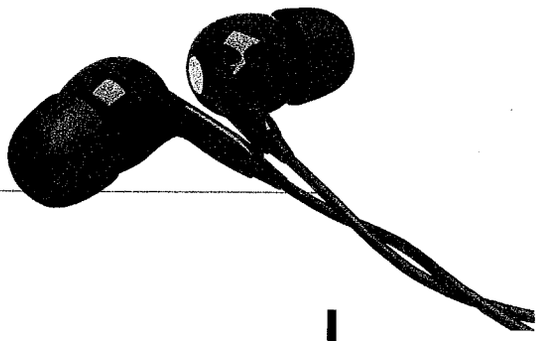
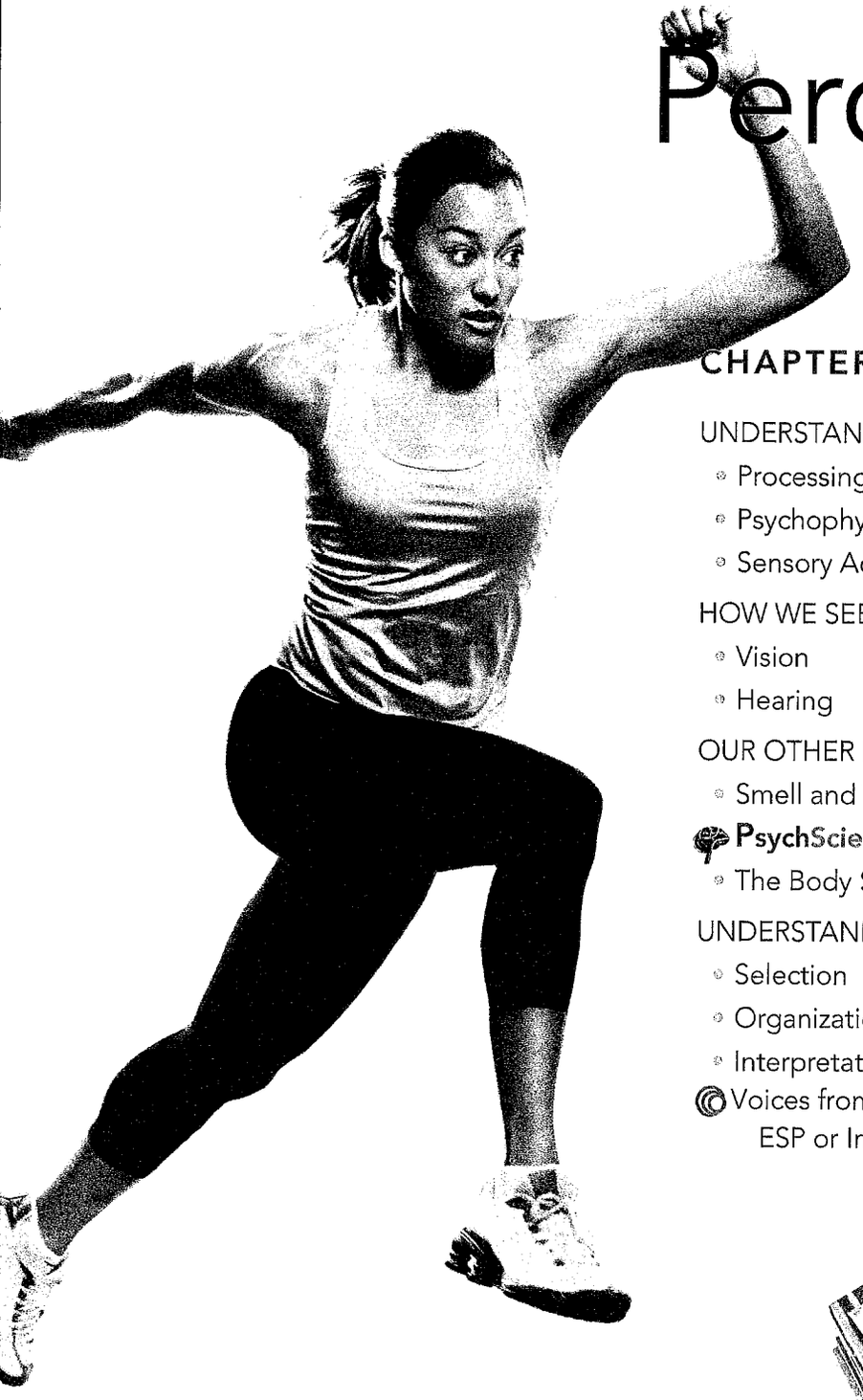
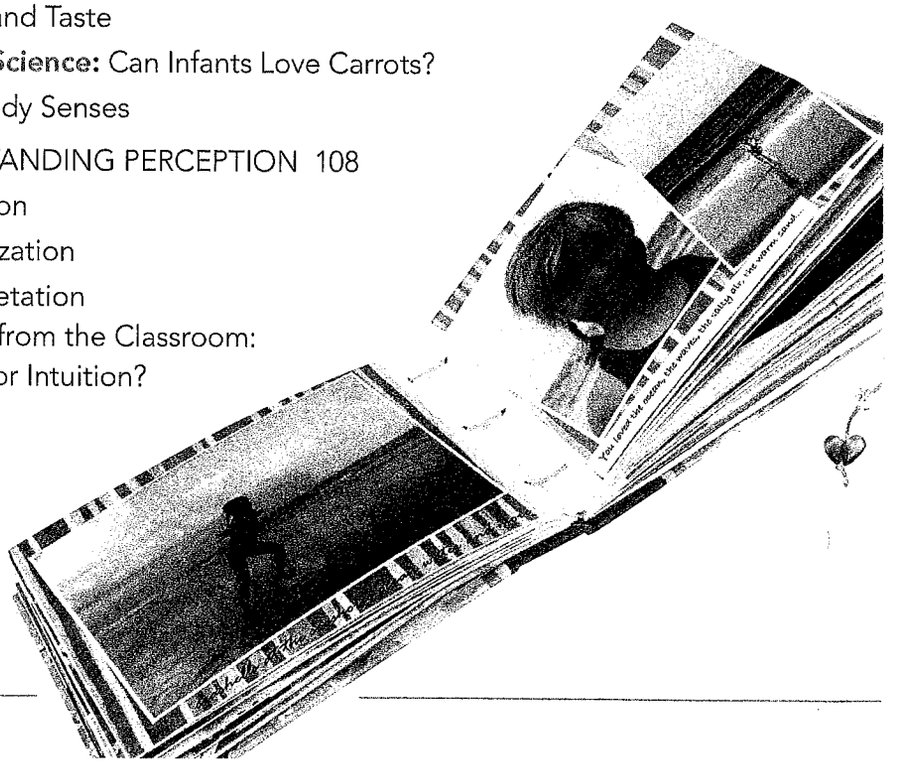
chapter four

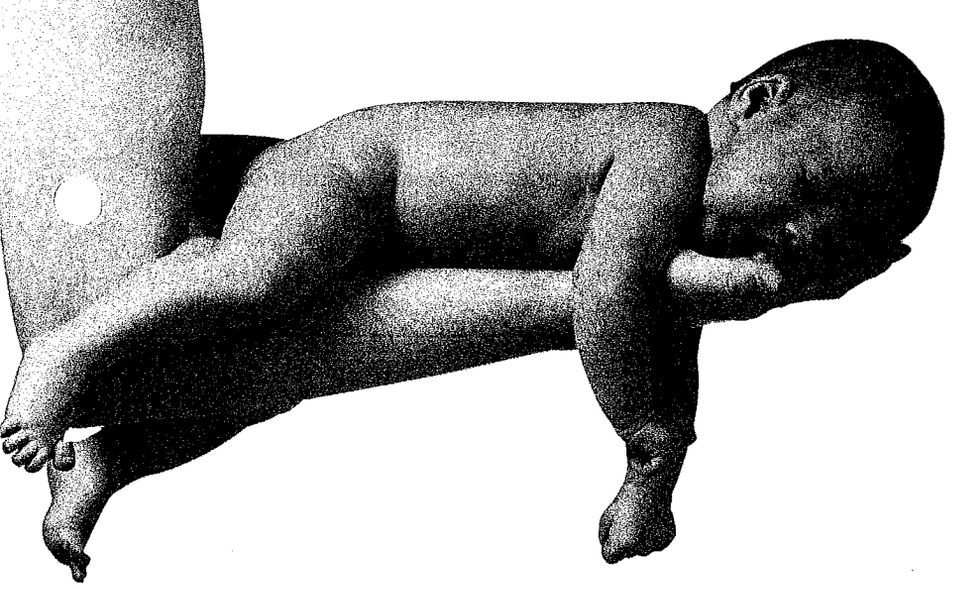


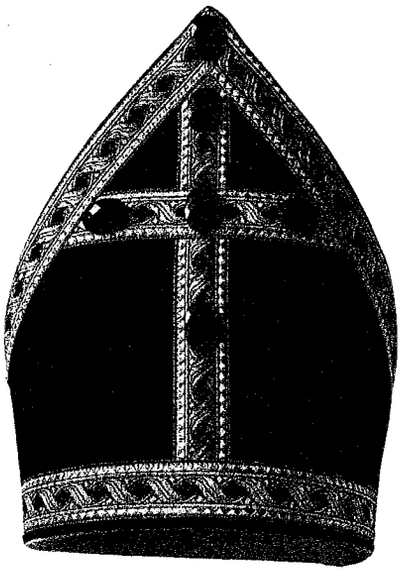
Sensation and Perception



CHAPTER OUTLINE







realworldpsychology

THINGS YOU'LL LEARN IN CHAPTER 4

Q1 Do athletes have a higher pain tolerance than non-athletes?

Q2 Can looking at a photograph of a loved one lead you to feel less pain?

Q3 How can listening to loud music on headphones damage your hearing?

Q4 Why do premature babies grow faster when they receive skin-to-skin contact?

Q5 Why do people rate themselves as more athletic if they compare themselves to the Pope than to a professional basketball player?

THROUGHOUT THE CHAPTER, MARGIN ICONS FOR Q1–Q5 INDICATE WHERE THE TEXT ADDRESSES THESE QUESTIONS.

