis**, a trance-like state of heightened suggestibility, deep relaxation, and intense focus. Once hypnotized, some people can be convinced that they are standing at the edge of the ocean, listening to the sound of the waves and feeling the ocean mist on their faces. Invited to eat a "delicious apple" that is actually an onion, the hypnotized person may relish the flavor. Told they are watching a very funny or sad movie, hypnotized people may begin to laugh or cry at their self-created visions.

From the 1700s to modern times, entertainers and quacks have used (and abused) hypnosis **(Table 5.5)**, but physicians, dentists, and therapists also have long employed it as a respected clinical tool. Modern scientific research has removed much of the mystery surrounding hypnosis. A number of features characterize the hypnotic state (Jamieson & Hasegawa, 2007; Jensen et al., 2008; Robertson, 2013):

- Narrowed, highly focused attention (ability to "tune out" competing sensory stimuli)
- Increased use of imagination and hallucinations
- A passive and receptive attitude
- Decreased responsiveness to pain
- Heightened suggestibility, or a greater willingness to respond to proposed changes in perception ("This onion is an apple")

Today, even with available anesthetics, hypnosis is occasionally used in surgery and for the treatment of cancer, chronic pain and severe burns (Jensen et al., 2008, 2011; Montgomery et al., 2013; Nusbaum et al., 2011; Smith, 2011). Hypnosis has found its best use in medical areas such as dentistry and childbirth, where patients have a high

TABLE 5.5 HYPNOSIS MYTHS AND FACTS

Myth	Fact
Faking Hypnosis participants are "faking it" and playing along with the hypnotist.	There are conflicting research positions about hypnosis. Although most participants are not consciously faking hypnosis, some researchers believe the effects result from a blend of conformity, relaxation, obedience, suggestion, and role playing. Other theorists believe that hypnotic effects result from a special altered state of consciousness. A group of "unified" theorists suggests that hypnosis is a combination of both relaxation/role playing and a unique alternate state or consciousness.
Forced hypnosis People can be hypnotized against their will or hypnotically "brainwashed."	Hypnosis requires a willing, conscious choice to relinquish control of one's consciousness to someone else. The best potential subjects are those who are able to focus attention, are open to new experiences, and are capable of imaginative involvement or fantasy.
Unethical behavior Hypnosis can make people behave immorally or take dangerous risks against their will.	Hypnotized people retain awareness and control of their behavior, and they can refuse to comply with the hypnotist's suggestions.
Superhuman strength Under hypnosis, people can perform acts of special superhuman strength.	When nonhypnotized people are simply asked to try their hardest on tests of physical strength, they generally can do anything that a hypnotized person can do.
Exceptional memory Under hypnosis, people can recall things they otherwise could not.	Although the heightened relaxation and focus that hypnosis engenders improves recall for some information, it adds little (if anything) to a regular memory. Hypnotized people are just more willing to guess. Because memory is normally filled with fabrication and distortion (Chapter 7), hypnosis generally increases the potential for error.

Sources: Hilgard, 1978, 1992; Lilienfeld et al., 2010; Lynn et al., 2010; Montgomery et al., 2013; Orne, 2006; Terhune et al., 2011; Wickramasekera, 2008.

RETRIEVAL PRACTICE: PSYCHOACTIVE DRUGS

Self-Test

Completing this self-test and comparing your answers with those in Appendix B provides immediate feedback and helpful practice for exams. Additional interactive, self-tests are available at www.wiley.com/college/huffman.

1. Psychoactive drugs _____.

a. change conscious awareness, mood, or perception
b. are addictive, mind altering, and dangerous to your health
c. are illegal unless prescribed by a medical doctor
d. all these options

2. Depressants include all the following *except* _____.

a. antianxiety drugs
b. alcohol
c. tobacco
d. Rohypnol

3. _____ drugs inhibit normal synaptic transmission, whereas _____ drugs enhance synaptic transmission.

a. Antagonist; agonist
b. Agonist; antagonist
c. Protagonist; agonist
d. Protagonist; co-agonist

4. Drug taking that causes emotional or physical harm to the drug user or others is known as _____.

a. addiction
b. physical dependence
c. psychological dependence
d. drug abuse

Think Critically

1. Which is more important in creating addiction—physical dependence or psychological dependence?
2. Do you think marijuana use should be legal? Why or why not?

realworldpsychology

Are you addicted to Facebook?

Can using marijuana decrease your IQ?

HINT: LOOK IN THE MARGIN FOR Q3 AND Q4

MEDITATION AND HYPNOSIS

LEARNING OBJECTIVES

RETRIEVAL PRACTICE While reading the upcoming sections, respond to each Learning Objective in your own words. Then compare your responses with those found at www.wiley.com/college/huffman.

1. **DESCRIBE** the effect of meditation on the nervous system.
2. **EXPLAIN** the features of the hypnotic state.

As we have seen, factors such as sleep, dreaming, and psychoactive drug use can create altered states of consciousness. Changes in consciousness also can be achieved by means of meditation and hypnosis.

Meditation

"Suddenly, with a roar like that of a waterfall, I felt a stream of liquid light entering my brain through the spinal cord . . . I experienced a rocking sensation and then felt myself slipping out of my body, entirely enveloped in a halo of light. I felt the point of consciousness that was myself growing wider, surrounded by waves of light" (Krishna, 1999, pp. 4–5).

This is how spiritual leader Gopi Krishna described his experience with **meditation**, a group of techniques designed to focus attention, block out distractions, and produce an altered state of awareness **(Figure 5.12)**. Most people in the beginning stages of meditation report a simpler, mellow type of relaxation, followed by a mild euphoria and a sense of timelessness. Some advanced meditators report experiences of profound rapture, joy, and/or strong hallucinations.

Meditation A group of techniques designed to alter consciousness; it's believed to enhance self-knowledge and well-being through reduced self-awareness.

Voices from the Classroom

Exercise, Marijuana, and Chocolate When discussing the benefits of exercise for stress relief, and the role of endorphins, I ask my students if they've heard the term "anandamide." Almost everyone say no. They're surprised to learn that it's a naturally produced neurotransmitter, like endorphins, which is released during exercise. And I tell them about a recent study that found male athletes who warmed up and cooled down and exercised for 45 minutes at 70% effort increased their anandamide release by 80%. They're even more surprised when I explain that anandamides bind to the same brain receptors as do the cannabinoid (THC/ marijuana) molecules. In that dark chocolate also has been found to promote anandamide release, I conclude the discussion by providing dark chocolate for the entire class.

Professor Jan Mendoza
Golden West College
Huntington Beach, California

Some research has found marijuana to be therapeutic in treating glaucoma (an eye disease), alleviating the nausea and vomiting associated with chemotherapy, and dealing with other health problems (Borgelt et al., 2013; Green & De-Vries, 2010; Hart & Ksir, 2013).

Despite many states now legalizing marijuana for either medical or recreational use, chronic marijuana use, however, can lead to throat and respiratory disorders, impaired lung functioning and immune response, declines in testosterone levels, reduced sperm count, and disruption of the menstrual cycle and ovulation (Hall & Degenhardt, 2010; Karavolos et al., 2013; Rooke et al., 2013; Skinner et al., 2011).

Marijuana use is also associated with decreases in IQ. Researchers in one study examined IQ in a sample of more than 1,000 13-year-olds and then retested their IQs 25 years later (Meier et al., 2012). Findings revealed that teenagers who started smoking marijuana before age 18 and were addicted to this drug by age 38 showed decreases in IQ points, including drops of as much as 8 points for those who reported the heaviest use. Although some research supports the popular belief that marijuana serves as a "gateway" to other illegal drugs, other studies find little or no connection (Hart & Ksir, 2013; Kirisci et al., 2013; Panlilio et al., 2013).

Marijuana also can be habit forming, but few users experience the intense cravings associated with cocaine or opiates. Withdrawal symptoms are mild because the drug dissolves in the body's fat and leaves the body very slowly, which explains why a marijuana user can test positive for days or weeks after the last use. Q4

Club Drugs

As you can see in **Figure 5.11**, and may know from television or newspapers, psychoactive drugs like Rohypnol (the "date rape drug," also called "roofies") and MDMA (3,4-methylenedioxymethylamphetamine, or "ecstasy") are among our nation's most popular drugs of abuse. Other "club" drugs, like GHB (gamma-hydroxybutyrate), Ketamine ("special K"), methamphetamine ("ice" or "crystal meth"), and LSD, are also gaining in popularity (DeMaria, 2012; Hopfer, 2011; Shimane et al., 2013; van Laar, 2012). However, these drugs can have very serious consequences. For example, recreational use of "ecstasy" is associated with a reduction in the neurotransmitter serotonin in the brain, which can lead to problems regulating mood, appetite, sleep, learning, and memory. Its use can also lead to death (Di Iorio et al., 2012).

One of the most threatening recent trends in club drugs is the swallowing, injecting, or snorting of synthetic stimulants, called "bath salts," which are currently legally sold in small packets. Although marked "not for human ingestion," they are increasingly popular among those associated with the dance music scene. Widely available on the Internet and marketed with enticing names such as"White Lightning" or "Lovey Dovey," these bath salts produce cocaine or ecstasy-like effects. But they're far more toxic. Following reports of cases like Neil Brown, who slit his face and stomach repeatedly with a skinning knife after using bath salts, and numerous overdoses or deaths, several states now ban their sale (Baumann et al., 2013; Oz, 2011; Winder et al., 2013).

In addition, club drugs, like all illicit drugs, are particularly dangerous because there are no truth-in-packaging laws to protect buyers from unscrupulous practices. Sellers often substitute unknown cheaper, and possibly even more dangerous, substances for the ones they claim to be selling. Also, club drugs (like most psychoactive drugs) affect the motor coordination, perceptual skills, and reaction time necessary for safe driving.

Impaired decision making is a serious problem as well. Just as "drinking and driving don't mix," club drug use may lead to risky sexual behaviors and increased risk of sexually transmitted infections. Add in the fact that some drugs, like Rohypnol, are odorless, colorless, tasteless, and can easily be added to beverages by individuals who want to intoxicate or sedate others, and you can see that the dangers of club drug use go far beyond the drug itself.

TEST YOURSELF: WHAT'S YOUR ALCOHOL IQ?

psychology and you

TRUE OR FALSE?

___ **1.** Alcohol increases sexual desire.

___ **2.** Alcohol helps you sleep.

___ **3.** Alcohol kills brain cells.

___ **4.** It's easier to get drunk at high altitudes.

___ **5.** Switching among different types of alcohol is more likely to lead to drunkenness.

___ **6.** Drinking coffee and taking a cold shower are great ways to sober up after heavy drinking.

___ **7.** Alcohol warms the body.

___ **8.** You can't become an alcoholic if you drink only beer.

___ **9.** Alcohol's primary effect is as a stimulant.

___ **10.** People experience impaired judgment after drinking only if they show obvious signs of intoxication.

Answers: All these statements are false. Detailed answers are provided in this chapter and in Lilienfeld et al., 2010.

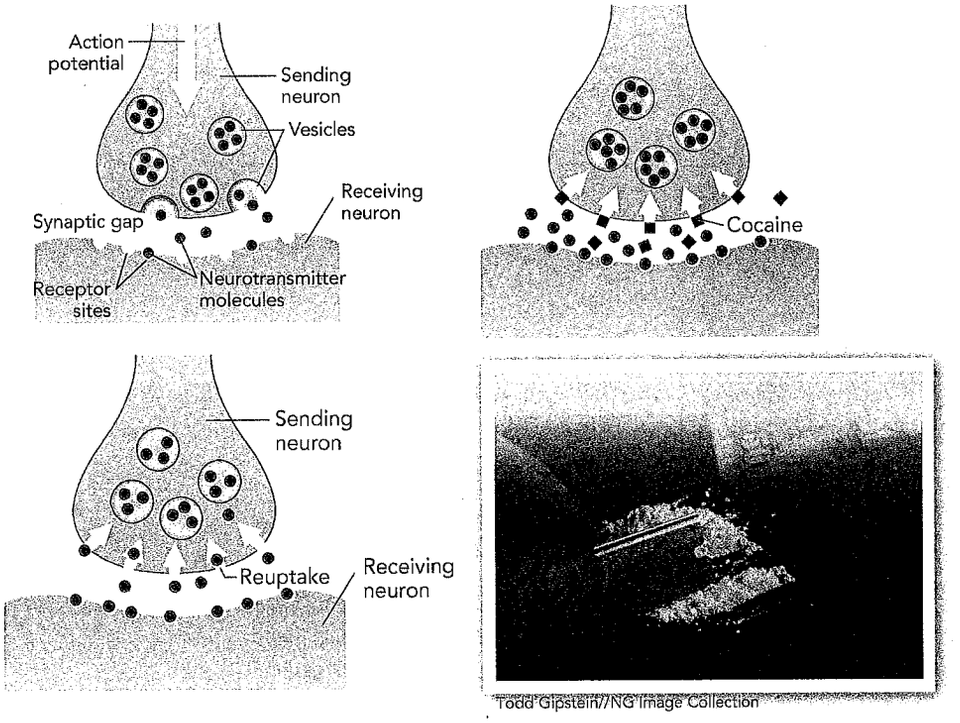
Stimulant A drug that increases overall activity and general responsiveness.