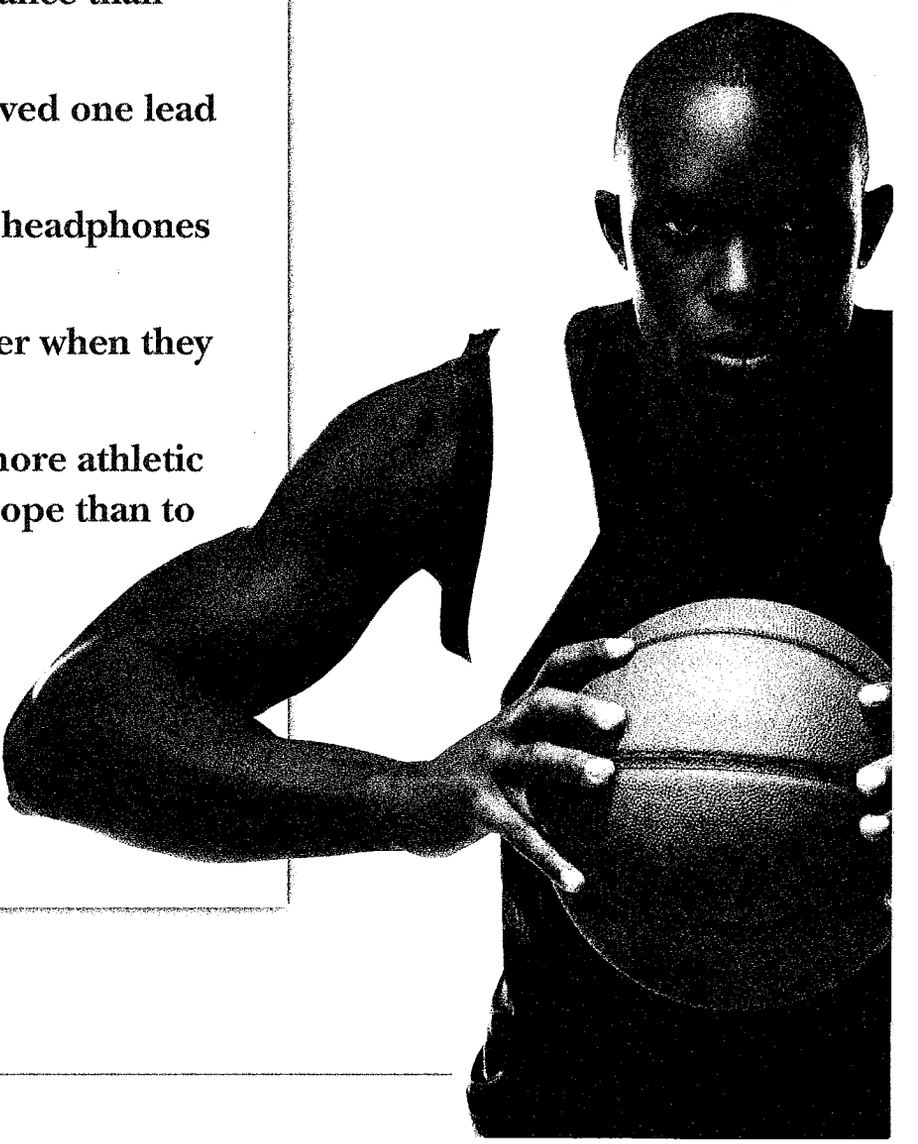
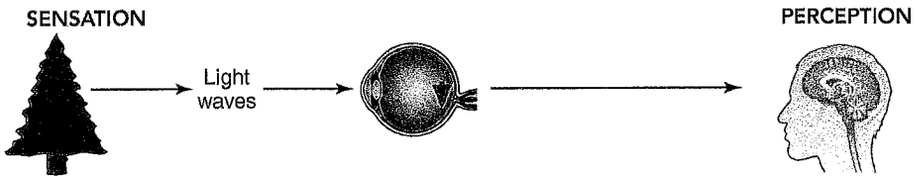
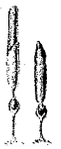


TABLE 4.1 SENSATION AND PERCEPTION



Sense	Stimulus	Receptors		Brain
Vision	Light waves	Light-sensitive rods and cones in eye's retina		Visual cortex in the occipital lobe
Audition (hearing)	Sound waves	Pressure-sensitive hair cells in ear's cochlea		Auditory cortex in the temporal lobe
Olfaction (smell)	Molecules dissolved on nose's mucous membranes	Neurons in the nose's olfactory epithelium		Temporal lobe and limbic system
Gustation (taste)	Molecules dissolved on tongue	Taste buds on tongue's surface		Limbic system, somatosensory cortex, and frontal lobe
Body senses	Variety of stimuli	Variety of receptors		Motor cortex in the frontal lobe and the somatosensory cortex in the parietal lobe

stimuli as distinct sensations because their neural impulses travel by different routes and arrive at different parts of the brain **(Figure 4.1)**.

We also have structures that purposefully reduce the amount of sensory information we receive. In this process of *sensory reduction*, we analyze and then filter incoming sensations before sending neural impulses on for further processing in other parts of our brain. Without this natural filtering of stimuli, we would constantly hear blood rushing through our veins and feel our clothes brushing against our skin. Some level of filtering is needed to prevent our brain from being overwhelmed with unnecessary information.

All species have evolved selective receptors that suppress or amplify information for survival. Humans, for example, cannot sense ultraviolet light, electric or magnetic fields, the ultrasonic sound of a dog whistle, or infrared heat patterns from warm-blooded animals, as some other animals can.

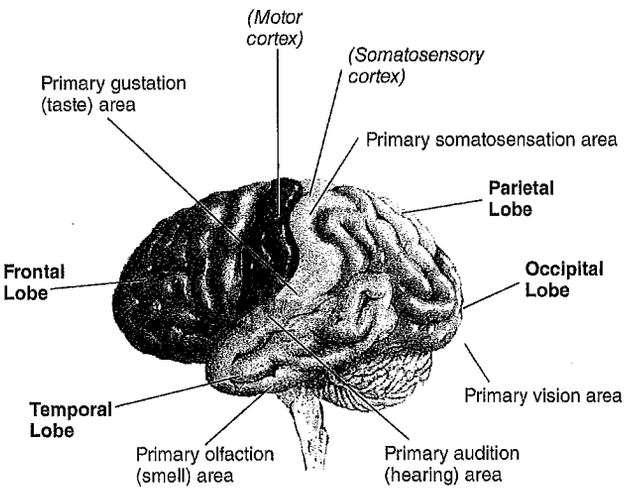


FIGURE 4.1 SENSORY PROCESSING WITHIN THE BRAIN

Neural messages from the various sense organs must travel to the brain in order for us to see, hear, smell, and so on. Shown here in the red-colored labels are the primary locations in the cerebral cortex for vision, hearing, taste, smell, and somatosensation (which includes touch, pain, and temperature sensitivity).

Psychophysics

How can scientists measure the exact amount of stimulus energy it takes to trigger a conscious experience? The answer come from the

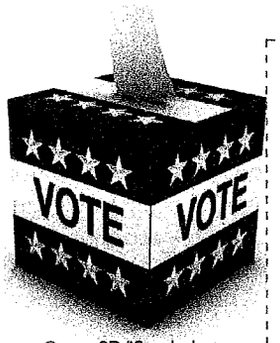
2013; Smith, 2012). Experimental studies on **subliminal perception** commonly use an instrument, called a *tachistoscope,* to flash images too quickly for conscious recognition but slowly enough to be registered by the brain.

For example, in one study, experimenters subliminally presented photographs to two groups of participants who were receiving either a painful or a not-so-painful heat shock (Jensen et al., 2012). A photo of one man was presented every time the painful heat shock was delivered. However, a different man's photo was presented every time the not-so-painful shock was delivered.

Next, the experimenters subliminally presented all participants with these same photos before they received a moderate shock. As predicted, participants from the group who saw the photo previously associated with the painful heat shock rated the moderate shock as more severe than those in the group who saw the photo associated with the not-so-painful shock.

FIGURE 4.3 PUTTING ANIMALS' HIGHER SENSORY RECEPTORS TO WORK

Subliminal perception The perception of stimuli presented below conscious awareness.



realworldpsychology **The Limits of Subliminal Perception**

Evidence that subliminal perception occurs doesn't necessarily mean that such processes lead to *subliminal persuasion.* Subliminal stimuli are basically weak stimuli. At best, they have a modest (if any) effect on consumer behavior, and they have absolutely no effect on the attitudes of youth listening to rock music, or on citizens' voting behavior (Bermeritinger et al., 2009; Fennis & Stroebe, 2010; Salpeter & Swirsky, 2012). As for subliminal tapes promising to help you lose weight or relieve stress, save your money! Blank "placebo" tapes appear to be just as effective (e.g., Merikle & Skanes, 1992).

Sensory Adaptation

Imagine that friends have invited you to come visit their beautiful new baby. As they greet you at the door, you are overwhelmed by the odor of a wet diaper. Why don't your friends do something about that smell? The answer lies in the previously mentioned sensory reduction, as well as **sensory adaptation**. When a constant stimulus is presented for a length of time, sensation often fades or disappears. Receptors in our sensory system become less sensitive. They get "tired" and actually fire less frequently.

Sensory adaptation The process by which receptor cells become less sensitive due to constant stimulation.

Sensory adaptation can be understood from an evolutionary perspective. We can't afford to waste attention and time on unchanging, normally unimportant stimuli. "Turning down the volume" on repetitive information helps the brain cope with an overwhelming amount of sensory stimuli and enables us to pay attention to change. Sometimes, however, adaptation can be dangerous, as when people stop paying attention to a small gas leak in the kitchen.

Although some senses, like smell and touch, adapt quickly, we never completely adapt to visual stimuli or to extremely intense stimuli, such as the odor of ammonia or the pain of a bad burn. From an evolutionary perspective, these limitations on sensory adaptation aid survival by reminding us, for example, to keep a watch out for dangerous predators, avoid strong odors and heat, and take care of that burn.

If we don't adapt to pain, how do athletes keep playing despite painful injuries? In certain situations, including times of physical exertion, the body releases natural painkillers called *endorphins* (Chapter 2), which inhibit pain perception. This is the so-called "runner's high," which may help explain why athletes have been found to have a higher pain tolerance than nonathletes (Tesarz et al., 2012). (As a critical thinker, is it possible that individuals with a naturally high pain tolerance are just more attracted to athletics? Or might the experience of playing sports change your pain tolerance?)

Q1

In addition to endorphin release, one of the most widely accepted explanations of pain perception is the **gate-control theory of pain**, first proposed by Ronald

Gate-control theory of pain The theory that pain sensations are processed and altered by certain cells in the spinal cord, which act as gates to interrupt and block some pain signals while sending others on to the brain.

TEST YOURSELF: HOW WELL DO YOU MANAGE YOUR PAIN?

psychology and you

Score yourself on how often you use one or more of these strategies, using the following scale:
0 = never, 1 = seldom, 2 = occasionally, 3 = often, 4 = almost always, 5 = always.

_____**1.** I do something I enjoy, such as watching TV or listening to music.

_____**2.** I try to be around other people.

_____**3.** I do something active, like household chores or projects.

_____**4.** I try to feel distant from the pain, almost as if the pain were in somebody else's body.

_____**5.** I try to think about something pleasant.

_____**6.** I replay in my mind pleasant experiences from the past.

_____**7.** I tell myself that I can overcome the pain.

_____**8.** I don't think about the pain.

These questions are based on effective pain management techniques, such as distraction, ignoring pain, and reinterpreting it. Review those items that you checked as "never" or "seldom" and consider adding them to your pain management skills.

RETRIEVAL PRACTICE: UNDERSTANDING SENSATION

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. Transduction is the process of converting _____.

a. sensory stimuli into neural impulses that are sent along to the brain
b. receptors into transmitters
c. a particular sensory stimulus into a specific area of the brain
d. receptors into neural impulses

2. Sensory reduction refers to the process of _____.

a. reducing your dependence on a single sensory system
b. decreasing the number of sensory receptors that are stimulated
c. filtering and analyzing incoming sensations before sending a neural message on for further processing
d. reducing environmental sensations by physically preventing your sensory organs from seeing, hearing, and so on

3. Experiments on subliminal perception have _____.

a. supported its existence, but shown that it has little or no effect on persuasion
b. shown that subliminal perception occurs only among children and some adolescents
c. shown that subliminal messages affect only people who are highly suggestible
d. failed to support the phenomenon

4. The _____ theory of pain helps explain why it sometimes helps to rub or massage an injured area.

a. sensory adaptation
b. gate-control
c. just noticeable difference
d. Lamaze

Think Critically

1 Sensation and perception are closely linked. What is the central distinction between the two?

2 If we sensed and attended equally to each stimulus in the world, the amount of information would be overwhelming. What sensory and perceptual processes help us lessen the din?

3 If we don't adapt to pain, why is it that people can sometimes "tune out" painful injuries?

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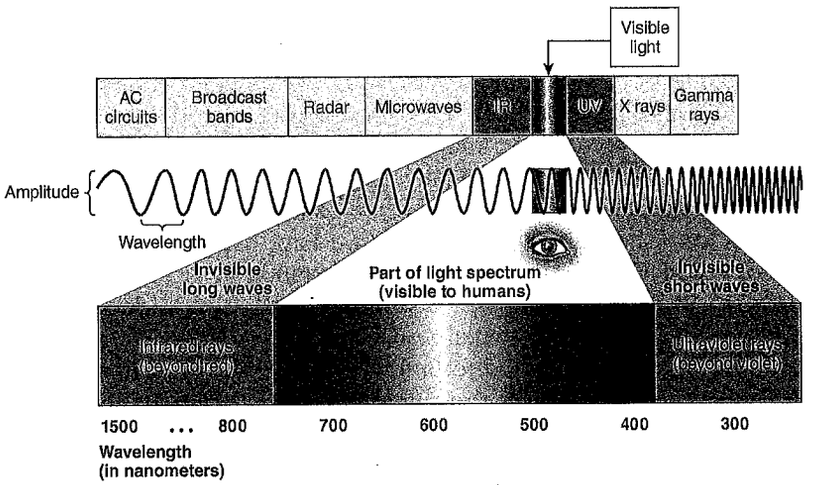
Do athletes have a higher pain tolerance than non-athletes?

Can looking at a photograph of a loved one lead you to feel less pain?

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

FIGURE 4.7 THE ELECTROMAGNETIC SPECTRUM FOR VISION



The full spectrum of electromagnetic waves contains very long wavelength AC circuits and radio waves at one end, and relatively short gamma ray waves at the other.

Only the light waves, in the middle of the electromagnetic spectrum, can be seen by the human eye. Note how the longer visible wavelengths are the light waves that we see as red, and the shortest are those we perceive as blue. In between are the rest of the colors.

FIGURE 4.8 HOW OUR EYES SEE

Various structures of your eye work together to capture and focus the light waves from the outside world. Receptor cells in your retina (rods and cones) then convert these waves into messages that are sent along the optic nerve to be interpreted by your brain.

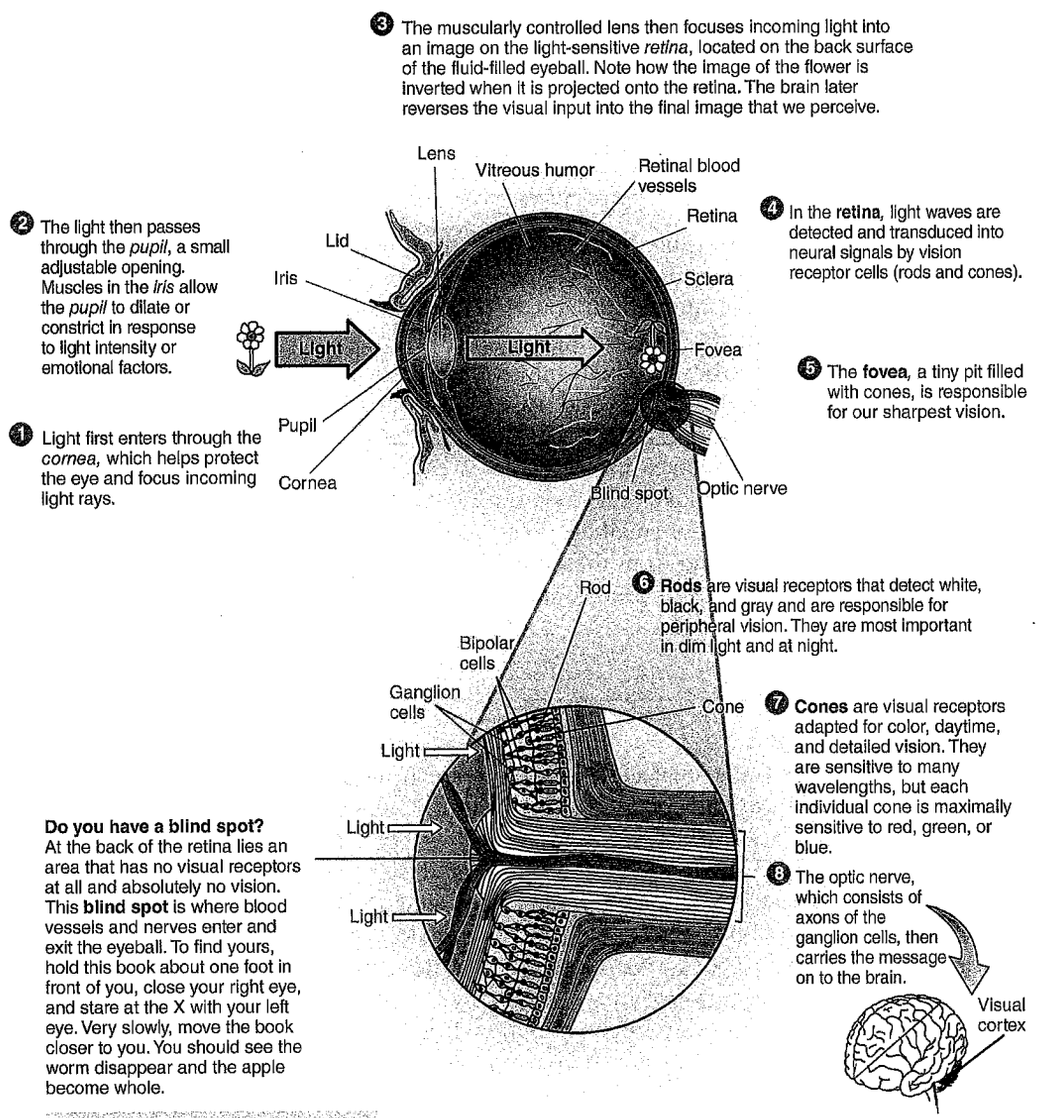
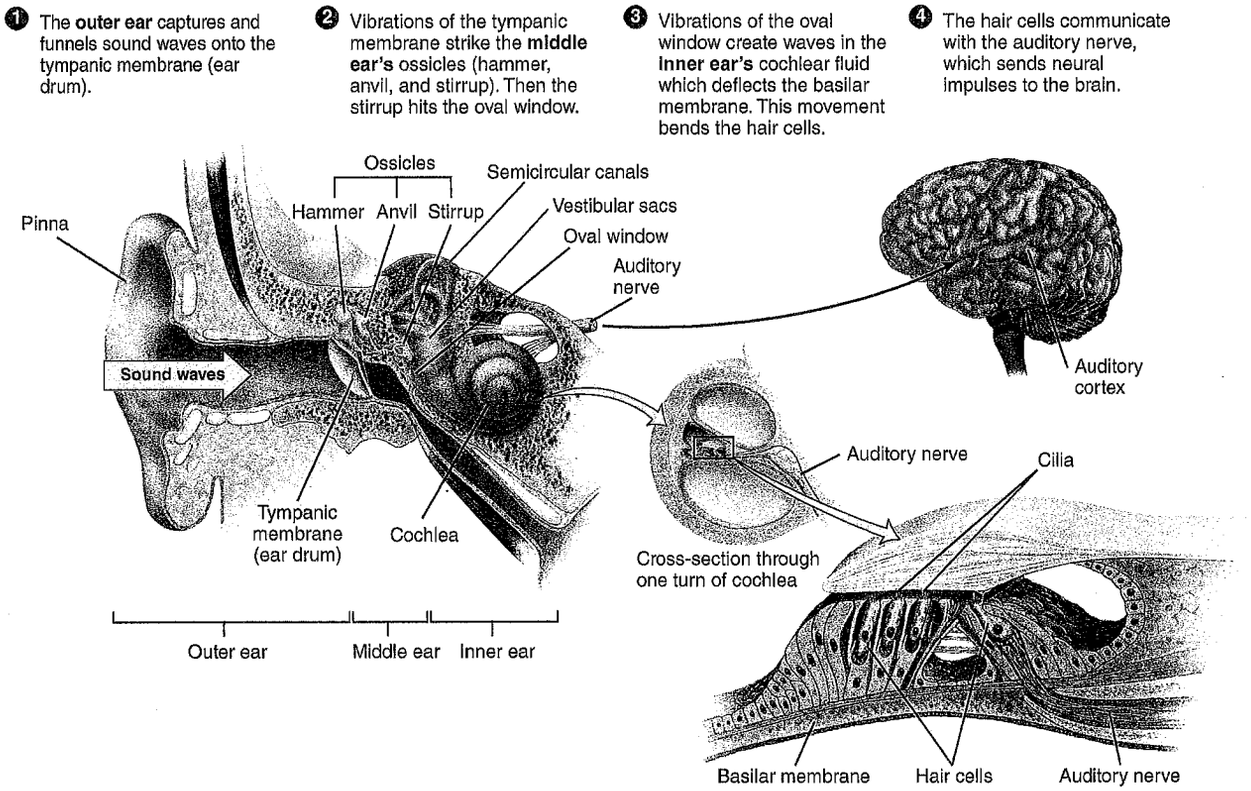


FIGURE 4.9 HOW OUR EARS HEAR

The **outer ear** captures and funnels sound waves into the eardrum. Next, three tiny bones in the **middle ear** pick up the eardrum's vibrations, and transmit them to the **inner ear**. Finally, the snail-shaped **cochlea** in the inner ear transforms (transduces) the sound waves into neural messages (action potentials) that our brain processes into what we consciously hear.



class **(Figure 4.10).** Ironically, the cell phone's ringtone that most adults can't hear is an offshoot of another device, called the Mosquito, which was originally designed to help shopkeepers annoy and drive away loitering teens!

Softness versus Loudness

How we detect a sound as being soft or loud depends on its amplitude (or wave height). Waves with high peaks and low valleys produce loud sounds; waves with relatively low peaks and shallow valleys produce soft sounds. The

TABLE 4.3 HOW WE DISTINGUISH AMONG SOUNDS OF DIFFERENT PITCH

Theory	Frequency	Pitch	Example
Place theory Hair cells are stimulated at different locations on basilar membrane.	High frequency	High-pitched sounds	A squeal or a child's voice
Frequency theory Hair cells fire at the same rate as the frequency for the sound.	Low frequency	Low-pitched sounds	A growl or an adult's voice

Outer ear The pinna, auditory canal, and eardrum structures which funnel sound waves to the middle ear.

Middle ear The hammer, anvil, and stirrup structures of the ear, which concentrate eardrum vibrations onto the cochlea's oval window.

Inner ear The semicircular canals, vestibular sacs, and cochlea, which generate neural signals that are sent to the brain.

Cochlea [KOK-lee-uh] The fluid-filled, coiled tube in the inner ear that contains the receptors for hearing.

psychology and you **Strategies for Protecting Hearing**

Given the limited benefits of medicine or technology to help improve hearing following damage, it's important to protect our sense of hearing. We can do this by avoiding exceptionally loud noises, wearing earplugs when we cannot avoid such stimuli, and paying attention to bodily warnings of possible hearing loss, including a change in our normal hearing threshold and *tinnitus*, a whistling or ringing sensation in the ears. These relatively small changes can have lifelong benefits!