Depressants suppress central nervous system activity, whereas **stimulants**, or "uppers," increase the overall activity and responsiveness of the central nervous system.

Cocaine is a powerful central nervous system stimulant extracted from the leaves of the coca plant. It produces feelings of alertness, euphoria, well-being, power, energy, and pleasure. But it also acts as an *agonist drug* to block the reuptake of our body's natural neurotransmitters that produce these same effects **(Figure 5.9)**.

Although cocaine was once considered a relatively harmless "recreational drug," even small initial doses can be fatal because cocaine interferes with the electrical system of the heart, causing irregular heartbeats and, in some cases, heart failure. It also can produce heart attacks, hypertension, and strokes by temporarily constricting blood vessels (Abadinsky, 2014; Kontak & Vongpatanasin, 2013; NIDA, 2010; Vidal et al., 2012), as well as cognitive declines and brain atrophy (Ersche et al., 2012). The most dangerous form of cocaine is the smokable, concentrated version known as "crack," or "rock." Its lower price makes it affordable and attractive to a large audience. And its greater potency makes it more highly addictive.

FIGURE 5.9 COCAINE: AN AGONIST DRUG IN ACTION



Todd Gipstein/NG Image Collection

A The two figures depict how after releasing neurotransmitter into the synapse, the sending neuron normally reabsorbs (or reuptakes) excess neurotransmitter back into the terminal buttons.

B This figure shows that when cocaine is present in the synapse, it will block the reuptake of dopamine, serotonin, and norepinephrine, and levels of these substances will increase. The result is overstimulation and a brief euphoric high. When the drug wears off, the depletion of neurotransmitters may cause the drug user to "crash."

Tolerance The bodily adjustment to continued use of a drug in which the drug user requires greater dosages to achieve the same effect.

Keep in mind that psychological dependence is no less damaging than physical dependence. The craving in psychological dependence can be strong enough to keep the user in a constant drug-induced state—and to lure an addict back to a drug habit long after he or she has overcome physical dependence. After repeated use of a drug, many of the body's physiological processes adjust to higher and higher levels of the drug, producing a decreased sensitivity called **tolerance**.

Tolerance leads many users to escalate their drug use and experiment with other drugs in an attempt to re-create the original pleasurable altered state. Sometimes using one drug increases tolerance for another, a result known as *cross-tolerance.* Developing tolerance or cross-tolerance does not prevent drugs from seriously damaging the brain, heart, liver, and other organs.

Four Drug Categories

Psychologists divide psychoactive drugs into four broad categories: depressants, stimulants, opiates, and hallucinogens **(Table 5.3)**.

TABLE 5.3 EFFECTS OF THE MAJOR PSYCHOACTIVE DRUGS

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TAYLOR S. KENNEDY/NG Image Collection

SAM ABELL/NG Image Collection

Uwe Schmid/OKAPIA/ Photo Researchers

JOEL SARTORE//NG Image Collection

Category	Desired Effects	Undesirable Effects
Depressants (sedatives) Alcohol, barbiturates, anxiolytics (antianxiety or tranquilizing drugs), alprazolam (xanax), flunitrazepam (rohypnol, "date-rape drug," "roofies"), ketamine (special K), gamma-hydroxybutyrate (GHB)	Tension reduction, euphoria, disinhibition, drowsiness, muscle relaxation	Anxiety, nausea, disorientation, impaired reflexes and motor functioning, amnesia, loss of consciousness, shallow respiration, convulsions, coma, death
Stimulants Cocaine, amphetamine, methamphetamine (crystal meth), MDMA (ecstasy)	Exhilaration, euphoria, high physical and mental energy, reduced appetite, perceptions of power, sociability	Irritability, anxiety, sleeplessness, paranoia, hallucinations, psychosis, elevated blood pressure and body temperature, convulsions, death
Caffeine	Increased alertness	Insomnia, restlessness, increased pulse rate, mild delirium, ringing in the ears, rapid heartbeat
Nicotine	Relaxation, increased alertness, sociability	Irritability, increased blood pressure, stomach pains, vomiting, dizziness, cancer, heart disease, emphysema
Opiates (narcotics) Morphine, heroin, codeine, oxycodone	Euphoria, "rush" of pleasure, pain relief, prevention of withdrawal, sleep	Nausea, vomiting, constipation, painful withdrawal, shallow respiration, convulsions, coma, death
Hallucinogens (psychedelics) Lysergic acid diethylamide (LSD), mescaline (extract from the peyote cactus), psilocybin (extract from mushrooms)	Heightened aesthetic responses, euphoria, mild delusions, hallucinations, distorted perceptions and sensation	Panic, nausea, longer and more extreme delusions, hallucinations, perceptual distortions ("bad trips"), psychosis
Marijuana	Relaxation, mild euphoria, nausea relief	Perceptual and sensory distortions, hallucinations, fatigue, increased appetite, lack of motivation, paranoia, possible psychosis

RETRIEVAL PRACTICE: CONSCIOUSNESS, SLEEP, AND DREAMING

Self-Test

Completing this self-test and comparing your answers with those in Appendix B provides immediate feedback and helpful practice for exams. Additional interactive, self-tests are available at www.wiley.com/college/huffman.

1. *Consciousness* is defined as _____.

a. ordinary and extraordinary wakefulness
b. an organism's awareness of internal events and of the external environment
c. mental representations of the world in the here and now
d. any mental state that requires thinking and processing of sensory stimuli

2. *Circadian rhythms* are _____.

a. patterns that repeat themselves on a twice-daily schedule
b. physical and mental changes associated with the cycle of the moon
c. circulating sleep processes in your brain
d. biological changes that occur on a 24- to 25-hour cycle

3. The sleep stage marked by irregular breathing, eye movements, high-frequency brain waves, and dreaming is called _____ sleep.

a. beta
b. hypnologic
c. REM
d. transitional

4. The _____ theory says that sleep allows us to replenish what was depleted during daytime activities.

a. repair/restoration
b. evolutionary/circadian
c. supply-demand
d. conservation of energy

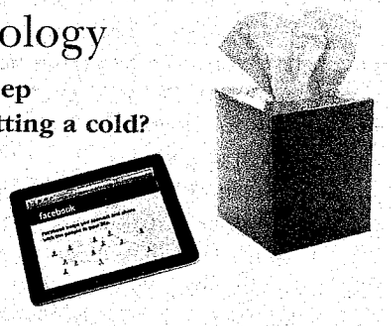
Think Critically

1. How are you affected by sleep deprivation and disruption of your circadian rhythms?
2. Which of the major theories of dreaming best explains your own dreams?

realworldpsychology

Can getting too little sleep increase your risk of getting a cold?

Can using a computer or an iPad late at night make it harder to fall asleep?



HINT: LOOK IN THE MARGIN FOR (Q1) AND (Q2)

PSYCHOACTIVE DRUGS

LEARNING OBJECTIVES

RETRIEVAL PRACTICE While reading the upcoming sections, respond to each Learning Objective in your own words. Then compare your responses with those found at www.wiley.com/college/huffman.

1. **EXPLAIN** how psychoactive drugs affect nervous system functioning.
2. **COMPARE** the four major categories of psychoactive drugs.
3. **DESCRIBE** the effects of club drugs on the nervous system.

Psychoactive drug A chemical that changes mental processes and conscious awareness, mood, and/or perception.

Agonist drug A drug that binds to a receptor and triggers a response in the cell, which mimics or enhances a neurotransmitter's effect.

Antagonist drug A drug that binds to a receptor and triggers a response in the cell, which blocks a neurotransmitter's effect.

Have you noticed how difficult it is to have a logical, nonemotional discussion about drugs? In our society, where the most popular **psychoactive drugs** are caffeine, tobacco, and ethyl alcohol, people often become defensive when these drugs are grouped with illicit drugs such as marijuana and cocaine. Similarly, marijuana users are disturbed that their drug of choice is grouped with "hard" drugs like heroin. Most scientists believe that there are good and bad uses of all drugs. The way drug use differs from drug abuse and how chemical alterations in consciousness affect a person, psychologically and physically, are important topics in psychology.

Alcohol, for example, has a diffuse effect on neural membranes throughout the nervous system. Most psychoactive drugs, however, act in a more specific way: by either enhancing a particular neurotransmitter's effect, as does an **agonist drug**, or inhibiting it, as does an **antagonist drug (Figure 5.7)**.

Fortunately, there are many effective strategies for alleviating sleep problems without medication. For example, did you know that you should not use your computer right before you try to fall asleep because it can make it harder to get to sleep (Wood et al., 2012)? Exposure to light from the electronic screens of a computer or a tablet reduces the level of melatonin in the body by about 22%, which makes it more difficult to fall asleep (especially for teenagers). See the following *Psychology and You* section for other recommendations about getting and staying asleep.

NATURAL SLEEP AIDS

psychology and you

Are you wondering what research recommends for sleep problems? Behavior therapy offers consistent benefits that you can apply in your own life (Constantino et al., 2007; Smith et al., 2005). For example, when you're having a hard time going to sleep, don't keep checking the clock and worrying about your loss of sleep. Instead, remove all TVs, stereos, and books and limit the use of your bedroom to sleep rather than reading, watching movies, checking e-mail, and the like. If you need additional help, try some of the following suggestions.

During the Day

Exercise. Daily physical activity works away tension. But don't exercise vigorously late in the day, or you'll get fired up instead.

Keep regular hours. An erratic schedule can disrupt biological rhythms. Get up at the same time each day.

Avoid stimulants. Coffee, tea, soft drinks, chocolate, and some medications contain caffeine. Nicotine may be an even more potent sleep disrupter.

Avoid late meals and heavy drinking. Overindulgence can interfere with your normal sleep pattern.

Stop worrying. Focus on your problems at a set time earlier in the day.

Use presleep rituals. Follow the same routine every evening: listen to music, write in a diary, meditate.

Practice yoga. These gentle exercises help you relax.

In Bed

Use progressive muscle relaxation. Alternately tense and relax various muscle groups.

Use fantasies. Imagine yourself in a tranquil setting. Feel yourself relax.

Use deep breathing. Take deep breaths, telling yourself you're falling asleep.

Try a warm bath. This can induce drowsiness because it sends blood away from the brain to the skin surface.

Narcolepsy The sudden and irresistible compulsion to sleep during the daytime. (*Narco* means "numbness," and *lepsy* means "seizure.")

Narcolepsy, a sleep disorder characterized by sudden and irresistible onsets of sleep during normal waking hours, afflicts about 1 person in 2,000 and generally runs in families (Kotagal & Kumar, 2013; Pedrazzoli et al., 2007; Raggi et al., 2011). During an attack, REM-like sleep suddenly intrudes into the waking state of consciousness. Victims may experience sudden, incapacitating attacks of muscle weakness or paralysis (known as cataplexy). They may even fall asleep while walking, talking, or driving a car. Although long naps each day and stimulant or antidepressant drugs can help reduce the frequency of attacks, both the causes and cure of narcolepsy are still unknown **(Figure 5.5)**.

Sleep apnea A sleep disorder of the upper respiratory system that causes a repeated interruption of breathing during sleep; it also leads to loud snoring or poor-quality sleep and excessive daytime sleepiness.

Perhaps the most serious sleep disorder is **sleep apnea**. People with sleep apnea may fail to breathe for a minute or longer and then wake up gasping for breath. When they do breathe during their sleep, they often snore. Sleep apnea seems to result from blocked upper airway passages and/or the brain's failure to send signals to the diaphragm, thus causing breathing to stop.

Unfortunately, people with sleep apnea are often unaware they have this disorder, and fail to understand how their repeated awakening during the night leave them feeling tired and sleepy during the day. More importantly, they should know that sleep apnea can lead to high blood pressure, strokes, cancer, depression, and heart attacks

Wish-fulfillment view of dreams The Freudian belief that dreams provide an outlet for unacceptable desires.

Latent content of dreams According to Freud, a dream's unconscious, hidden meaning transformed into symbols within the dream's manifest content (story line).

Manifest content of dreams In Freudian dream analysis, the "surface," or remembered, story line, which contains symbols that mask the dream's latent content (the true meaning).

Activation–synthesis hypothesis of dreams The perspective that dreams are by-products of random stimulation of brain cells, which the brain attempts to combine (or synthesize) into coherent patterns, known as dreams.

Cognitive view of dreams The perspective that dreams are a type of information processing that helps interpret daily experiences and organize them into memories.