Bernd Leitner Fotodesign/Shutterstock

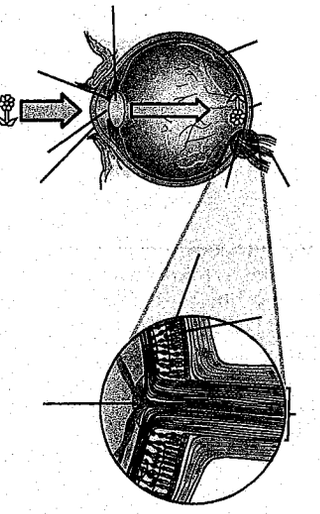
RETRIEVAL PRACTICE: HOW WE SEE AND HEAR

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. Identify the parts of the eye, placing the appropriate label on the figure to the right.

cornea	rod
iris	cone
pupil	fovea
lens	blind spot
retina	optic nerve

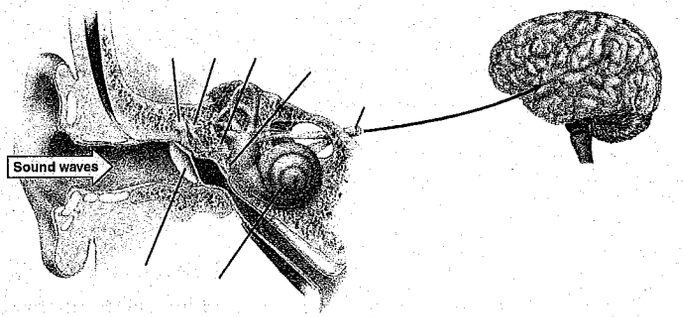


2. A visual acuity problem that occurs when the cornea and lens focus an image in front of the retina is called _____.

a. farsightedness
b. hyperopia
c. myopia
d. presbyopia

3. Identify the parts of the ear, placing the appropriate label on the figure to the right.

tympanic membrane	hammer
anvil	oval window
stirrup	cochlea



4. Chronic exposure to loud noise can cause permanent _____.

a. auditory illusions
b. auditory hallucinations
c. nerve deafness
d. conduction deafness

Think Critically

1. Which of your sensations, vision or hearing, would you most and least like to lose? Why?
2. Many people believe that blind people have supernatural hearing. How would brain plasticity explain how enhanced hearing might result from greater reliance on hearing or from just using auditory information more effectively?
3. Using what you've learned about pitch, how would you explain why an older person often has an easier time of hearing a man's voice than a woman's voice?

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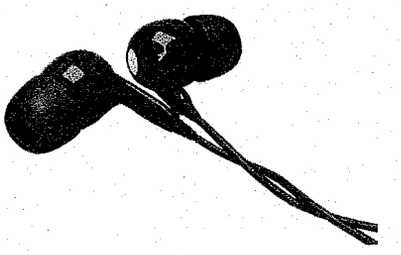
How can listening to loud music on headphones damage your hearing?



HINT: LOOK IN THE MARGIN FOR Q3

FIGURE 4.12 WHY WE ENJOY EATING PIZZA: OLFACTION PLUS GUSTATION

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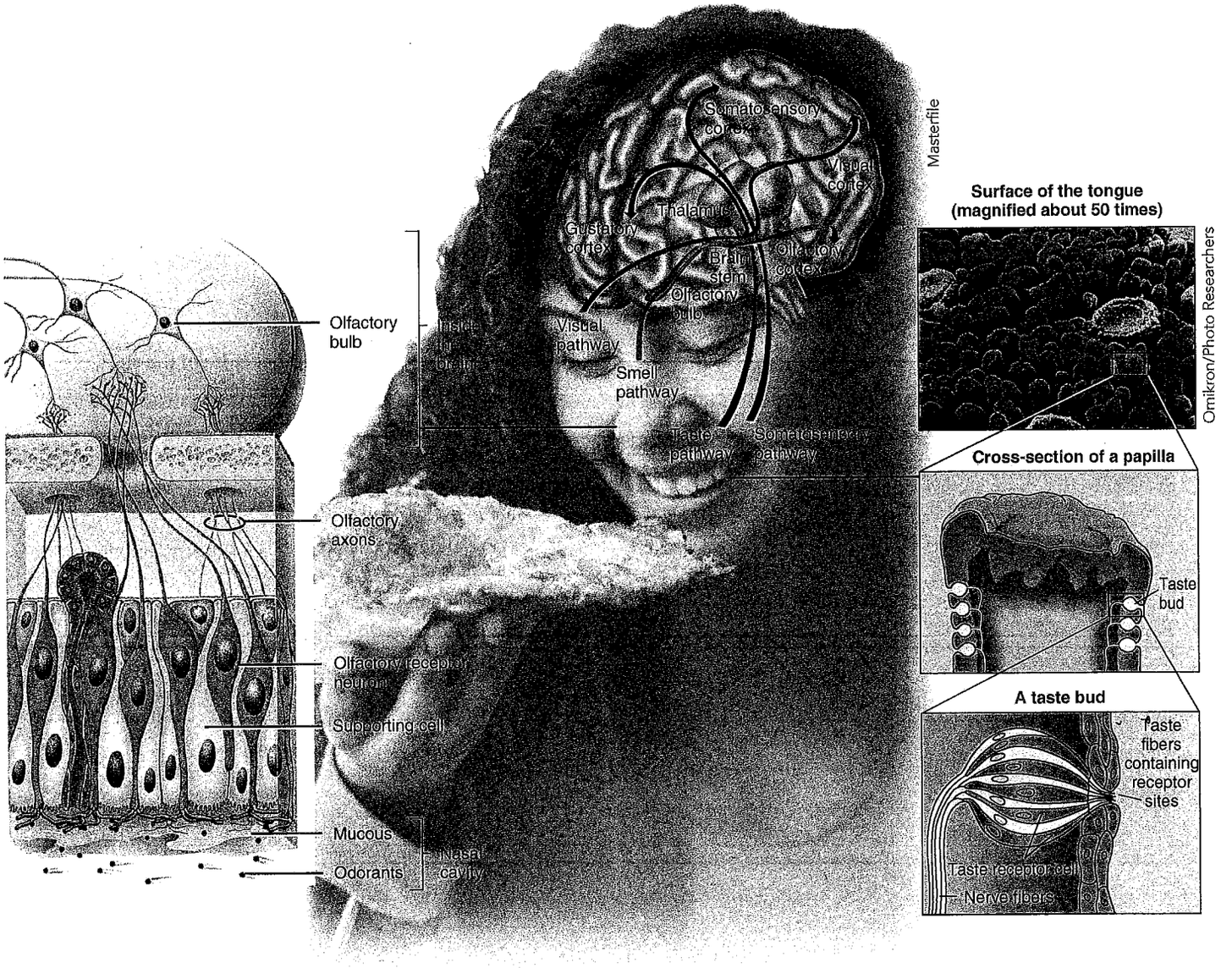
What happens when we eat pizza? Taste receptor cells, as well as sensory cells that respond to touch and temperature, are activated on our tongues. Smell receptor cells in our nose are activated by odors from the pizza. This combined sensory information is then sent to the brain, where it is processed in various association regions of the cerebral cortex. These circuits, together with those that store memories related to our previous pizza experiences, work together to produce our perceptions of each pizza experience.



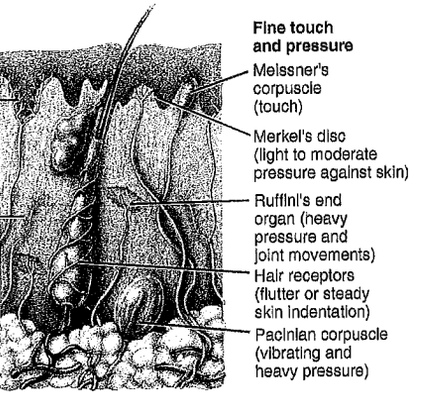
A The smell pathway
Olfactory receptor neurons (shown here in blue) transduce information from odorant molecules that enter the nose. The olfactory nerve carries this information into the olfactory bulb, where most information related to smell is processed before being sent on to other parts of the brain. (Note that olfaction is the only sensory system that is NOT routed through the thalamus.)

B The taste pathway
When we eat and drink, liquids and dissolved foods flow over papillae (the lavender circular areas) and into their pores to the taste buds, which contain the receptors for taste. These nerves carry information into the brain stem, thalamus, gustatory cortex, and somatosensory cortex.

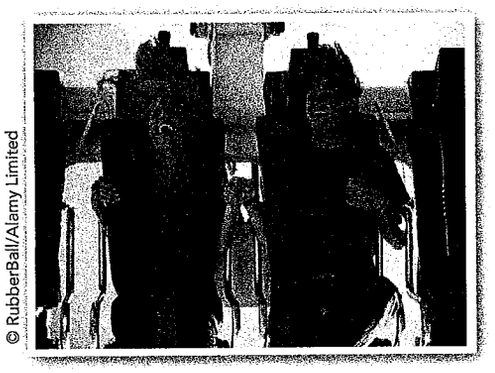
FIGURE 4.13 OUR BODY SENSES—SKIN, VESTIBULAR, AND KINESTHESIS

Ⓐ Skin senses
The tactile senses rely on a variety of receptors located in different parts of the skin. Both humans and nonhuman animals are highly responsive to touch.

© Philip Dyer/iStockphoto



Ⓑ Vestibular sense
Part of the "thrill" of amusement park rides comes from our vestibular sense becoming confused. The vestibular sense is used by the eye muscles to maintain visual fixation and sometimes by the body to change body orientation. We can become dizzy or nauseated if the vestibular sense becomes "confused" by boat, airplane, or automobile motion. Children between ages 2 and 12 years have the greatest susceptibility to motion sickness.



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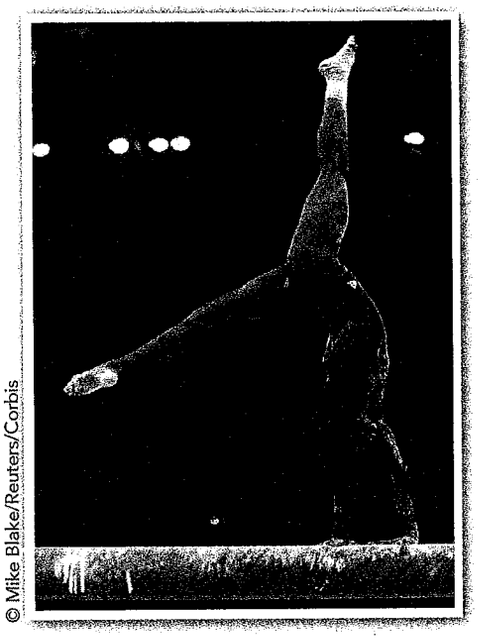

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Ⓒ Kinesthesis
This athlete's finely-tuned behaviors are the result of information provided by receptors in her muscles, joints, and tendons that detect bodily position and movement.

because we have many receptors on our fingertips. Some receptors respond to more than one type of stimulation. For example, itching, tickling, and vibrating sensations seem to be produced by light stimulation of both pressure and pain receptors.

The benefits of touch are so significant for human growth and development that the American Academy of Pediatrics recommends that all mothers and babies have skin-to-skin contact in the first hours after birth. This type of contact, which is called *kangaroo care*, is especially beneficial for preterm and low-birth-weight infants, who then experience greater weight gain, fewer infections, and improved cognitive and motor development.

How does kangaroo care lead to these improvements in infant health? This type of skin-to-skin touch helps babies in several ways, including providing warmth (babies don't have to expend so much energy themselves to stay warm), reducing pain (babies have lower levels of stress and arousal, which improves immune functioning), and improving sleep quality (babies have more time and energy to devote to growth) (Johnston et al., 2011).

Q4

Vestibular Sense

Our sense of balance, the **vestibular sense**, informs our brain of how our body (particularly our head) is oriented with respect to gravity and three-dimensional space **(Figure 4.13b)**. When our head tilts, liquid in the *semicircular canals*,

Vestibular sense The sense, located in the inner ear, that detects body movement and position with respect to gravity; also called the sense of balance.

Normally, our perceptions agree with our sensations. When they do not, the result is called an **illusion**, a false or misleading impression produced by errors in the perceptual process or by actual physical distortions, as in desert mirages. Illusions provide psychologists with a tool for studying the normal process of perception **(Figure 4.14)**.

Illusion A false or misleading perception shared by others in the same perceptual environment.

Note that illusions are NOT the same as hallucinations or delusions. *Hallucinations* are false sensory experiences that occur without external stimuli, such as hearing voices during a psychotic episode or seeing particular images after using some type of hallucinogenic drug, such as LSD or hallucinogenic mushrooms. *Delusions* refer to false beliefs, often of persecution or grandeur, that may accompany drug or psychotic experiences.

Selection

In almost every situation, we confront more sensory information than we can reasonably pay attention to. Three major factors help us focus on some stimuli and ignore others: *selective attention*, *feature detectors*, and *habituation*.

Certain basic mechanisms for perceptual selection are built into the brain. For example, through the process of **selective attention (Figure 4.15)**, the brain picks out the information that is important to us and discards the rest (Haab et al., 2011; Kar, 2013; Lamy et al., 2013).

Selective attention The process of filtering out and attending only to important sensory messages.

FIGURE 4.14 UNDERSTANDING PERCEPTUAL ILLUSIONS

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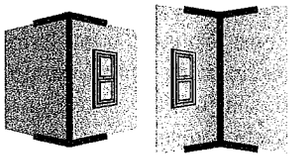
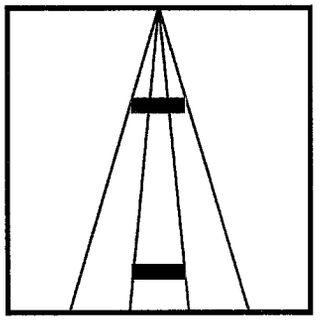
As you may have noticed, this text highlights numerous popular *myths* about psychology because it's important to understand and correct our misperceptions. For similar reasons, you need to know how illusions mislead out normal information processing and recognize that "seeing is believing, but seeing isn't always believing correctly" (Lilienfeld et al., 2010, p.7).



A Müller-Lyer illusion
Which vertical line is longer? In fact, the two vertical lines are the same length, but psychologists have learned that people who live in urban environments normally see the one on the right as longer. This is because they have learned to make size and distance judgments from perspective cues created by right angles and horizontal and vertical lines of buildings and streets.



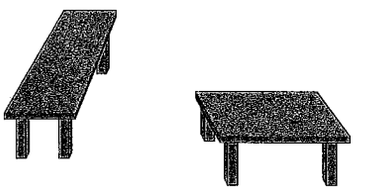
B Ponzo illusion
Which of the two horizontal lines is longer? In fact, both lines are the exact same size, but the converging lines provide depth cues telling you that the top dark, horizontal line is farther away than the bottom line and therefore much larger.

Think Critically

1. What do you think causes "errors" in the perceptual process, such as the optical illusions described here?
2. When you watch films of moving cars, the wheels appear to go backward. Can you explain this common visual illusion?

C The horizontal-vertical illusion
Which is longer, the horizontal (flat) or the vertical (standing) line? People living in areas where they regularly see long straight lines, such as roads and train tracks, perceive the horizontal line as shorter because of their environmental experiences.

D Shepard's tables
Do these two table tops have the same dimensions? Get a ruler and check it for yourself.



Organization

Raw sensory data are like the parts of a watch—the parts must be assembled in a meaningful way before they are useful. We organize sensory data in terms of form, depth, constancy, and color.

Form perception Gestalt psychologists were among the first to study how the brain organizes sensory impressions into a *gestalt*—a German word meaning "form" or "whole." They emphasized the importance of organization and patterning in enabling us to perceive the whole stimulus rather than perceive its discrete parts as separate entities. The Gestaltists proposed several laws of organization that specify how people perceive form **(Figure 4.17)**.

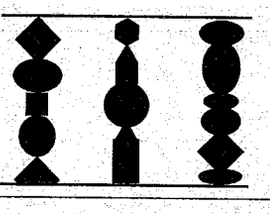
The most fundamental Gestalt principle of organization is our tendency to distinguish between the *figure* (our main focus of attention) and *ground* (the background or surroundings).

Your sense of figure and ground is at work in what you are doing right now—reading. Your brain is receiving sensations of black lines and white paper, but your brain is organizing these sensations into black letters and words on a white background. You perceive the letters as the figure and the white as the ground. If you make a great effort, you might be able to force yourself to see the page reversed, as though a black

FIGURE 4.17 UNDERSTANDING GESTALT PRINCIPLES OF ORGANIZATION

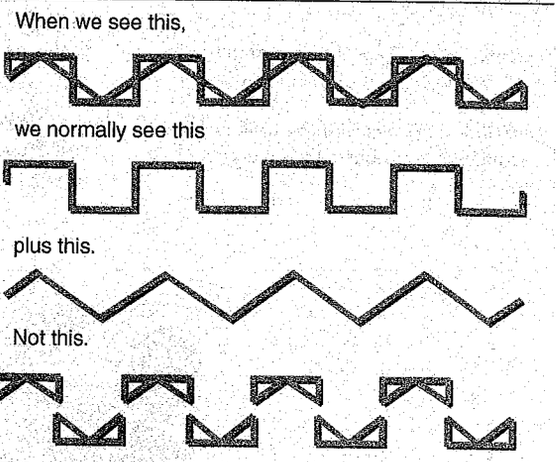
Gestalt principles are based on the notion that we all share a natural tendency to force patterns onto whatever we see. Although the examples of the Gestalt principles in this figure are all visual, each principle applies to other modes of perception as well. For example, the Gestalt principle of *contiguity* cannot be shown because it involves nearness in time, not visual nearness. Similarly, the aural (hearing) effects of figure and ground aren't shown in this figure, but you've undoubtedly experienced them in a movie theater. Despite nearby conversations in the audience, you can still listen to the voices on the film because you make them your focus (the figure) versus the ground.

Figure–Ground:
Objects (the *figure*) are seen as distinct from the surroundings (the *gound*). (Here the red objects are the figure and the yellow backgound is the ground).

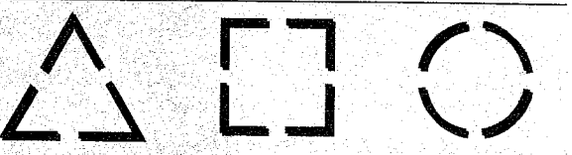


Proximity:
Objects that are physically close together are grouped together. (In this figure, we see 3 groups of 6 hearts, not 18 separate hearts.)

Continuity:
Objects that continue a pattern are grouped together. (When we see line **a.**, we normally see a combination of lines **b.** and **c.** — not **d.**)



Closure:
The tendency to see a finished unit (triangle, square, or circle) from an incomplete stimulus.



Similarity:
Similar objects are grouped together (the green colored dots are grouped together and perceived as the number 5).

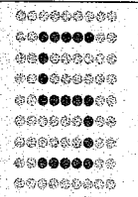
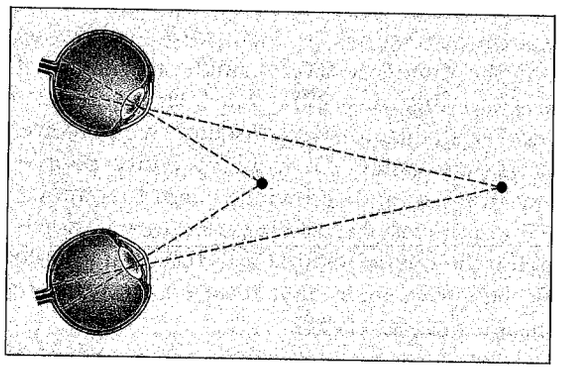


FIGURE 4.20 BINOCULAR DEPTH CUES

How do we perceive a three-dimensional world with a two-dimensional receptor system? One mechanism is the interaction of both eyes to produce binocular cues.

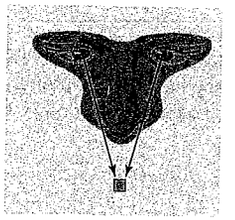
Ⓐ Retinal disparity

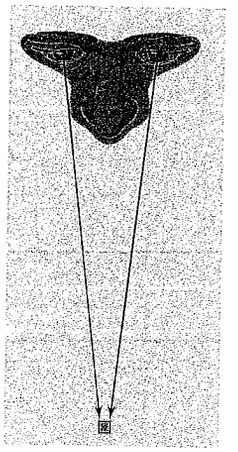
Stare at your two index fingers a few inches in front of your eyes with their tips half an inch apart. Do you see the "floating finger"? Move it farther away and the "finger" will shrink. Move it closer and it will enlarge. Because our eyes are about 2½ inches apart, objects at different distances (such as the "floating finger") project their images on different parts of the retina, an effect called **retinal disparity**. Far objects project on the retinal area near the nose, whereas near objects project farther out, closer to the ears.



Ⓑ Convergence

Hold your index finger at arm's length in front of you and watch it as you bring it closer until it is right in front of your nose. The amount of strain in your eye muscles created by the **convergence**, or turning inward of the eyes, is used as a cue by your brain to interpret distance.





The binocular (two eyes) cues of **retinal disparity** and **convergence** are inadequate in judging distances longer than the length of a football field. Luckily, we have several monocular (one-eye) cues available separately to each eye. Imagine yourself as an artist and see whether you can identify each of the following cues in this beautiful photo of the Taj Mahal, a famous mausoleum in India (Figure 4.21):

- **Linear perspective** Parallel lines converge, or angle toward one another, as they recede into the distance.
- **Interposition** Objects that obscure or overlap other objects are perceived as closer.
- **Relative size** Close objects cast a larger retinal image than distant objects.
- **Texture gradient** Nearby objects have a coarser and more distinct texture than distant ones.
- **Aerial perspective** Distant objects appear hazy and blurred compared to close objects because of intervening atmospheric dust or haze.
- **Light and shadow** Brighter objects are perceived as being closer than darker objects.
- **Relative height** Objects positioned higher in our field of vision are perceived as farther away.

Two additional monocular cues for depth perception, **accommodation** of the lens of the eye and *motion parallax*, cannot be used by artists and are not shown in Figure 4.21. In *accommodation*, muscles that adjust the shape of the lens as it focuses on an object send neural messages to the brain, which interprets the signal to perceive distance. For near objects, the lens bulges; for

Retinal disparity The binocular cue of distance in which the separation of the eyes causes different images to fall on each retina.