Three Dream Theories

Now let's look at three theories of why we dream—and whether dreams carry special meaning or information.

One of the oldest and most scientifically controversial explanations for why we dream is Freud's **wish-fulfillment view**. Freud proposed that unacceptable desires, which are reportedly normally repressed, rise to the surface of consciousness during dreaming. We avoid anxiety, Freud believed, by disguising our forbidden unconscious needs (what Freud called the dream's **latent content**) as symbols (**manifest content**). For example, a journey supposedly symbolizes death; horseback riding and dancing could symbolize sexual intercourse; and a gun might represent a penis.

Most modern scientific research does not support Freud's view (Domhoff, 2004; Dufresne, 2007; Siegel, 2010). Critics also say that Freud's theory is highly subjective and that the symbols can be interpreted according to the particular analyst's view or training.

In contrast to Freud, a biological view called the **activation–synthesis hypothesis** suggests that dreams are a by-product of random stimulation of brain cells during REM sleep (Hobson, 1999, 2005; Wamsley & Stickgold, 2010). Alan Hobson and Robert McCarley (1977) proposed that specific neurons in the brain stem fire spontaneously during REM sleep and that the cortex struggles to "synthesize," or make sense of, this random stimulation by manufacturing dreams. This is *not* to say that dreams are totally meaningless. Hobson (1999, 2005) suggests that even if our dreams begin with essentially random brain activity, our individual personalities, motivations, memories, and life experiences guide how our brains construct the dream.

Finally, other researchers support the **cognitive view of dreams**, which suggests that dreams are simply another type of information processing. That is, our dreams help us organize and interpret our everyday, waking experiences and thoughts into memories. For example, some research reports strong similarities between dream content and waking thoughts, fears, and concerns (Domhoff, 2005, 2007, 2010; Erlacher & Schredl, 2004).

Gender Differences and Similarities

Men and women tend to share many of the common dream themes shown in **Table 5.1.** But women are more likely to report dreams of children, family members and other familiar people, household objects, and indoor events. In contrast, men tend to report dreams about strangers, violence, weapons, sexual activity, achievement, and outdoor events (Blume-Marcovici, 2010; Domhoff, 2003, 2007, 2010; Schredl, 2012). (As a critical thinker, can you see how attitudes toward "proper" male and female gender roles, like caring for children, sex, weapons, and violence, might have affected what the participants were willing to report?)

TABLE 5.1 TOP TEN COMMON DREAM THEMES

1. Being attacked or pursued
2. Falling
3. Sexual experiences
4. Being lost
5. Being paralyzed
6. Flying
7. Being naked in public
8. School, teachers, studying
9. Arriving too late
10. Death of close people or dead people as alive

Sources: Griffith et al., 1958/2009; Nielsen et al., 2003; Schredl, 2010; Yu, 2012.

Best View Stock /Getty Images, Inc.

Non-rapid-eye-movement (NREM) sleep Stages 1 through 4 of sleep during which a sleeper does not show rapid eye movements.

When awakened from REM sleep, people almost always report dreaming. Because REM sleep is so different from the other periods of sleep, Stages 1 through 4 are often collectively referred to as **non-rapid-eye-movement (NREM) sleep**. Dreams very similar to those from REM sleep also occur during NREM sleep, but less frequently (Chellappa et al., 2011; Wamsley et al., 2007).

Why Do We Sleep and Dream?

There are many myths and misconceptions about why we sleep and dream (see *Psychology and You*). Fortunately, scientists have carefully studied what sleep and dreaming do for us and why we spend approximately 25 years of our life in these alternate states of consciousness (ASCs).

TEST YOURSELF: HAVE YOU HEARD THESE COMMON MYTHS?

psychology and you

Before reading the facts about each myth, place a check by any statement that you currently believe to be true.

1. _____ *Everyone needs 8 hours of sleep a night to maintain sound mental and physical health.*
2. _____ *Dreams have special or symbolic meaning.*
3. _____ *Some people never dream.*
4. _____ *Dreams last only a few seconds and occur only in REM sleep.*
5. _____ *When genital arousal occurs during sleep, it means the sleeper is having a sexual dream.*
6. _____ *Most people dream only in black and white, and blind people don't dream.*
7. _____ *Dreaming of dying can be fatal.*
8. _____ *It's easy to learn new, complicated things, like a foreign language, while asleep.*

Facts:

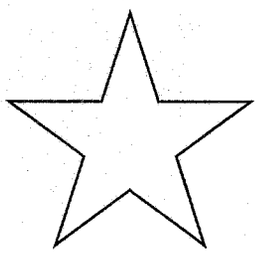
1. *Fact:* Although the average is 7.6 hours of sleep a night, some people get by on an incredible 15 to 30 minutes. Others may need as much as 11 hours (Colrain, 2011; Daan, 2011; Doghramji, 2000; Maas et al., 1999).
2. *Fact:* Many people mistakenly believe that dreams can foretell the future, reflect unconscious desires, have secret meaning, reveal the truth, or contain special messages. But scientific research finds little or no support for these beliefs (Blum, 2011; Domhoff, 2010; Hobson et al., 2011; Lilienfeld et al., 2010; Montangero, 2012).
3. *Fact:* In rare cases, adults with certain brain injuries or disorders do not dream (Solms, 1997). But otherwise, virtually all adults regularly dream, but many don't remember doing so. Even people who firmly believe they never dream report dreams if they are repeatedly awakened during an overnight study in a sleep laboratory. Children also dream regularly. For example, between ages 3 and 8, they dream during approximately 25% of their sleep time (Foulkes, 1993, 1999).
4. *Fact:* Research shows that most dreams occur in real time. For example, a dream that seemed to last 20 minutes probably did last approximately 20 minutes (Dement & Wolpert, 1958). Dreams also occur in NREM sleep (Jones & Benca, 2013; Oudiette et al., 2012).
5. *Fact:* When sleepers are awakened during this time, they are no more likely to report sexual dreams than at other times.
6. *Fact:* People frequently report seeing color in their dreams. Those who are blind do dream, but they report visual images only if they lost their sight after approximately age 7 (Lilienfeld et al., 2010).
7. *Fact:* This is a good opportunity to exercise your critical thinking skills. Where did this myth come from? Although many people have personally experienced and recounted a fatal dream, how would we scientifically prove or disprove this belief?
8. *Fact:* Although some learning can occur doing the lighter stages (1 and 2) of sleep, processing and retention of this material is minimal (Lilienfeld et al., 2010; Ogilvie et al., 1989). Wakeful learning is much more effective and efficient.

TEST YOURSELF: SLEEP DEPRIVATION

psychology and you

Take the following test to determine whether you are sleep deprived.

Part 1 Set up a small mirror next to this text and trace the black star pictured here, using your nondominant hand, while watching your hand in the mirror. The task is difficult, and sleep-deprived people typically make many errors. If you are not sleep deprived, it still may be difficult to trace the star, but you'll probably do it accurately.



Part 2 Give yourself one point each time you answer yes to the following:

_____ **1.** I generally need an alarm clock or my cell phone alarm to wake up in the morning.

_____ **2.** I have a hard time getting out of bed in the morning.

_____ **3.** I try to only take late morning or early afternoon college classes because it's so hard to wake up early.

_____ **4.** People often tell me that I look tired and sleepy.

_____ **5.** I often struggle to stay awake during class, especially in warm rooms.

_____ **6.** I find it hard to concentrate and often nod off while I'm studying.

_____ **7.** I often feel sluggish and sleepy in the afternoon.

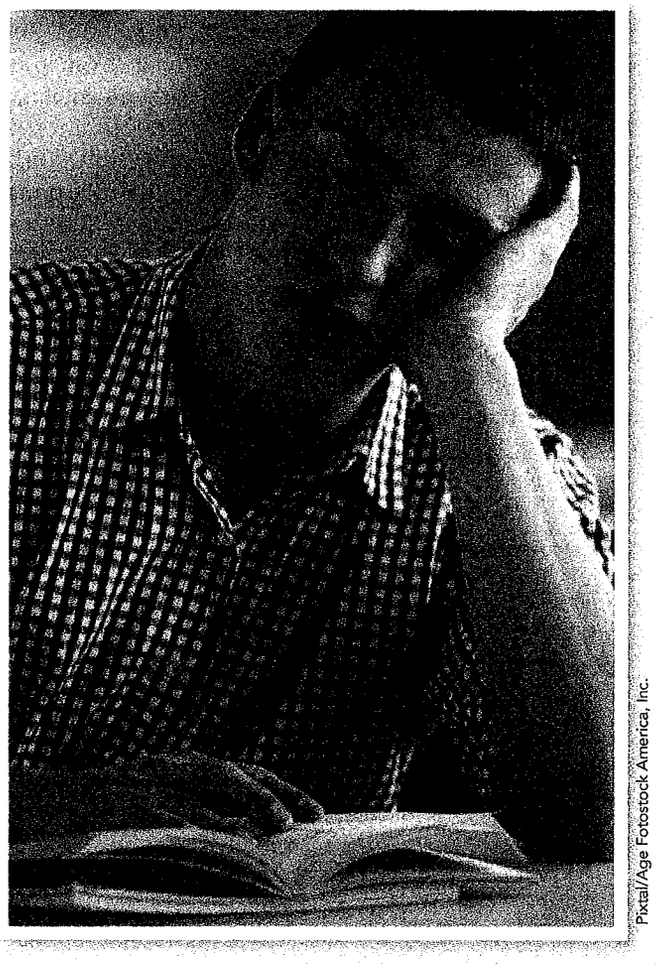
_____ **8.** I need several cups of coffee or other energy drinks to make it through the day.

_____ **9.** My friends often tell me I'm less moody and irritable when I've had enough sleep.

_____ **10.** I tend to get colds and infections, especially around final exams.

_____ **11.** When I get in bed at night, I generally fall asleep within four minutes.

_____ **12.** I try to catch up on my sleep debt by sleeping as long as possible on the weekends.



Pixtal/Age Fotostock America, Inc.

Effects of sleep deprivation
Insufficient sleep can seriously affect your college grades, as well as your physical health, motor skills, and overall mood.

The average student score is between 4 and 6. The higher your number, the greater your level of sleep deprivation.

Sources: Kaida et al., 2008; Mathis & Hess, 2009; National Sleep Foundation, 2012; Smith et al., 2012; Winerman, 2004.

Stages of Sleep

Having discussed our 24- to 25-hour circadian cycle, and the problems associated with its disruption, we now turn our attention to our cyclic patterns of sleep, which consist of five different stages. We begin with an exploration of how scientists study sleep. Surveys and interviews can provide general information, but for more detailed and precise data researchers in sleep laboratories use a number of sophisticated instruments **(Figure 5.2)**.

Imagine that you are a participant in a sleep experiment. When you arrive at the sleep lab, you are assigned one of several bedrooms. The researcher hooks you up

Circadian Rhythms

Circadian rhythm A consistent pattern of cyclical bodily activities, governed by an internal biological clock, that generally occurs on a 24- to 25-hour cycle. (*Circa* means "about," and *dies* means "day.")

Most animals have adapted to our planet's cycle of days and nights by developing a pattern of bodily functions that wax and wane over each 24-hour period. For humans, our alertness, core body temperature, moods, learning efficiency, blood pressure, metabolism, immune responses, and pulse rate all follow these **circadian rhythms** (Jones & Benca, 2013; Karatsoreos et al., 2011; Kyriacou & Hastings, 2010; Scheiermann et al., 2013). Usually, these activities reach their peak during the day and their low point at night **(Figure 5.1)**.

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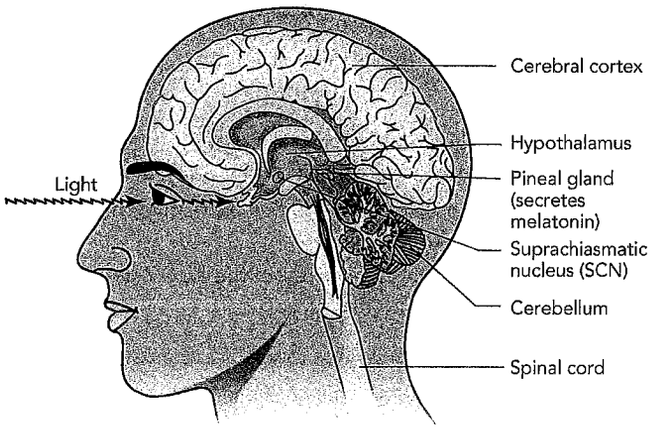
realworldpsychology **Circadian Challenges for Teenagers** Do you remember having trouble going to bed at a "reasonable hour" when you were a teenager and then having a really difficult time getting up each morning? This common pattern of staying up late at night and then sleeping longer in the morning appears to be a result of the natural shift in the timing of circadian rhythms that occurs during puberty (Carskadon et al., 1998). This shift is caused by a delay in the release of the hormone melatonin. In adults, this hormone is typically released around 10 p.m., signaling the body that it is time to go to sleep. But in teenagers, melatonin isn't released until around 1 a.m.—thus explaining why it's more difficult for teenagers to fall asleep as early as adults or younger children do.