Convergence A binocular depth cue in which the eyes turn inward (or converge) to fixate on an object.

Accommodation The process by which the eye's ciliary muscles change the shape (thickness) of the lens so that light is focused on the retina; adjustment of the eye's lens permitting focusing on near and distant objects.

FIGURE 4.21 MONOCULAR DEPTH CUES AND THE TAJ MAHAL

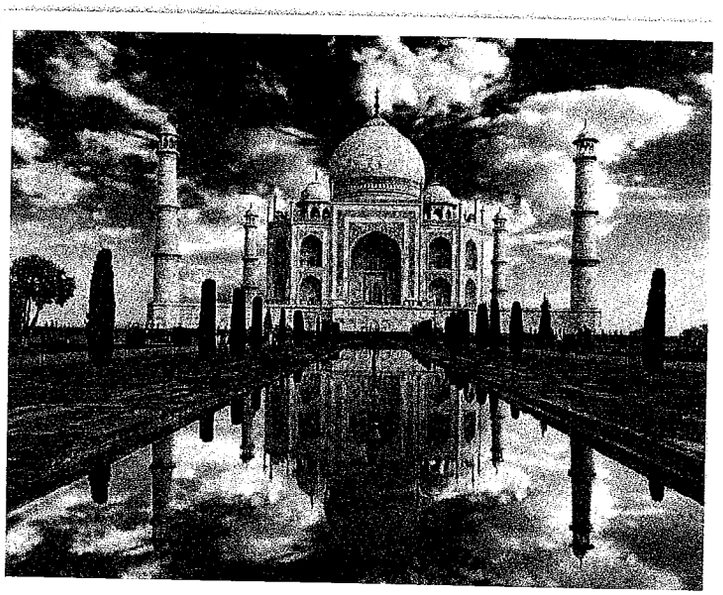
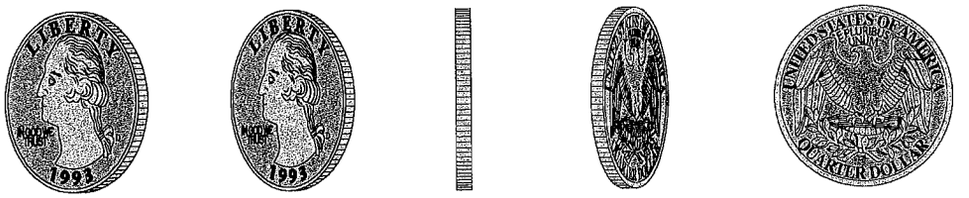
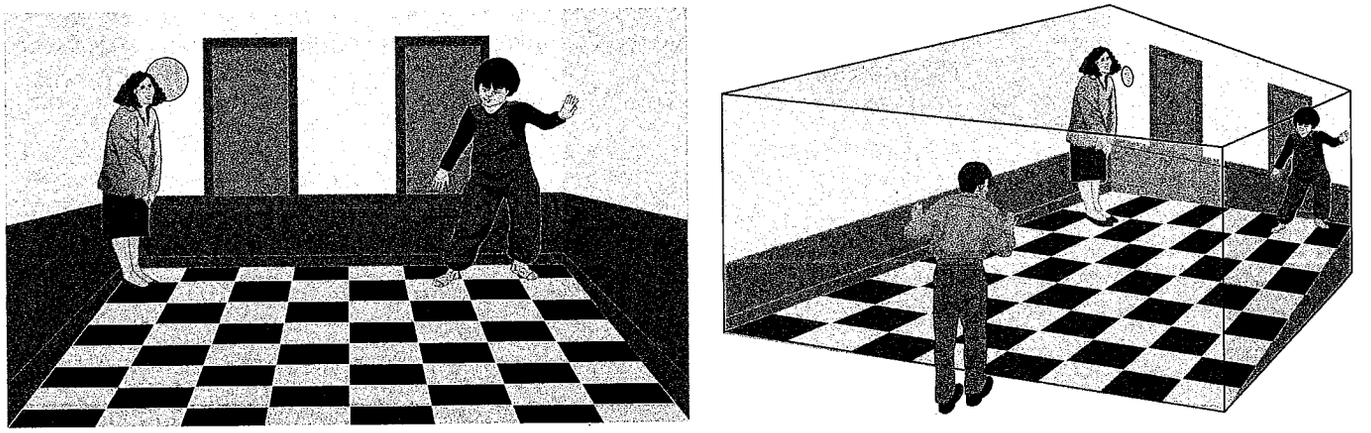


FIGURE 4.24 SHAPE CONSTANCY



Note how as the coin is rotated, it changes shape, but we still perceive it as the same coin—thanks to shape constancy.



The so-called Ames room illusion (shown in these two diagrams) illustrates both size and shape constancy. To a viewer peering through the peephole, the Ames room appears to be a normal cubic-shaped room. But the true shape is trapezoidal. In addition, the walls are slanted and the floor and ceiling are at an incline. Because our brains mistakenly assume that the two people are the same distance away, we compensate for the apparent size difference by making the person on the left appear much smaller.

despite the fact that the wavelength of light reaching our retina may vary as the light changes.

Shape constancy One additional perceptual constancy is the tendency to perceive an object's shape as staying constant even when the angle of our view changes **(Figure 4.24)**.

Color Perception

Our ability to perceive color is at least as remarkable and useful as depth perception. Humans may be able to discriminate among 7 million different hues, and research conducted in many cultures suggests that we all seem to see essentially the same colored world (Davies, 1998; Ozturk et al., 2013). Furthermore, studies of infants old enough to focus and move their eyes show that they are able to see color nearly as well as adults and have color preferences similar to those of adults (Franklin et al., 2010).

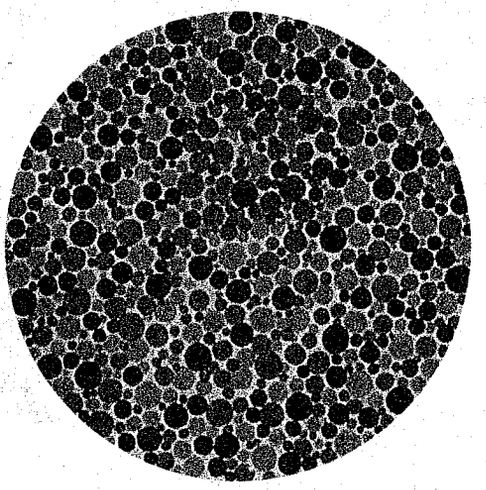
Although we know color is produced by different wavelengths of light, the actual way in which we perceive color is a matter of scientific debate. Traditionally, there have been two theories of color vision: the trichromatic (three-color) theory and the opponent-process theory. The **trichromatic theory of color** (from the Greek word *tri*, meaning "three," and *chroma*, meaning "color") suggests that we have three "color systems," each of which is maximally sensitive to red, green, or blue (Young, 1802). The proponents of this theory demonstrated that mixing lights of these three colors could yield the full spectrum of colors we perceive.

Trichromatic theory of color The theory that color perception results from three types of cones in the retina, each most sensitive to either red, green, or blue; other colors result from a mixture of these three.

TEST YOURSELF: UNDERSTANDING COLOR BLINDNESS

psychology and you

Are you color blind? People who suffer red–green deficiency have trouble perceiving the number in this design. Although we commonly use the term *color blindness*, most problems are color confusion rather than color blindness. Furthermore, most people who have some color blindness are not even aware of it.



Interpretation

After selectively sorting through incoming sensory information and organizing it, the brain uses this information to explain and make judgments about the external world. This final stage of perception—*interpretation*—is influenced by several factors, including sensory adaptation, perceptual set, frame of reference, and bottom-up or top-down processing.

Stratton's experiment with the inverting goggles, discussed in the chapter overview, illustrates the critical role that *sensory adaptation* plays in the way we interpret the information that our brains gather. Without his ability to adapt his perceptions to a skewed environment, Stratton would not have been able to function. His brain's ability to retrain itself to interpret his new surroundings allowed him to create coherence from what would otherwise have been chaos.

As you can see in the *Real World Psychology* example below, our previous experiences, assumptions, and expectations also affect how we interpret and perceive the world, by creating a **perceptual set**, or a readiness to perceive in a particular manner, based on expectations (Dunning & Balcetis, 2013). In other words, we largely see what we expect to see!

Perceptual set The readiness to perceive in a particular manner, based on expectations.

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Crime and Perceptual Sets In some cases, our *perceptual sets*, or expectations, can have hazardous effects. For example, researchers asked both white and black participants to play a videogame in which they were told to shoot targets who were carrying a gun but not those who were unarmed (Correll et al., 2002).

Participants of both races made the decision to shoot an armed target more quickly if the target was black, rather than white. They also chose NOT to shoot an unarmed target more quickly if the target was white, rather than black.

This study points to the influence of our expectations on real-life situations in which police officers must decide almost instantly whether to shoot a potential suspect—and may partially explain why blacks are at greater risk than whites of being accidentally shot by police officers.

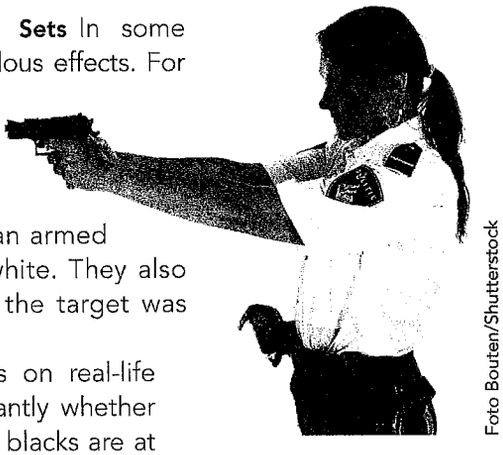

Foto Bouten/Shutterstock

So why do so many people believe in ESP? One reason is that, as mentioned earlier in the chapter, our motivations and interests often influence our perceptions, driving us to selectively attend to things we want to see or hear. In addition, the subject of extrasensory perception often generates strong emotional responses. When individuals feel strongly about an issue, they sometimes fail to recognize the faulty reasoning underlying their beliefs.

Belief in ESP is particularly associated with illogical or noncritical thinking. For example, people often fall victim to the *fallacy of positive instances*, or the *confirmation bias*, noting and remembering events that confirm personal expectations and beliefs (the "hits") and ignoring nonsupportive evidence (the "misses"). Other times, people fail to recognize chance occurrences for what they are. Finally, human information processing often biases us to notice and remember the most vivid information. Rather than relying on scientific research based on analyzing numerous data points, we prefer colorful anecdotes and heartfelt personal testimonials.

Voices from the Classroom

ESP or Intuition? I had been dating my girlfriend for nearly three years when a job offer caused me to move to another state. Soon after moving, I realized that I needed to propose to her to show her how serious I was about our relationship. When she came in town to visit me, I proposed to her the day after we had been dating for four years. I told no one in advance of this proposal. I was very excited to share this news with my mother; my mom and I have always been close. Even though we lived far from each other, we talked at least once or twice a week. So, I called my mom to share the big news with her. I said, "Hi mom." The first thing my mother said was, "Are you engaged?" Was this ESP or just mother's intuition? What do you believe?