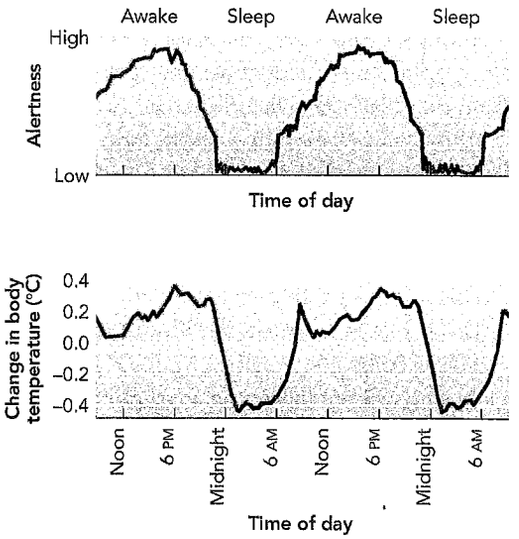
Recognition of this unique biological shift in circadian rhythms among teenagers has led some school districts to delay the start of school in the morning. Research shows that even a 30-minute delay allows teenagers to be more alert and focused during class, and contributes to improvements in their moods and overall health (Owens et al., 2010). Even more importantly, delaying the start of school in one large county in Kentucky was associated with a 16.5% decrease in car crashes among teenage drivers over the next two years (Danner & Philips, 2008).

FIGURE 5.1 WHAT CONTROLS CIRCADIAN RHYTHMS?

Circadian rhythms are regulated by a part of the hypothalamus called the *suprachiasmatic nucleus* (SCN).



Ⓐ The SCN receives information about light and darkness from the eyes, and then sends control messages to the *pineal gland*, which releases the hormone *melatonin*. Like other feedback loops in the body, the level of melatonin in the blood is sensed by the SCN, which then can modify the output of the pineal to maintain the "desired" level.



Ⓑ Melatonin is thought to influence sleep, alertness, and body temperature. Note how our degree of alertness and core body temperature rise and fall in similar ways.

chapteroverview

Control of consciousness determines the quality of life.

—Mihaly Csikszentmihaly

With the arrival of humans, it has been said, the universe has suddenly become conscious of itself. This, truly, it the greatest mystery of all.

—V. S. Ramachandran

We all commonly use the term *consciousness*, but what exactly does it mean? Is it simple awareness? What would it be like to be unaware? How can we study and understand the contents of our own consciousness when the only tool of discovery is consciousness itself?

In this chapter, we begin with an exploration of how consciousness is affected by circadian rhythms. Next, we'll discuss two alternate states—sleep and dreaming—followed by psychoactive drugs. Finally, we explore additional routes to altered consciousness through meditation and hypnosis.

CONSCIOUSNESS, SLEEP, AND DREAMING

LEARNING OBJECTIVES

RETRIEVAL PRACTICE While reading the upcoming sections, respond to each Learning Objective in your own words. Then compare your responses with those found at www.wiley.com/college/huffman.

1. **DEFINE** consciousness and alternate states of consciousness (ASCs).
2. **EXPLAIN** how circadian rhythms affect our lives.
3. **REVIEW** the stages of sleep.
4. **COMPARE** and contrast the theories about why we sleep and dream.
5. **SUMMARIZE** the types of sleep disorders.

Consciousness An organism's awareness of internal events and of the external environment.

William James, the first U.S. psychologist, likened **consciousness** to a stream that's constantly changing yet always the same. It meanders and flows, sometimes where the person wills and sometimes not. However, the process of *selective attention* (Chapter 4) allows us to control this stream of consciousness through deliberate concentration and full attention. For example, at the present moment you are, we hope, fully awake and concentrating on the words on this page. At times, however, your control may weaken, and your attention may drift to thoughts of a laptop you want to buy, a job, or an attractive classmate.

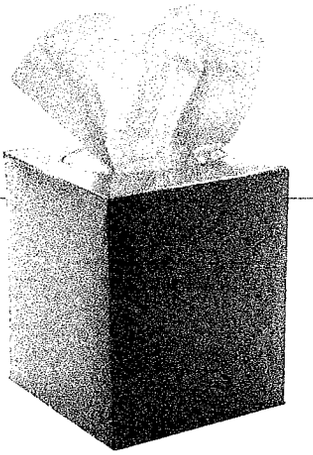
In addition to meandering and flowing, your stream of consciousness also varies in range and depth. It is not an all-or-nothing phenomenon—you are not either conscious or unconscious. Instead, consciousness exists along a continuum.

Other than wakefulness, there are common altered states, such as sleep and dreaming, psychoactive drug states, meditation, and hypnosis. You may think of yourself as being unconscious while you sleep, or fully conscious while "high" on certain drugs, but that's not true. Rather, you are in an **alternate state of consciousness (ASC)**. In this chapter, you will learn about both everyday, wakeful consciousness and ASCs.

Alternate state of consciousness (ASC) A mental state, other than ordinary waking consciousness, that occurs during sleep, dreaming, psychoactive drug use, and hypnosis.

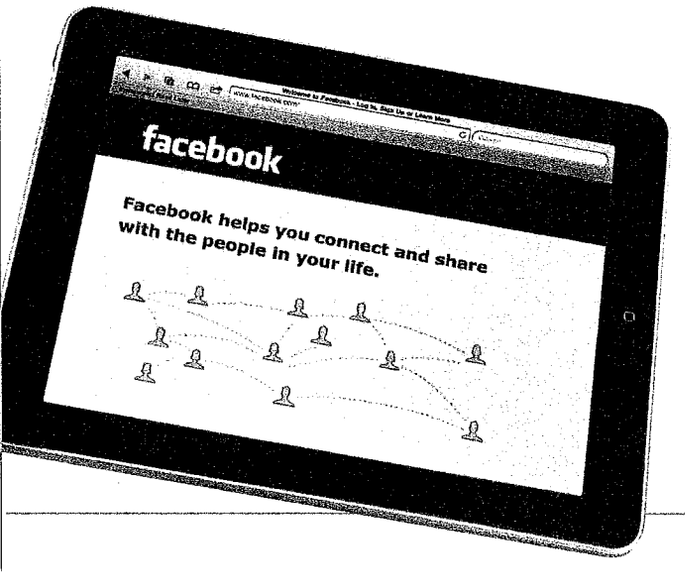
Before we begin, *Psych Science* describes how talking on a cell phone can lead to a dangerous drift down this meandering stream of consciousness.

chapter five



States of Consciousness

CHAPTER OUTLINE



Summary

1 UNDERSTANDING SENSATION 92

- **Sensation** is the process by which we detect stimuli and convert them into neural signals (**transduction**). During **coding**, the neural impulses generated by different physical stimuli travel by separate routes and arrive at different parts of the brain. In sensory reduction, we filter and analyze incoming sensations.
- In **sensory adaptation**, sensory receptors fire less frequently with repeated stimulation so that sensation decreases over time.
- **Psychophysics** measures our experience of sensory stimuli. The **absolute threshold** is the minimum stimulation necessary to consciously detect a stimulus 50% of the time. The **difference threshold**, or just noticeable difference (JND), is the smallest difference between two stimuli that is consciously detectable 50% of the time.
- Subliminal stimuli, though perceivable, have a modest effect on behavior.
- According to the **gate-control theory**, our experience of pain depends partly on whether the neural message gets past a "gatekeeper" in the spinal cord, which researchers believe is chemically controlled.

2 HOW WE SEE AND HEAR 98

- Light and sound move in waves. Light waves are a form of electromagnetic energy, and sound waves are produced when air molecules move in a particular wave pattern. Both light waves and sound waves vary in wavelength/frequency, wave height/amplitude, and wave range/complexity.
- Light enters the eye at the front of the eyeball. The cornea protects the eye and helps focus light rays. The lens further focuses light, adjusting to allow focusing on objects at different distances. At the back of the eye, incoming light waves reach the **retina**, which contains light-sensitive **rods** and **cones**. A network of neurons in the retina transmits neural information to the brain.
- The **outer ear** gathers sound waves, the **middle ear** amplifies and concentrates the sounds, and the **inner ear** changes the mechanical energy of sounds into neural impulses. The frequency and intensity of sounds determine how we distinguish among sounds of different pitches and loudness, respectively.

3 OUR OTHER IMPORTANT SENSES 104

- Smell and taste, sometimes called the chemical senses, involve chemoreceptors that are sensitive to certain chemical molecules. In **olfaction**, odor molecules stimulate receptors in the olfactory epithelium, in the nose. The resulting neural impulse travels to the olfactory bulb, where the information is processed before being sent elsewhere in the brain. Our sense of taste (**gustation**) involves five tastes: sweet, sour, salty, bitter, and umami (umami means "savory" or "delicious"). The taste buds are clustered on our tongues within the papillae.
- The body senses— the skin senses, the **vestibular sense**, and **kinesthesis**—tell the brain what it's touching or being touched by, how the body is oriented, and where and how it is moving.

4 UNDERSTANDING PERCEPTION 108

- **Perception** is the process of selecting, organizing, and interpreting incoming sensations into useful mental representations of the world. **Selective attention** allows us to filter out unimportant sensory messages. **Feature detectors** are specialized cells that respond only to certain sensory information. **Habituation** is a decrease in responsiveness due to repeated stimulation of the same stimulus.
- To be useful, sensory data must be assembled in a meaningful way. We organize sensory data in terms of form, constancy, depth, and color. Size and shape constancy are demonstrated in the Ames room. Traditionally there have been two theories of color vision: the **trichromatic theory** and the **opponent-process theory**.
- **Perceptual adaptation**, **perceptual set**, frame of reference, and **bottom-up processing** versus **top-down processing** affect our interpretation of what we sense and perceive.

Lindsey Hebberd/Corbis

applyingrealworldpsychology

We began this chapter with five intriguing Real World Psychology questions, and you were asked to revisit these questions at the end of each section. Questions like these have an important and lasting impact on all of our lives. See if you can answer these additional critical thinking questions related to real world examples.

1. The man in this photo willingly endures what would normally be excruciating pain. What information did you gain from this chapter that would help explain this man's behavior?
2. How has sensory adaptation been both advantageous and disadvantageous in your own life?
3. Why is it important to test all young children's vision and hearing capabilities?
4. If scientists could improve your sensory capabilities (for example, vision and hearing) far beyond the normal range, would you volunteer for this treatment? What might be the advantages and disadvantages?
5. Imagine yourself as a hiker who happens upon an unusual structure in the middle of the desert. How might information from this chapter help you capture this structure in a painting?

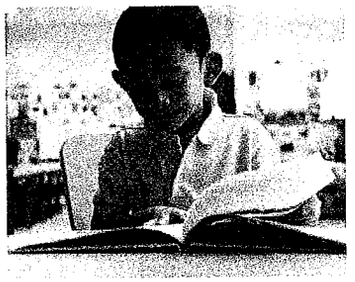
FIGURE 4.25 PERCEPTUAL SET?
When you look at this drawing, do you see a young woman looking back over her shoulder or an older woman with her chin buried in a fur collar? It may depend on your age. Younger students tend to first see a young woman, and older students first see an older woman. Although the basic sensory input stays the same, your brain's attempt to interpret ambiguous stimuli creates a type of perceptual dance, shifting from one interpretation to another (Gaetz et al., 1998).

In addition to possible problems with *perceptual set* **(Figure 4.25)**, the way we perceive people, objects, or situations is also affected by the *frame of reference*, or context. An elephant is perceived as much larger when it is next to a mouse than when it stands next to a giraffe. This is the reason professional athletes who make huge amounts of money sometimes feel underpaid: They're comparing what they make to the pay of those around them, who also make huge sums, and not to the average person in the United States! The influence of frame of reference on perception also helps explain why people rate themselves as more athletic if they compare themselves to the Pope than to a professional basketball player (Mussweiler et al., 2004)!

Finally, recall that we began this chapter by discussing how we receive sensory information (sensation) and work our way upward to the top levels of perceptual processing (perception), **bottom-up processing**. In contrast, **top-down processing** begins with "higher," top-level processing of thoughts, previous experiences, expectations, language, and cultural background and then works down to the sensory level (Antúnez et al., 2013; Chica et al., 2013; Freeman & Ambady, 2011; Zhaoping & Guyader, 2007). See the *Psychology and You.*

Bottom-up processing Perceptual analysis that begins "at the bottom," with raw sensory data being sent "up" to the brain for higher-level analysis; it is data-driven processing that moves from the parts to the whole.