Professor David Baskind
Delta College
University Center, Michigan

RETRIEVAL PRACTICE: UNDERSTANDING PERCEPTION

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. When our brain is sorting out and attending only to the most important messages from the senses, it is engaged in the process of _____.

a. sensory adaptation
b. sensory habituation
c. selective attention
d. selective sorting

2. In the _____ shown below, the discrepancy between figure and ground is too vague, and we may have difficulty perceiving which is figure and which is ground.

a. illusion
b. reversible figure
c. optical illusion
d. hallucination

3. The tendency for the environment to be perceived as remaining the same even with changes in sensory input is called _____.

a. perceptual constancy
b. the constancy of expectation
c. an illusory correlation
d. Gestalt's primary principle

4. The _____ of color vision says that color perception results from three types of cones in the retina.

a. tricolor theory
b. trichromatic theory
c. tripigment theory
d. opponent-process theory

5. A readiness to perceive in a particular manner is known as _____.

a. sensory adaptation
b. perceptual set
c. habituation
d. frame of reference

Think Critically

1. Can you explain how your own perceptual sets might create prejudice or discrimination?
2. How has reading this chapter's information about ESP influenced your beliefs about this topic?
3. Why do you think no one has ever received the $1 million dollar award that was offered for a provable case of ESP?

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Why do people rate themselves as more athletic if they compare themselves to the Pope than to a professional basketball player?

HINT: LOOK IN THE MARGIN FOR Q5

Key Terms

RETRIEVAL PRACTICE Write a definition for each term before turning back to the referenced page to check your answer.

- absolute threshold 94
- accommodation 113
- audition 100
- binocular cues 112
- blind spot 100
- bottom-up processing 118
- cochlea 101
- coding 92
- conduction hearing loss 102
- cones 100
- convergence 113
- depth perception 112
- difference threshold 94
- extrasensory perception (ESP) 118
- feature detectors 110
- fovea 100
- frequency theory for hearing 100
- gate-control theory of pain 95
- gustation 104
- habituation 110
- illusion 109
- inner ear 101
- kinesthesis 108
- middle ear 101
- monocular cues 112
- olfaction 104
- opponent-process theory of color 116
- outer ear 101
- perception 92
- perceptual constancy 114
- perceptual set 117
- pheromones 104
- place theory for hearing 100
- psychophysics 94
- retina 100
- retinal disparity 113
- rods 100
- selective attention 109
- sensation 92
- sensorineural hearing loss 102
- sensory adaptation 95
- subliminal perception 95
- top-down processing 118
- transduction 92
- trichromatic theory of color 115
- vestibular sense 107

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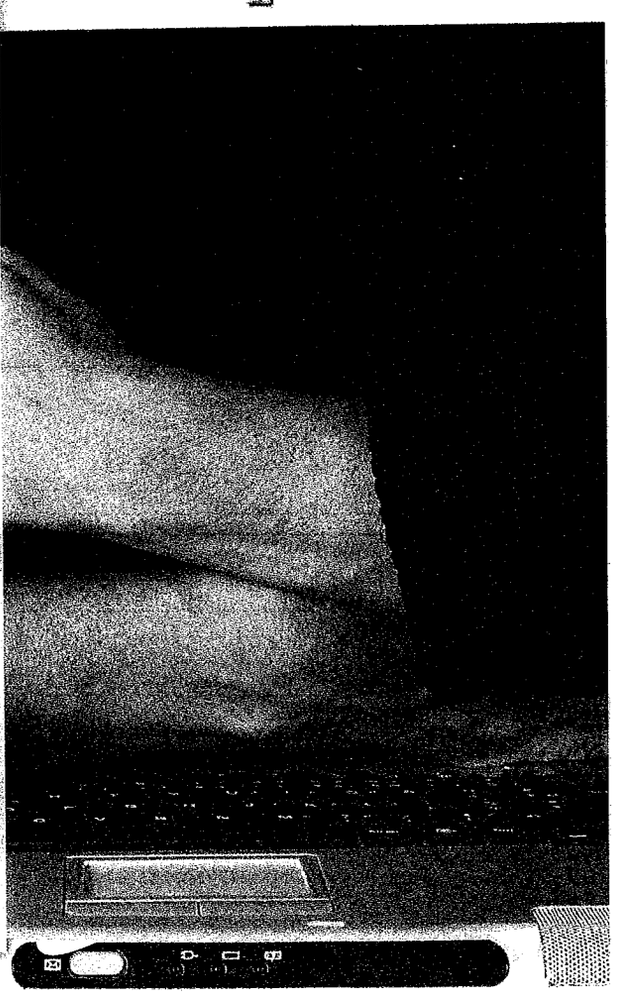
THINGS YOU'LL LEARN IN CHAPTER 5

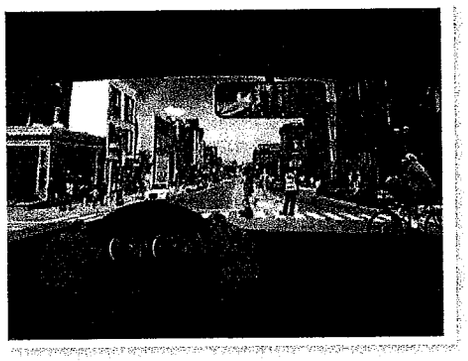


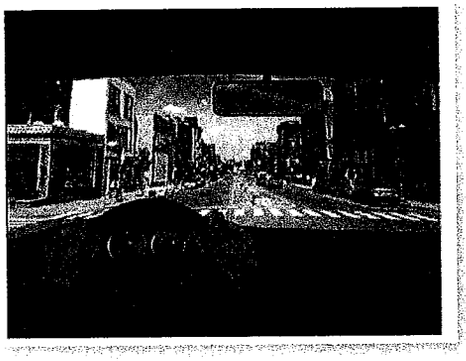
- **Q1** Can getting too little sleep increase your risk of getting a cold?
- **Q2** Can using a computer or iPad late at night make it harder to fall asleep?
- **Q3** Are you addicted to Facebook?
- **Q4** Can using marijuana decrease your IQ?
- **Q5** Can hypnosis decrease the pain of childbirth?

THROUGHOUT THE CHAPTER, MARGIN ICONS FOR Q1–Q5 INDICATE WHERE THE TEXT ADDRESSES THESE QUESTIONS.

PSYCHSCIENCE

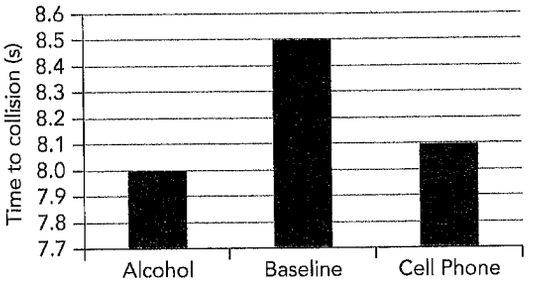
WHY DRIVING AND CELL PHONE USE JUST DON'T MIX





Strayer et al (2011). Cognitivedistraction while multitasking in theautomobile. In B. Ross (Ed.), *The Psychology of Learning and Motivation*, 54, 29-58

Driving while using a cell phone
The photo on the left shows what a driver sees when not distracted by using a cell phone. In the photo on the right, note what the driver does NOT see while talking on a cell phone. Can you understand why cell phone use (including texting) leads to accidents?



Does your state have laws about driving and talking—or texting—on a cell phone? These types of regulations are increasingly common, in part because of research conducted by psychologists that shows the extreme hazards of divided attention. Researchers in one study observed more than 1,700 drivers approaching an intersection. They recorded (1) whether the driver was talking on a cell phone as he or she approached the sign, and (2) if the car came to a complete stop (as the law requires) before going through the intersection. Their findings revealed that 75% of the drivers who were talking on a cell phone failed to come to a complete stop. In contrast, only 21% of those who were not talking on a cell phone failed to stop.

A follow-up laboratory study (also conducted by Strayer et al., 2011) recruited 40 volunteers and tested their skills on a driving simulator. Each volunteer was randomly assigned to one of three conditions:

- Driving while talking on a cell phone
- Driving while intoxicated (with a blood alcohol concentration of 0.08)
- Driving without talking on a cell phone or being intoxicated

The researchers examined a number of different measures of driving, including number of accidents, brake reaction time, and speed.

Can you predict what this research revealed? Both intoxicated drivers and drivers talking on a cell phone performed worse than those who were able to fully concentrate on driving (see the figure).

Keep in mind that all participants gave their informed consent for this research and that the "drunk drivers" were only tested in a driving simulator, not in an actual car.

RESEARCH CHALLENGE

1. Based on the information provided, did the two studies (Strayer et al., 2011) use descriptive, correlational, and/or experimental research? (Be sure to answer separately for each of the two Strayer studies.)
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 text books 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.

Disruptions in circadian rhythms are not just a problem for teenagers. We all are at risk of serious health issues and personal concerns, including increased risk of cancer, heart disease, autoimmune disorders, obesity, sleep disorders, and accidents, as well as decreased concentration and productivity (Dawson et al., 2011; Eckel-Mahan & Sassone-Corsi, 2013; Halvig et al., 2013; Jackson et al., 2013; Karatsoreos et al., 2011; Kyriacou & Hastings, 2010; Menegaux et al., 2013; Narasimamurthy et al., 2012; Pilcher et al., 2013; Wyse, 2012; Zhu & Zee, 2012). The most serious disruptions and ill effects from these sleep and circadian disturbances tend to be with physicians, nurses, police, and others—about 20% of employees in the United States—whose occupations require rotating "shift work" schedules. Typically divided into a first shift (8 a.m. to 4 p.m), second shift (4 p.m. to midnight) and a third shift (midnight to 8 a.m.), these work shifts often change from week to week, and clearly disrupt the workers' circadian rhythms. Some research suggests that shifting from days to evenings to nights may make it easier to adjust to rotating shift schedules—probably because it's easier to go to bed later than to get up earlier. Workers' health, productivity, and safety are also believed to increase when shifts are rotated every three weeks instead of every week, and napping is allowed (Asaoka et al., 2013; Landy & Conte, 2013; Roth, 2012).

Image Source/Getty Images

Coping with disrupted circadian rhythms?

Although you might assume that only babies and small children need to nap, napping is actually very common among professional athletes. This extra sleep is important because they often play their games at night and in varying time zones, which disrupts their regular night-time sleep cycle (Abrams, 2011).

psychology and you **Understanding Jet Lag** Like shift work, flying across several time zones can also cause fatigue and irritability, decreased alertness and mental agility, as well as exacerbation of psychiatric disorders (Jones & Benca, 2013; Paul et al., 2011; Sack, 2010). Jet lag tends to be worse when we fly eastward because our bodies adjust more easily to going to bed later than to going to sleep earlier than normal.

© Pierivb/iStockphoto

Sleep Deprivation

One of the biggest problems with disrupted circadian rhythms is the corresponding disruptions in the amount and quality of our sleep, which poses its own set of hazards. Sleep deprivation is clearly associated with reduced cognitive and motor performance, irritability and other mood alterations, and increased cortisol levels, which are all signs of stress (Doane et al., 2010; Gupta & Gupta, 2013; Martella et al., 2011; Orzel-Gryglewska, 2010). Sleep deprivation also leads to impairment in the immune system, which is one reason adults who get fewer than seven hours of sleep a night are three times as likely to develop a cold as those who sleep at least eight hours a night (Ackerman et al., 2012; Cohen et al., 2009). In addition, sleep-deprived adults are more likely to become obese. This may be because getting inadequate amounts of sleep interferes with the production of hormones that control appetite (Knutson, 2012).