Top-down processing Perceptual analysis that starts "at the top," with higher-level cognitive processes (such as expectations and knowledge), and then works down; it is conceptually driven processing that moves from the whole to the parts.



Jose Luis Pelaez/Iconica/Getty Images, Inc.

psychology and you **Reading and Processing** When first learning to read, you used bottom-up processing. You initially learned that certain arrangements of lines and "squiggles" represented specific letters. You later realized that these letters make up words.

Now, yuor aiblity to raed uisng top-dwon prcessoing mkaes it psosible to unedrstnad thsi sntenece desipte its mnay mssipllengis.

Science and ESP

So far in this chapter, we have talked about sensations provided by our eyes, ears, nose, mouth, and skin. What about a so-called sixth sense? Can some people perceive things that cannot be perceived with the usual sensory channels, by using **extrasensory perception (ESP)**? Those who claim to have ESP profess to be able to read other people's minds (*telepathy*), perceive objects or events that are inaccessible to their normal senses (*clairvoyance*), predict the future (*precognition*), or move or affect objects without touching them (*psychokinesis*).

Extrasensory perception (ESP) The perceptual, so-called "psychic," abilities that supposedly go beyond the known senses (for example, telepathy, clairvoyance, precognition, and psychokinesis).

As we discussed in Chapter 1, each of these claims falls under the name *pseudopsychology,* including Daryl Bem's highly publicized research (Bem, 2011). Furthermore, virtually all reports and so-called studies of ESP have been successfully debunked (Alcock, 2011; Bones, 2012; Galak et al., 2012; Irwin, 2008; Shaffer & Jadwiszczok, 2010). Findings in ESP are notoriously "fragile" in that they do not hold up to intense scrutiny.

Perhaps the most serious weakness of ESP is its failure of replication by rivals in independent laboratories, which is a core requirement for scientific acceptance (Francis, 2012; Hyman, 1996; Rouder et al., 2013). (Recall also from Chapter 1 that magician James Randi and the MacArthur Foundation has offered $1 million to "anyone who proves a genuine psychic power under proper observing conditions." But even after many years, the money has never been collected!)

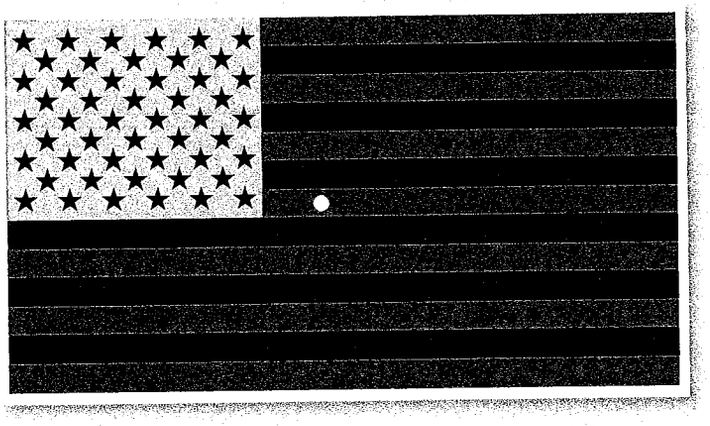
Opponent-process theory of color The theory that all color perception is based on three systems, each of which contains two color opposites (red versus green, blue versus yellow, and black versus white).

However, trichromatic theory doesn't fully explain color vision, and other researchers have proposed alternative theories. For example, the **opponent-process theory of color** agrees that we have three color systems, but it says that each system is sensitive to two opposing colors—blue and yellow, red and green, black and white—in an "on/off" fashion. In other words, each color receptor responds either to blue or yellow, or to red or green, with the black-or-white systems responding to differences in brightness levels. This theory makes a lot of sense because when different-colored lights are combined, people are unable to see reddish greens and bluish yellows. In fact, when red and green lights or blue and yellow lights are mixed in equal amounts, we see white. This opponent-process theory also explains *color afterimages*, a fun type of optical illusion in which an image briefly remains after the original image has faded (see *Test Yourself*).

TEST YOURSELF: UNDERSTANDING AND TESTING YOURSELF FOR COLOR AFTERIMAGES

psychology and you

Try staring at the dot in the middle of this color-distorted U.S. flag for 60 seconds. Then stare at a plain sheet of white paper. You should get interesting color aftereffects—red in place of green, blue in place of yellow, and white in place of black: a "genuine" U.S. flag. (If you don't see the afterimage, blink once or twice and try again.)



What happened? As you stared at the green, black, and yellow colors, the neural systems that process those colors became fatigued. Then when you looked at the plain white paper, which reflects all wavelengths, a reverse opponent process occurred: Each fatigued receptor responded with its opposing red, white, and blue colors! This is a good example of color afterimages—and further support for the opponent-process theory.

Think Critically

1. In what kinds of situations do you think color afterimages are likely to occur?
2. Other than learning that our eyes can play tricks on our brain, why might illusions like this afterimage be important?

Today we know that both trichromatic and opponent-process theories are correct—they just operate at different levels in visual processing. Color vision is processed in a trichromatic fashion in the retina. In contrast, color vision during opponent processing involves the retina, optic nerve, and brain.

Color-Deficient Vision Most people perceive three different colors—red, green, and blue—and are called *trichromats*. However, a small percentage of the population has a genetic deficiency in the red–green system, the blue–yellow system, or both. Those who perceive only two colors are called *dichromats*. People who are sensitive to only the black–white system are called *monochromats*, and they are totally color blind. If you'd like to test yourself for red–green color blindness, see *Test Yourself*.

far objects, it flattens. *Motion parallax* (also known as *relative motion)* refers to the fact that when we are moving, close objects appear to whiz by, whereas farther objects seem to move more slowly or remain stationary. This effect can easily be seen when traveling by car or train.

Constancies Perception

Perceptual constancy The ability to retain an unchanging perception of an object despite changes in the sensory input.

To organize our sensations into meaningful patterns, we develop **perceptual constancies**, the learned tendency to perceive the environment as stable, despite changes in an object's *size*, *shape*, *color*, and *brightness*. Without perceptual constancy, things would seem to grow as we get closer to them, change shape as our viewing angle changes, and change color as light levels change (Durgin et al., 2012; Goldstein, 2014; Granrud, 2012).

Size constancy Regardless of the distance from us (or the size of the image it casts on our retina), *size constancy* allows us to interpret an object as always being the same size. For example, the image of the couple in the foreground of the photo **(Figure 4.22)** is much larger on our retina than the trees behind them. However, thanks to size constancy, we perceive them to be of normal size. Without this constancy, we would perceive people as "shrinking" when they move away from us, and "growing" when they move toward us. Although researchers have found evidence of size constancy in newborns, it also develops from learning and the environment. Case studies of people who have been blind since birth, and then have their sight restored, find that they initially have little or no size constancy (Sacks, 1995).

Color and brightness constancies Our perception of color and brightness remain the same even when the light conditions change. Look at the two dogs' fur in this photo **(Figure 4.23)**. We perceive the color and brightness as constant

FIGURE 4.22 SIZE CONSTANCY

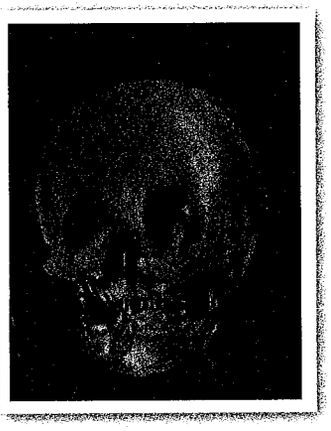
courtesy Karen Huffman

FIGURE 4.23 COLOR AND BRIGHTNESS CONSTANCIES

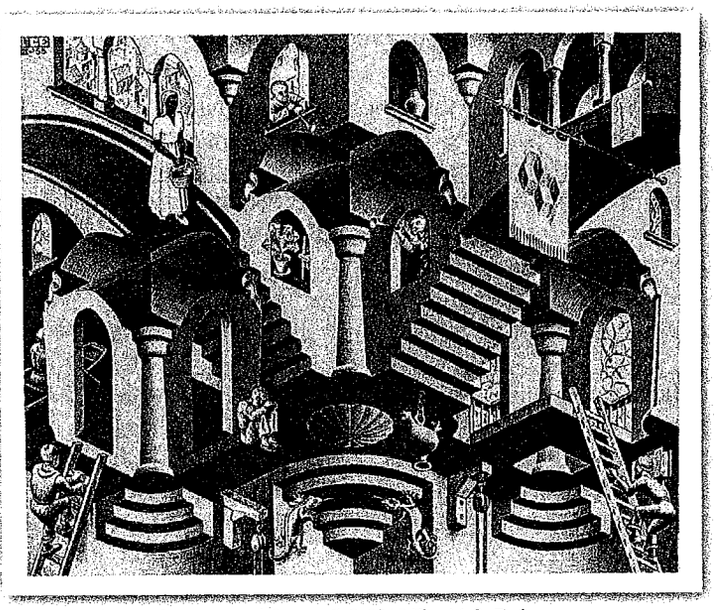
GK Hart/Vikki Hart/Getty Images, Inc.

FIGURE 4.18 UNDERSTANDING REVERSIBLE AND IMPOSSIBLE FIGURES

Ⓐ This so-called *reversible figure* demonstrates alternating figure–ground relations. It can be seen as a woman looking in a mirror or as a skull, depending on what you see as figure or ground.



Rykoff Collection/Corbis



M.C. Escher's "Concave and Convex" © 2012 The M.C. Escher Company-Holland. All rights reserved

Ⓑ When you first glance at this famous painting by the Dutch artist M.C. Escher, you detect specific features of the stimuli and judge them as sensible figures. But as you try to sort and organize the different elements into a stable, well-organized whole, you realize they don't add up—they're impossible. There is no one-to-one correspondence between your actual sensory input and your final perception.

background were showing through letter-shaped-holes in a white foreground. There are times, however, when it is very hard to distinguish the figure from the ground, as you can see in **Figure 4.18a**. This is known as a *reversible figure*. Your brain alternates between seeing the light areas as the figure and seeing them as the ground.

Like reversible figures, *impossible figures* help us understand perceptual principles—in this case, the principle of form organization **(Figure 4.18b)**.

Depth perception The ability to perceive three-dimensional space and to accurately judge distance.

Binocular cues Visual input from two eyes that allows perception of depth or distance.

Monocular cues Visual input from a single eye alone that contributes to perception of depth or distance.

Depth Perception

In our three-dimensional world, the ability to perceive the depth and distance of objects—as well as their height and width—is essential. **Depth perception** is learned primarily through experience. However, research using an apparatus called the *visual cliff* **(Figure 4.19)** suggests that some depth perception is inborn.

One mechanism by which we perceive depth is the interaction of both eyes to produce **binocular cues (Figure 4.20)**. The other relies on **monocular cues**, which work with each eye separately **(Figure 4.21)**.

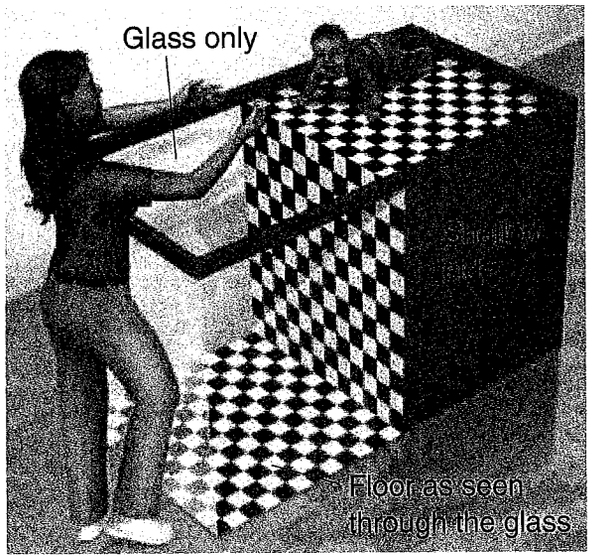


FIGURE 4.19 VISUAL CLIFF

realworldpsychology

Crawling infants hesitate or refuse to move to the "deep end" of the visual cliff indicating that they perceive the difference in depth. The same is true for baby animals that walk almost immediately after birth. Even 2-month-old human infants show a change in heart rate when placed on the deep versus shallow side of the visual cliff (Adolph & Kretch, 2012; Banks & Salapatek, 1983; Gibson & Walk, 1960; Ueno et al., 2012).

FIGURE 4.15 SELECTIVE ATTENTION

Have you noticed that when you're at a noisy party, you can still select and attend to the voices of people you find interesting, or that you can suddenly pick up on another group's conversation if someone in that group mentions your name? These are prime examples of *selective attention*, also called the "cocktail party phenomenon."

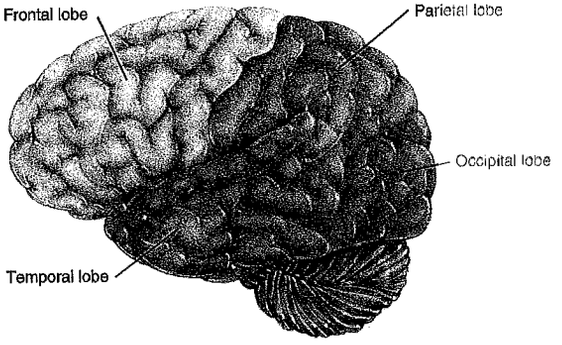


FIGURE 4.16 LOCATION OF FEATURE DETECTORS IN THE BRAIN

In addition to selective attention, the brains of humans and other animals contain specialized cells, called **feature detectors**, which respond only to certain stimuli. For example, studies with humans have found feature detectors in the temporal and occipital lobes that respond maximally to faces **(Figure 4.16)**. Problems in these areas can produce a condition called *prosopagnosia* (*prosopon* means "face," and *agnosia* means "failure to know"). Interestingly, people with prosopagnosia can recognize that they are looking at a face. But they cannot say whose face is reflected in a mirror, even if it is their own or that of a friend or relative (Avidan et al., 2013; Stollhoff et al., 2011; Susilo & Duchaine, 2013).

Other examples of the brain's ability to filter experience occurs with **habituation**, a decrease in responding due to repeated stimulation by the same stimulus. Apparently, the brain is "prewired" to pay more attention to changes in the environment than to stimuli that remain constant. As you'll discover in Chapter 9, developmental psychologists often use measurements of habituation to tell when a stimulus can be detected and discriminated by infants who are too young to speak. When presented with a new stimulus, infants pay attention, but with repetition their responses weaken.

Habituation also can help explain why attention and compliments from a stranger are generally more exciting than those from a long-term romantic partner. Unfortunately, some people (who haven't taken psychology courses or read this text) may misinterpret and overvalue this new attention. They may even leave good relationships, not realizing that they will also soon habituate to the new person!

Feature detectors Specialized neurons that respond only to certain sensory information.

Habituation The brain's reduced responsiveness due to repeated stimulation of the same receptors.

realworldpsychology **Using Selective Attention, Feature Detectors, and Habituation in Advertising** As advertisers and political operatives well know, people tend to automatically select stimuli that are intense, novel, moving, contrasting, and repetitious. For sheer volume of sales (or votes), if an ad gets your attention, that's all that matters. Whether you like the ad or not is irrelevant. This phenomenon also helps explain why sometimes you don't like a song when you first hear it on the radio or at a club, but after you've heard it hundreds of times, you actually might find it kind of catchy!

located in our inner ear, moves and bends hair cell receptors. In addition, at the end of the semicircular canals are *vestibular sacs*, which contain hair cells sensitive to our bodily movement relative to gravity (as shown in the amusement park ride examples in Figure 4.9). Information from the semicircular canals and the *vestibular sacs* is converted to neural impulses that are then carried to our brain.

Kinesthesis

Kinesthesis The sense, located in muscles, joints, and tendons, that detects bodily posture, orientation, and movement of body parts relative to each other.

The sense that provides the brain with information about bodily posture, orientation, and movement of individual body parts is called **kinesthesis (Figure 4.13c)**. Kinesthetic receptors are found throughout the muscles, joints, and tendons of our body. They tell our brain which muscles are being contracted or relaxed, how our body weight is distributed, where our arms and legs are in relation to the rest of our body, and so on.

RETRIEVAL PRACTICE: OUR OTHER IMPORTANT SENSES

Self-Test

Completing this self-test and comparing your answers with those in Appendix B provides immediate feedback and helpful practice for exams. Additional interactive, self-tests are available at www.wiley.com/college/huffman.

1. Most information related to smell is processed in the _____.

a. nasal cavity
b. temporal lobe
c. olfactory bulb
d. parietal lobe

2. Most of our taste receptors are found on the _____.

a. olfactory bulb
b. gustatory cells
c. taste buds
d. frenulum

3. The skin senses include _____.

a. pressure
b. pain
c. warmth and cold
d. all of these options

4. The weightlessness experienced by space travelers from zero gravity has its greatest effect on the _____ senses.

a. visceral
b. reticular
c. somasthetic
d. vestibular

Think Critically

1. From an evolutionary perspective, which is more important—smell or taste?
2. From a personal perspective, which sense is most important to you—your sense of smell, taste, skin senses, vestibular, or kinesthetic?

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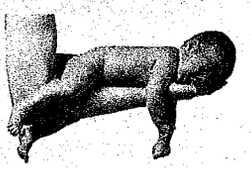
Why do premature babies grow faster when they receive skin-to-skin contact?



HINT: LOOK IN THE MARGIN FOR Q4

UNDERSTANDING PERCEPTION

LEARNING OBJECTIVES

RETRIEVAL PRACTICE While reading the upcoming sections, respond to each Learning Objective in your own words. Then compare your responses with those found at www.wiley.com/college/huffman.

1. **DOCUMENT** the relationship between selective attention, feature detectors, and habituation.
2. **DESCRIBE** the four ways we organize sensory data.
3. **SUMMARIZE** the factors in perceptual interpretation.

We are ready to move from *sensation* and the major senses to *perception*, the process of selecting, organizing, and interpreting incoming sensations into useful mental representations of the world.

PSYCHSCIENCE

CAN INFANTS LOVE CARROTS?

Would you believe that our taste preferences are shaped even before we are born? Researchers have conducted very clever studies to examine how the foods that pregnant women eat influence the types of tastes their babies prefer after birth. In one study, pregnant women who were planning to breast-feed were randomly assigned to one of three groups (Mennella et al., 2001):

- Women in one group drank carrot juice four times a week for three weeks during pregnancy.
- Women in another group drank carrot juice four times a week for three weeks after the baby was born.
- Women in the third group did not drink carrot juice.

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The researchers then asked the mothers to rate their babies' facial reactions to different types of foods and to measure how much of a carrot-flavored cereal the babies ate. Babies who were exposed to the taste of carrots either during pregnancy or through breast milk ate more of the carrot-flavored cereal than babies who had no exposure to this taste. Thus showing that taste preferences may be established very early in life—in fact, even before birth.

RESEARCH CHALLENGE

1. Based on the information provided, did the study (Menella et al., 2001) use descriptive, correlational, and/or experimental research?
2. If you chose:
   - descriptive research, is this a naturalistic observation, survey/interview, case study, or archival research?
   - correlational research, is this a positive, negative, or zero correlation?
   - experimental research, label the IV, DV, experimental group(s), and control group.

>> CHECK YOUR ANSWERS IN APPENDIX B.

NOTE: The information provided in this study is admittedly limited, but the level of detail is similar to what is presented in most textbooks and public reports of research findings. Answering these questions, and then comparing your answers to those in the Appendix, will help you become a better critical thinker and consumer of scientific research.

and liquid molecules. The major taste receptors—taste buds—are distributed all over our tongues within little bumps called papillae (refer to Figure 4.12).

The Body Senses

In addition to smell and taste, we have three important body senses that help us navigate our world—skin, vestibular, and kinesthesis **(Figure 4.13)**.

Skin Senses

Our skin is uniquely designed for the detection of touch (or pressure), temperature, and pain **(Figure 4.13a)**. The concentration and depth of the receptors for each of these stimuli vary (Fitzpatrick & Mooney, 2012; Hsiao & Gomez-Ramirez, 2013). For example, touch receptors are most concentrated on the face and fingers and least concentrated in the back and legs. Getting a paper cut can feel so painful

OUR OTHER IMPORTANT SENSES

LEARNING OBJECTIVES

RETRIEVAL PRACTICE While reading the upcoming sections, respond to each Learning Objective in your own words. Then compare your responses with those found at www.wiley.com/college/huffman.

1. **DESCRIBE** how the information contained in odor molecules reaches the brain.
2. **EXPLAIN** how the information contained in food molecules reaches the brain.
3. **IDENTIFY** the body senses.

Vision and audition may be the most prominent of our senses, but the others—smell, taste, and the body senses—are also important for gathering information about our environment.

Smell and Taste

Smell and taste are sometimes called the *chemical senses* because they both rely on chemoreceptors that are sensitive to certain chemical molecules. Have you wondered why we have trouble separating the two sensations? Smell and taste receptors are located near each other and closely interact **(Figure 4.12)**.

Olfaction The sense or act of smelling.

Pheromones [FARE-oh-mones] Chemical signals released by organisms to communicate with others; they may affect behavior, including recognition of family members, aggression, territorial marking, and sexual mating.

Gustation The sense or act of taste.

Our sense of smell, **olfaction**, is remarkably useful and sensitive. We possess more than 1,000 types of olfactory receptors, which allow us to detect more than 10,000 distinct smells. The nose is more sensitive to smoke than any electronic detector, and—through practice—blind people can quickly recognize others by their unique odors.

Some research on **pheromones**—chemicals found in natural body scents that affect various behaviors—supports the idea that certain chemical odors increase sexual behaviors—even in humans (Derntl et al., 2013; Kohl, 2012; Marazziti et al., 2010; Pause, 2012). However, others suggest that human sexuality is far more complex than that of other animals—and more so than perfume advertisements would have you believe.

Today, the sense of taste, **gustation**, may be the least critical of our senses. In the past, however, it probably contributed significantly to our survival. For example, humans and other animals have a preference for sweet foods, which are generally nonpoisonous and are good sources of energy. However, the major function of taste, aided by smell, is to help us avoid eating or drinking harmful substances. Because many plants that taste bitter contain toxic chemicals, an animal is more likely to survive if it avoids bitter-tasting plants (Cooper et al., 2002; Goldstein, 2014; Negri et al., 2012).

Learning and Culture

Many food and taste preferences also are learned from personal experiences (Liem et al., 2012; Yantis, 2013). For example, adults who are told a bottle of wine costs $90 (rather than its real price of $10) report that it tastes better than the supposedly cheaper brand. Ironically, these false expectations actually trigger areas of the brain that respond to pleasant experiences (Plassmann et al., 2008). This means that in a neurochemical sense, the wine we believe is better does, in fact, taste better!

The culture we live in also affects our taste preferences. Many Japanese children eat raw fish, and some Chinese children eat chicken feet as part of their normal diet. Although most U.S. children might consider these foods "yucky," they tend to love cheese, which children in many other cultures find repulsive. The upcoming *Psych Science* section describes how these tastes preferences are created very early in life.

Before going on, we need to update you on recent research findings on taste perception. It was long believed that we had only four distinct tastes: sweet, sour, salty, and bitter. However, we now know that we also have a fifth taste sense, *umami*, a word that means "delicious" or "savory" and refers to sensitivity to an amino acid called glutamate (Jinap & Hajeb, 2010; Lanfer et al., 2013). Glutamate is found in meats, meat broths, and monosodium glutamate (MSG).

Scientists also once believed that specific areas of the tongue were dedicated to detecting bitter, sweet, salty, and other tastes. Today, we know that taste receptors, like smell receptors, respond differentially to the varying shapes of food

FIGURE 4.10 STUDENTS EXPLOITING AGE-RELATED HEARING LOSS

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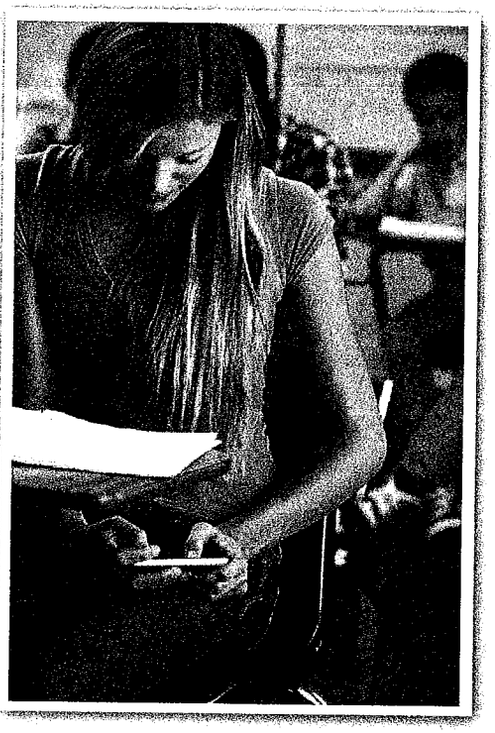

relative loudness or softness of sounds is measured on a scale of *decibels* **(Figure 4.11)**.

Hearing Problems

What are the types, causes, and treatments of hearing loss? **Conduction hearing loss**, also called conduction deafness, results from problems with the mechanical system that conducts sound waves to the cochlea. Hearing aids that amplify the incoming sound waves, and some forms of surgery, can help with this type of hearing loss.

In contrast, **sensorineural hearing loss**, also known as nerve deafness, results from damage to the cochlea's receptor (hair) cells or to the auditory nerve. Disease and biological changes associated with aging can result in sensorineural hearing loss. But its most common (and preventable) cause is continuous exposure to loud noise, which can damage hair cells and lead to permanent hearing loss. Even brief exposure to really loud sounds, like a stereo or headphones at full blast, a jackhammer, or a jet airplane engine, can cause permanent nerve deafness (refer to Figure 4.11). In fact, a high volume on earphones can reach the same noise level as a jet engine! All forms of high volume noise can damage the coating on nerve cells, making it harder for the nerve cells to send information from the ears to the brain (Pilati et al., 2012).

Q3

Although most hearing loss is temporary, damage to the auditory nerve or receptor cells is generally considered irreversible. The only treatment for auditory nerve damage is a small electronic device called a *cochlear implant*. If the auditory nerve is intact, the implant bypasses hair cells to stimulate the nerve. Currently, cochlear implants produce only a crude approximation of hearing, but the technology is improving.

Conduction hearing loss A type of hearing loss that results from damage to the mechanical system that conducts sound waves to the cochlea; also called conduction deafness.

Sensorineural hearing loss A type of hearing loss resulting from damage to cochlea's receptor (hair) hearing cells or to the auditory nerve; also called nerve deafness.

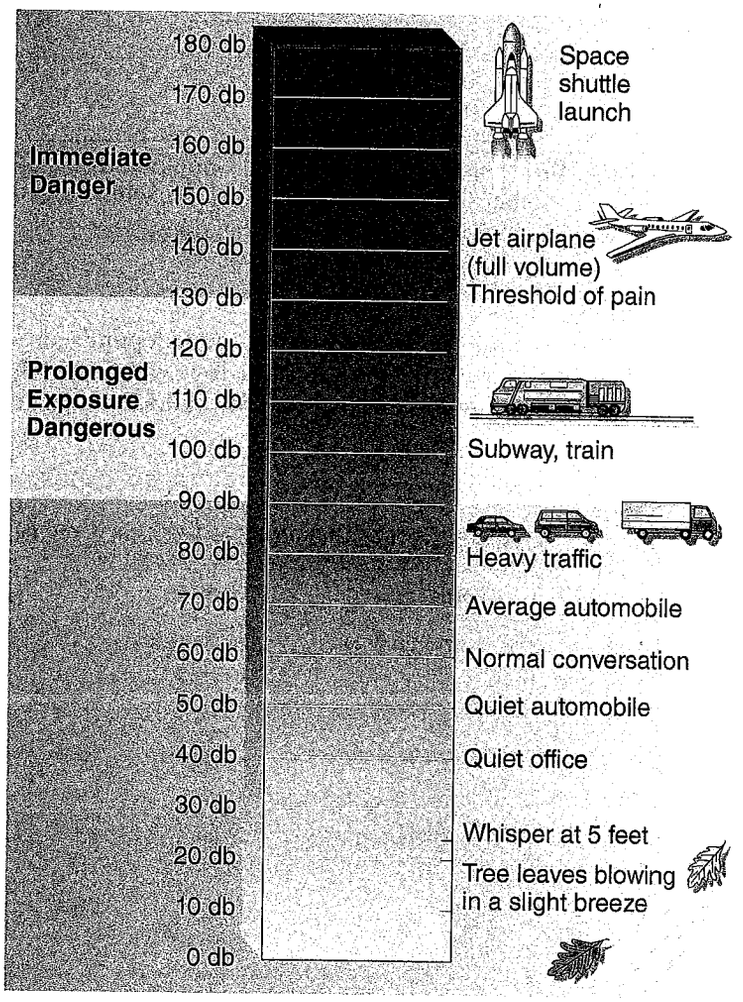

FIGURE 4.11 BEWARE OF LOUD SOUNDS

The higher a sound's decibel reading, the more damaging it is to the ear.

Vision Problems and Peculiarities

Thoroughly understanding the processes detailed in Figure 4.8 offers clues that help us understand several visual peculiarities. For example, small abnormalities in the eye sometimes cause images to be focused in front of the **retina** in the case of *nearsightedness (myopia)*, or behind it in the case of *farsightedness (hyperopia)*. In addition, during middle age, most people's lenses lose elasticity and the ability to accommodate for near vision, a condition known as *presbyopia*. Corrective lenses or laser surgery can often correct these visual acuity problems.

A visual peculiarity occurs where the optic nerve exits the eye. Because there are no receptor cells for visual stimuli in that area, we have a tiny hole, or **blind spot**, in our field of vision. (See Figure 4.8 for a demonstration.)

Two additional peculiarities happen when we go from a bright to dark setting and vice versa. Have you noticed that when you walk into a dark movie theater on a sunny afternoon, you're almost blind for a few seconds? The reason is that in bright light, the pigment inside the **rods** (refer to Figure 4.8) is bleached, making them temporarily nonfunctional. It takes a second or two for the rods to become functional enough again for you to see. This process of *dark adaptation* continues for 20 to 30 minutes.

In contrast, *light adaptation*, the adjustment that takes place when you go from darkness to a bright setting, takes about 7 to 10 minutes and is the work of the **cones**. Interestingly, a region in the center of the retina, called the **fovea**, has the greatest density of cones, which are most sensitive in brightly lit conditions. They're also responsible for color vision and fine detail.

Retina The light-sensitive inner surface of the back of the eye, which contains the receptor cells for vision (rods and cones).

Blind spot The point at which the optic nerve leaves the eye, which contains no receptor cells for vision—thus creating a "blind spot."

Rods Photoreceptors concentrated in the periphery of the retina that are most active in dim illumination; rods do not produce sensation of color.

Cones Visual receptor cells that are concentrated near the center of the retina and are responsible for color vision and fine detail; they are most sensitive in brightly lit conditions.

Fovea A tiny pit in the center of the retina that is densely filled with cones; it is responsible for sharp vision.

Audition The sense or act of hearing.

Hearing

The sense or act of hearing, known as **audition**, has a number of important functions, ranging from alerting us to dangers to helping us communicate with others. In this section we talk first about sound waves, then about the ear's anatomy and function, and finally about problems with hearing.

Like the visual process, which transforms light waves into vision, the auditory system is designed to convert sound waves into hearing. Sound waves are produced by air molecules moving in a particular wave pattern. For example, vibrating objects like vocal cords or guitar strings create waves of compressed and expanded air resembling ripples on a lake that circle out from a tossed stone. Our ears detect and respond to these waves of small air pressure changes, our brain then interprets the neural messages resulting from these waves, and we hear!

To fully understand this process, pay close attention to the step-by-step diagram in **Figure 4.9**.

Pitch perception

How do we determine that certain sounds are from a child's voice and not from an adult's? We distinguish between high- and low-pitched sounds by the *frequency* of the sound waves. High-frequency sound waves, which produce high-pitched sounds, maximally stimulate the hair cells at different locations along the basilar membrane (refer to Figure 4.9). This is known as the **place theory for hearing**. Conversely, low-pitched sounds cause hair cells along the basilar membrane to bend and fire neural messages (action potentials) at the same rate as the frequency of that sound, the **frequency theory for hearing**.

In short, place theory best explains how we hear high-pitched sounds, whereas frequency theory is a better explanation for how we hear low-pitched sounds **(Table 4.3)**.

Interestingly, as we age, we tend to lose our ability to hear high-pitched sounds but are still able to hear low-pitched sounds. Given that young students can hear a cell phone ringtone that sounds at 17 kilohertz—too high for adult ears to detect—they can take advantage of this age-related hearing difference and call one another during

Place theory for hearing The theory that pitch perception is linked to the particular spot on the cochlea's basilar membrane that is most stimulated; pitch is coded by the place at which activation occurs.

Frequency theory for hearing The theory that pitch perception occurs when a tone produces a rate of vibration in the basilar membrane equal to its frequency, with the result that pitch can be coded by the frequency of the neural response.

HOW WE SEE AND HEAR

LEARNING OBJECTIVES

RETRIEVAL PRACTICE While reading the upcoming sections, respond to each Learning Objective in your own words. Then compare your responses with those found at www.wiley.com/college/huffman.

1. **IDENTIFY** the three major characteristics of light and sound waves.
2. **EXPLAIN** how the eye captures and focuses light energy and how it converts it into neural signals.
3. **DESCRIBE** the path that sound waves take in the ear.
4. **SUMMARIZE** the two theories that explain how we distinguish among different pitches.

Many people mistakenly believe that what they see and hear is a copy of the outside world. In fact, vision and hearing are the result of what our brains create in response to light and sound waves. What we see and hear is based on wave phenomena, similar to ocean waves **(Figure 4.5)**.

In addition to wavelength/frequency shown in Figure 4.5, waves also vary in height (technically called *amplitude*). This wave height/amplitude determines the intensity of sights and sounds. Finally, waves also vary in range, or complexity, which mixes together waves of various wavelength/frequency and wave height/amplitude **(Figure 4.6)**.

Vision

Did you know that Major League batters can routinely hit a 90-miles-per-hour fastball four-tenths of a second after it leaves the pitcher's hand? How can the human eye receive and process information that fast? To understand the marvels of vision, we need to start with the basics—that light waves are a form of electromagnetic energy and only a small part of the full *electromagnetic spectrum* **(Figure 4.7)**.

To fully appreciate how our eyes turn these light waves into the experience we call *vision*, we need to first examine the various structures in our eyes that capture and focus the light waves. Then, we need to understand how these waves are transformed (transduced) into neural messages (action potentials) that our brain can process into images we consciously see. (Be sure to carefully study this step-by-step process in **Figure 4.8**.)

FIGURE 4.5 WAVES OF LIGHT AND SOUND

Ocean waves have a certain distance between them (the *wavelength*), and they pass by you at intervals. If you counted the number of passing waves in a set amount of time (for example, 5 waves in 60 seconds), you could calculate the *frequency* (the number of complete wavelengths that pass a point in a given time). Longer wavelength means lower frequency and vice versa.

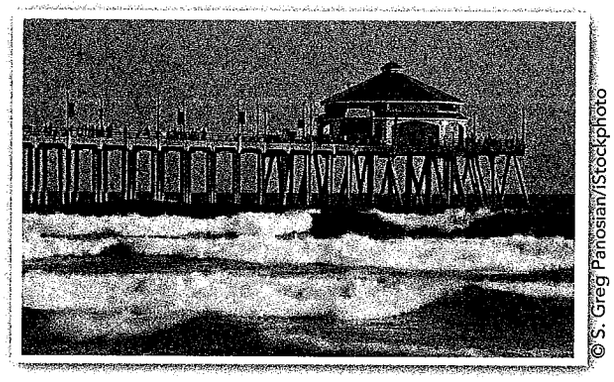

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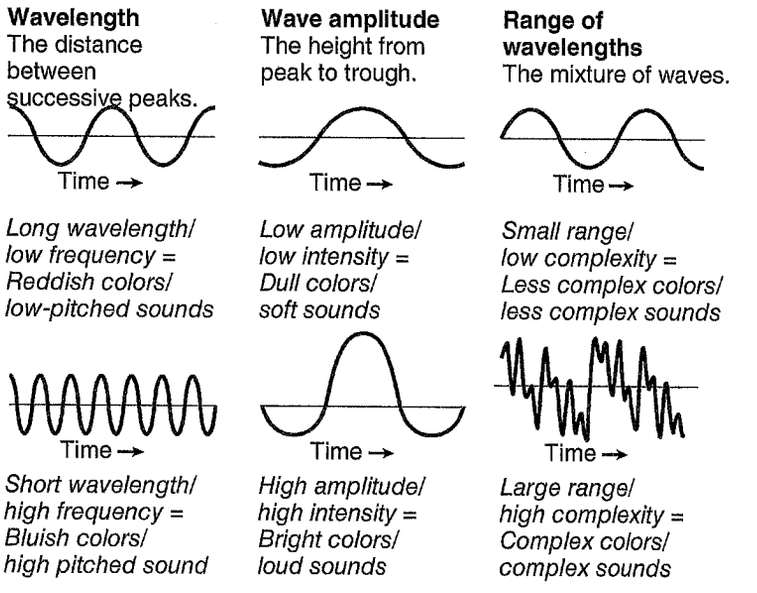
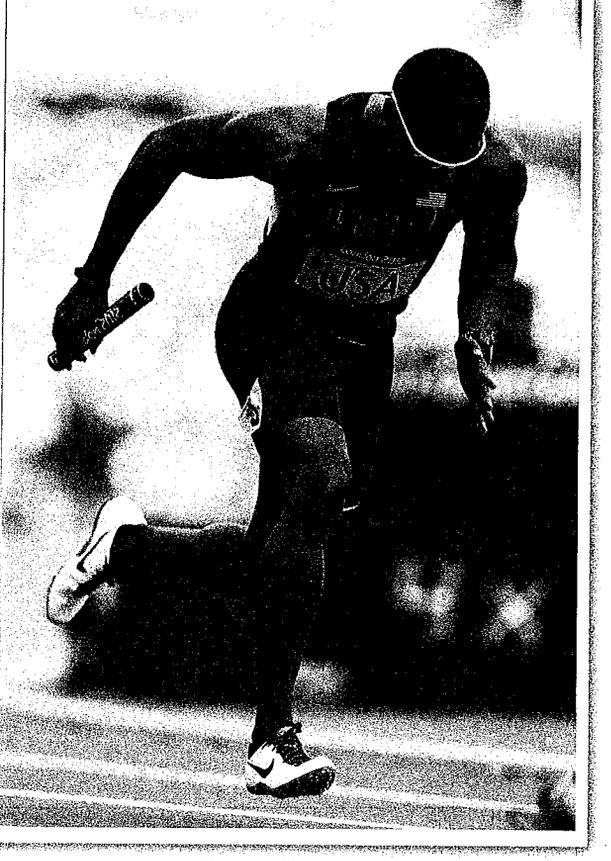
FIGURE 4.6 PROPERTIES OF LIGHT AND SOUND





Ian MacNicol/Getty Images

FIGURE 4.4 OVERCOMING EXCRUCIATING PAIN!

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Our body's ability to inhibit pain perception sometimes makes it possible for athletes to "play through" painful injuries. For example, Manteo Mitchell broke his left leg in the qualifying heats of the 4 × 400-meter relay race in the 2012 Olympics. Recalling the moment of the accident, Manteo said, "I felt it break . . . it hurt so bad . . . it felt like somebody literally just snapped my leg in half" (Moore, 2013). However, he continued running so that the American team could get into the finals. Many people admired his courage and determination, while others thought the potential for lasting damage was too high a price to pay for an Olympic medal. What do you think?

Melzack and Patrick Wall (1965). According to this theory, the experience of pain depends partly on whether the neural message gets past a "gatekeeper" in the spinal cord. Normally, the gate is kept shut, either by impulses coming down from the brain or by messages coming from large-diameter nerve fibers that conduct most sensory signals, such as touch and pressure. However, when body tissue is damaged, impulses from smaller pain fibers open the gate (Goldstein, 2014; Moayedi & Davis, 2013).

Can you see how this gate-control theory helps explain why massaging an injury or scratching an itch can temporarily relieve discomfort? It's because pressure on large-diameter neurons interferes with pain signals.

Messages from our brain also can control the pain gate, which explains how athletes and soldiers can carry on despite excruciating pain. When we're soothed by endorphins or distracted by competition or fear, our experience of pain can be greatly diminished **(Figure 4.4)**. Holding the hand of a loved one—or even just looking at a photograph of him or her—can also help reduce pain during a medical procedure (Master et al., 2009). Similarly, actively listening to music—meaning concentrating on specific musical cues in songs people know well, such as "Mary Had a Little Lamb"—can help reduce pain, especially among those who are very anxious (Bradshaw et al., 2012).

Research also suggests that the pain gate may be chemically controlled. A neurotransmitter called *substance P* opens the pain gate, and that endorphins close it (Bianchi et al., 2008; Lin et al., 2012; Papathanassoglou et al., 2010). Other research finds that when normal sensory input is disrupted, the brain can generate pain and other sensations on its own (Melzack, 1999; Moayedi & Davis, 2013; Snijders et al., 2010).

For example, amputees sometimes continue to feel pain (and itching or tickling) long after a limb has been amputated. This *phantom limb pain* occurs because nerve cells send conflicting messages to the brain. The brain interprets this "static" as pain since the message arises in the area of the spinal cord responsible for pain signaling. When amputees are fitted with prosthetic limbs and begin using them, and sometimes when *mirror visual therapy* is used, phantom pain often disappears because the brain is somehow tricked into believing that there is no longer a missing limb (Foell & Flor, 2012; Giummarra & Moseley, 2011; Gracely et al., 2002; Plumbe et al., 2013).

(Mirror therapy involves a box with two mirrors—one facing each way. The amputee patient places his or her intact limb into one side of the box and the amputated limb in the other. He or she then concentrates on looking into the mirror on the side that reflects the intact limb, while making movements with both the intact and amputated limbs. Thanks to the artificial feedback provided by the two mirrors, the patient sees only the reflected image of the intact limb moving and interprets this as the phantom limb also moving.)

Now that we've studied how we perceive pain and how we might ignore or "play through" it, it's important to point out that other research finds that when we get anxious or dwell on our pain, we can intensify it (Lin et al., 2013; Ruscheweyh et al., 2013; Sullivan et al., 1998). Interestingly, social and cultural factors, such as well-meaning friends who ask chronic pain sufferers about their pain, may unintentionally reinforce and increase it (Flor, 2013; Jolliffe & Nicholas, 2004).

The following *Psychology and You* offers an assessment and strategies for managing your personal pain.

TABLE 4.2 EXAMPLES OF HUMAN ABSOLUTE THRESHOLDS

Sense	Absolute Threshold
Vision	A candle flame seen from 30 miles away on a clear, dark night
Audition (hearing)	The tick of an old-fashioned watch at 20 feet
Olfaction (smell)	One drop of perfume spread throughout a six-room apartment
Gustation (taste)	One teaspoon of sugar in 2 gallons of water
Body senses	A bee's wing falling on your cheek from a height of about half an inch

field of **psychophysics**, which studies and measures the link between the physical characteristics of stimuli and the sensory experience of them.

One of the most interesting insights from psychophysics is that what is out there is not directly reproduced in here. At this moment, there are light waves, sound waves, odors, tastes, and microscopic particles touching us that we cannot see, hear, smell, taste, or feel. We are consciously aware of only a narrow range of stimuli in our environment. German scientist Ernst Weber (1795–1878) was one of the first to study the smallest difference between two weights that could be detected (Coren, 2013).

Psychophysics The study of the link between the physical characteristics of stimuli and the psychological experience of them.

Difference threshold The smallest physical difference between two stimuli that is consciously detectable 50% of the time; also called the *just noticeable difference* (*JND*).

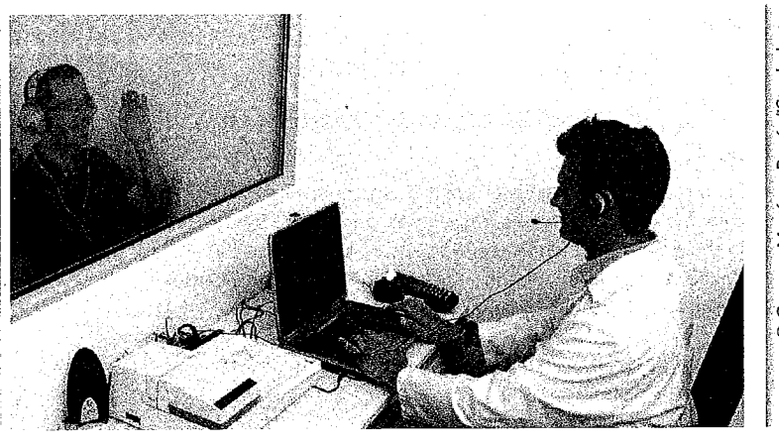
Absolute threshold The minimum amount of stimulation necessary to consciously detect a stimulus 50% of the time.

This **difference threshold**, also known as *Weber's Law of just noticeable differences* (*JND*), is the minimum difference that is consciously detectable 50% of the time. Another scientist, Gustav Fechner (1801–1887), expanded on Weber's law to determine what is called the **absolute threshold**, the minimum stimulation necessary to consciously detect a stimulus 50% of the time. See **Table 4.2** for a list of absolute thresholds for our various senses.

To measure your senses, an examiner presents a series of signals that vary in intensity and asks you to report which signals you can detect. In a hearing test, the softest level at which you can consistently hear a tone is your absolute threshold. The examiner then compares your threshold with those of people with normal hearing to determine whether you have hearing loss **(Figure 4.2)**.

Interestingly, many nonhuman animals have higher and lower thresholds than humans. For example, a dog's absolute and difference thresholds for smell are far more sensitive than those of a human. For this reason, specially trained dogs provide invaluable help in sniffing out dangerous plants, animals, drugs, and explosives; tracking criminals; and assisting in search-and-rescue operations **(Figure 4.3)**. Some researchers believe dogs can even detect chemical signs of certain illnesses, such as diabetes or cancer, and possibly even predict seizures in humans (Akers & Denbow, 2008; Buszewski et al., 2012; McCulloch et al., 2012).

FIGURE 4.2 MEASURING THE ABSOLUTE AND DIFFERENCE THRESHOLDS FOR HEARING



Subliminal Stimuli

Have you heard some of the wild rumors about subliminal messages? During the 1970s, it was said that rock songs contained demonic messages, which could only be heard when the songs were played backwards! Similarly, in the 1990s, many suggested that some Disney films contained obscene subliminal messages. For example, in the film *Aladdin*, the lead character supposedly whispers, "all good teenagers take off your clothes," and *The Lion King* reportedly showed close ups of the dust with a secret spelling out of the word "sex." In addition, at one time movie theaters were reportedly flashing messages like "Eat popcorn" and "Drink Cola-Cola" on the screen. Even though the messages were so brief that viewers weren't aware of seeing them, it was believed they increased consumption of these products (Blecha, 2004; Vokey & Read, 1985).

Can unconscious stimuli affect our behavior? To answer this question, we need to first acknowledge that it's clearly possible to perceive something without conscious awareness (Brooks et al., 2012; Irvine,

chapteroverview

Imagine that your visual field has been suddenly inverted and reversed. Things you normally expect to be on your right are now on your left, and those above your head are now below. How would you ride a bike, read a book, or even walk through your home? Do you think you could ever adapt to this upside-down world?

To answer that question, psychologist George Stratton (1896) invented, and for eight days wore, special prism goggles that flipped his view of the world from up to down and right to left. For the first few days, Stratton had a great deal of difficulty navigating in this environment and coping with everyday tasks. But by the third day, he noted:

Walking through the narrow spaces between pieces of furniture required much less care than hitherto. I could watch my hands as they wrote, without hesitating or becoming embarrassed thereby.

By the fifth day, Stratton had almost completely adjusted to his strange perceptual environment, and when he later removed the headgear, he quickly readapted.

What does this experiment have to do with everyday life? At this very moment, our bodies are being bombarded with stimuli from the outside world—light, sound, heat, pressure, texture, and so on—while our brains are floating in complete silence and utter darkness within our skulls. Stratton's experiment shows us that sensing the world is not enough. Our brains must receive, convert, and constantly adapt the information from our sense organs into useful mental representations of the world. How we get the outside world inside to our brains, and what our brains do with this information, are the key topics of this chapter.

UNDERSTANDING SENSATION

LEARNING OBJECTIVES

RETRIEVAL PRACTICE While reading the upcoming sections, respond to each Learning Objective in your own words. Then compare your responses with those found at www.wiley.com/college/huffman.

1. **DESCRIBE** how raw sensory stimuli are processed and converted to signals in the brain.
2. **EXPLAIN** how our experience of stimuli can be measured.
3. **SUMMARIZE** the factors involved in sensory adaptation.

Psychologists are keenly interested in our senses because they are our mind's window to the outside world. We're equally interested in how our mind perceives and interprets the information it receives from the senses.

Sensation begins with specialized receptor cells located in our sense organs (eyes, ears, nose, tongue, skin, and internal body tissues). When sense organs detect an appropriate stimulus (light, mechanical pressure, chemical molecules), they convert it into neural impulses (action potentials) that are transmitted to our brain. Through the process of **perception**, the brain then assigns meaning to this sensory information **(Table 4.1)**.

Sensation The process of detecting, converting, and transmitting raw sensory information from the external and internal environments to the brain.

Perception The processes of selecting, organizing, and interpreting sensory information into meaningful patterns; interpreting sensory images as having been produced by stimuli from the external, three-dimensional world.

Transduction The process whereby sensory receptors convert stimuli into neural impulses to be sent to the brain (for example, transforming light waves into neural impulses).

Coding The process in which neural impulses travel by different routes to different parts of the brain; it allows us to detect various physical stimuli as distinct sensations.

Processing

Our eyes, ears, skin, and other sense organs all contain special cells called receptors, which receive and process sensory information from the environment. For each sense, these specialized cells respond to a distinct stimulus, such as sound waves or odor molecules. Next, during the process of **transduction**, the receptors convert the energy from the specific sensory stimulus into neural impulses, which are sent to the brain. For example, in hearing, tiny receptor cells in the inner ear convert mechanical vibrations from sound waves into electrochemical signals. Neurons then carry these signals to the brain, where specific sensory receptors detect and interpret the information.

How does our brain differentiate between sensations, such as sounds and smells? Through a process known as **coding**, the brain interprets different physical