Q1

Suzanne DeChillo/The New York Times/Redux

Sleep deprivation can be fatal!

At 5:30 a.m. on March 12, 2011, a bus crashed on the outskirts of New York City, killing 15 people and injuring 14 others. In the three days prior to the crash, the bus driver had slept only during a few brief naps (McGeehan, 2012). The National Transportation Safety Board attributed the cause of this accident to driver fatigue.

Perhaps the most frightening danger is that lapses in attention among sleep-deprived pilots, physicians, truck drivers, and other workers cause serious accidents and cost thousands of lives each year (Chiang et al., 2012; Hallvig et al., 2013; Jackson et al., 2013; Mansukhani et al., 2012; Williamson et al., 2011). Are you wondering if you're sleep-deprived? Take the two-part test in the following *Psychology and You* to find out.

to various physiological recording devices **(Figure 5.2a)**. You will probably need a night or two to adapt to the equipment before the researchers can begin to monitor your typical night's sleep. At first, you enter a relaxed, *presleep* state. As you continue relaxing, your brain's electrical activity slows even further. In the course of about an hour, you progress through several distinct stages of sleep, each progressively deeper **(Figure 5.2b)**. Then the sequence begins to reverse. Note that we don't necessarily go through all sleep stages in this exact sequence. But during the course of a night, people usually complete four to five cycles of light to deep sleep and back, each lasting about 90 minutes **(Figure 5.2c)**.

Figure 5.2c also shows an interesting phenomenon that occurs at the end of the first sleep cycle (and subsequent cycles). You reverse back through Stages 3, 2, and 1. At the end of Stage 1, you enter a very different phase noted by the characteristic rapid eye movements occurring under your closed eyelids. Researchers call this stage **rapid-eye-movement (REM) sleep**. During REM sleep, your scalp recordings display a pattern of small-amplitude, fast-wave activity, similar to an awake, vigilant person's brain waves. Your breathing and pulse rates become fast and irregular, and your genitals likely show signs of arousal. Yet your musculature is deeply relaxed and unresponsive. Because of these contradictory qualities, this REM stage is also sometimes referred to as *paradoxical sleep*.

Rapid-eye-movement (REM) sleep The fifth stage of sleep marked by rapid eye movements, high-frequency brain waves, paralysis of large muscles, and often dreaming.

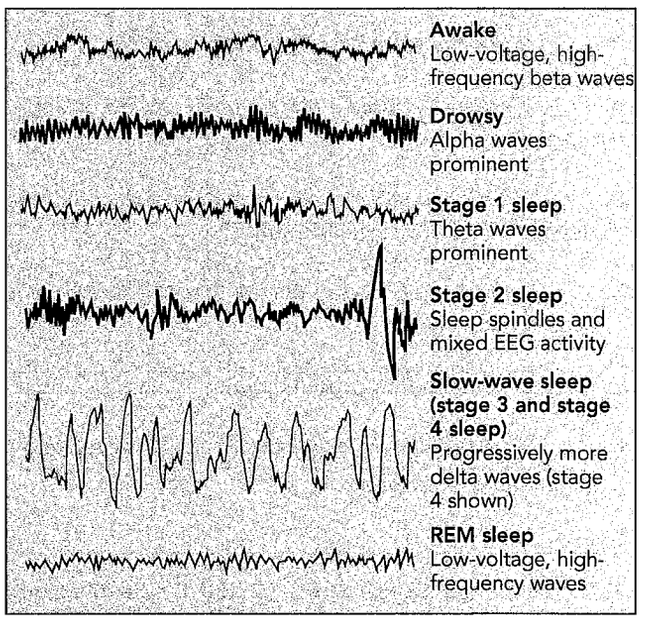
FIGURE 5.2 SCIENTIFIC STUDY OF SLEEP AND DREAMING

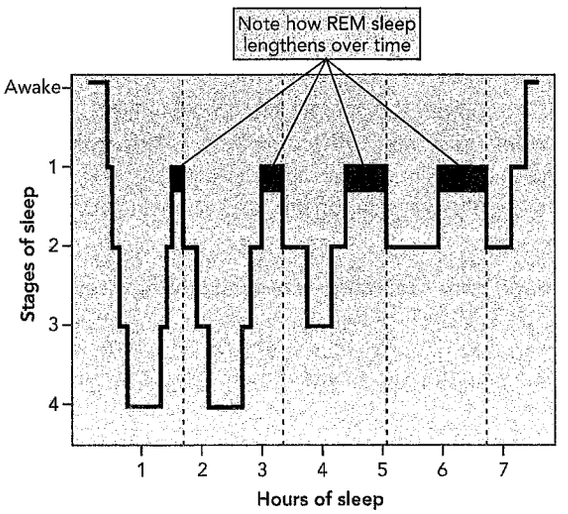
Data collected in sleep labs has helped scientists understand the stages of sleep.

A Participants in sleep research labs wear electrodes on their heads and bodies to measure brain and bodily responses during the sleep cycle. An electroencephalogram (EEG) detects and records brain-wave changes by means of small electrodes on the scalp. Other electrodes measure muscle activity and eye movements.

Philippe Garo/Photo Researchers

B The stages of sleep, defined by telltale changes in brain waves, are indicated by the jagged lines. The compact brain waves of alertness gradually lengthen as we drift into Stages 1–4. Then we enter a fifth stage, called REM sleep, which has a different set of compact, faster brain waves.





C Your first sleep cycle generally lasts about 90 minutes from awake and alert, downward through Stages 1–4, and then back up through Stages 3, 2, and REM. If you sleep 8 hours, you'll typically go through approximately four or five sleep cycles (as shown by the vertical dotted lines). Note how the overall amount of REM sleep increases as the night progresses, while the amount of deep sleep (Stages 3 and 4) decreases.

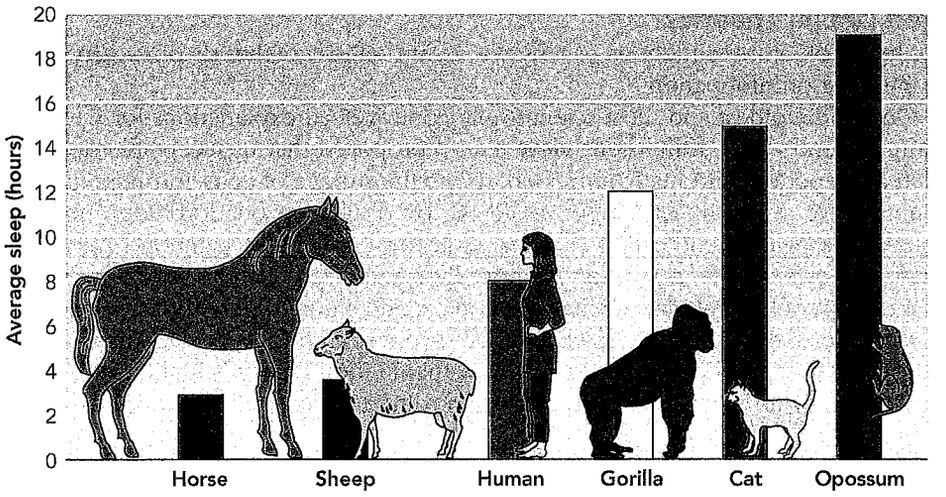


FIGURE 5.3 AVERAGE DAILY HOURS OF SLEEP FOR DIFFERENT MAMMALS

According to the adaptation/protection theory, differences in diet and number of predators affect different species' sleep habits. For example, opossums sleep many hours each day because they are relatively safe in their environment and are able to easily find food and shelter. In comparison, sheep and horses sleep very little because their diets require almost constant foraging for food in more dangerous open grasslands.

Four Sleep Theories

How do scientists explain our shared need for sleep? There are four key theories:

1. **Adaptation/protection theory** Sleep evolved because animals need to conserve energy and protect themselves from predators that are more active at night (Acerbi & Nunn, 2011; Drew, 2013; Siegel, 2008; Tsoukalas, 2012). However, as you can see in **Figure 5.3**, animals vary greatly in how much sleep they need each day. Those with the highest likelihood of being eaten by others, a higher need for food, and the lowest ability to hide tend to sleep the least.
2. **Repair/restoration theory** Sleep helps us recuperate from the depleting effects of daily waking activities. Essential chemicals and bodily tissues are repaired or replenished while we sleep. We recover not only from physical fatigue but also from emotional and intellectual demands (Colrain, 2011). When deprived of REM sleep, most people "catch up" later by spending more time than usual in this state (the so-called REM rebound), which further supports this theory.
3. **Growth/development theory** The percentage of deepest sleep (Stage 4) changes over the life span and coincides with changes in the structure and organization of the brain, as well as the release of growth hormones from the pituitary gland—particularly in children. As we age, our brains change less, and we release fewer of these hormones, grow less, and sleep less.
4. **Learning/memory theory** Sleep is important for learning and the consolidation, storage, and maintenance of memories (Fenn & Hambrick, 2012; Inostroza et al., 2013; Payne et al., 2012; Sara, 2010). This is particularly true for REM sleep, which increases after periods of stress or intense learning. For example, infants and young children, who generally are learning more than adults, spend far more of their sleep time in REM sleep **(Figure 5.4)**.

Adaptation/protection theory of sleep The theory that sleep evolved to conserve energy and provide protection from predators.

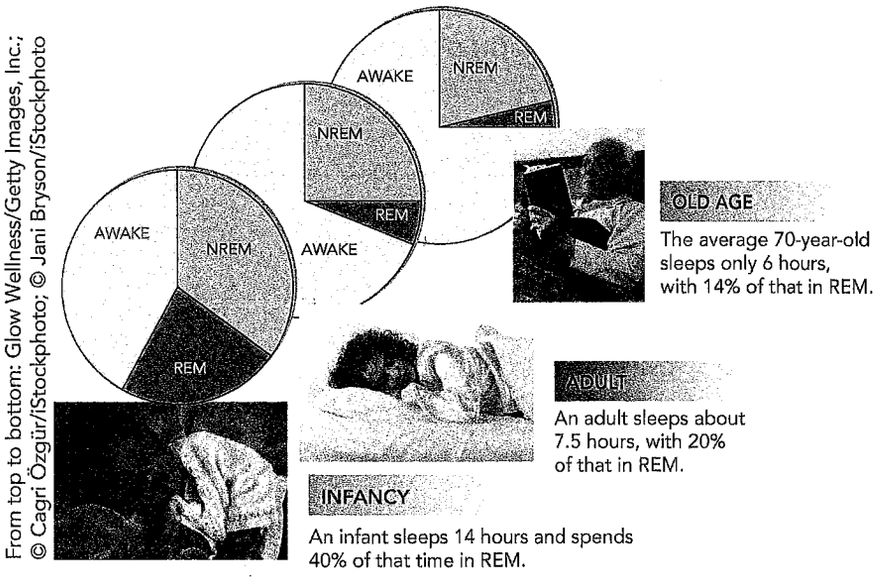
Repair/restoration theory of sleep The theory that sleep allows organisms to repair or recuperate from depleting daily waking activities.

Growth/development theory of sleep The theory that deep sleep (Stage 4) is correlated with physical development, including changes in the structure and organization of the brain; infants spend far more time in Stage 4 sleep than adults.

Learning/memory theory of sleep The theory that sleep is important for learning and for the consolidation, storage, and maintenance of memories.

FIGURE 5.4 AGING AND THE SLEEP CYCLE

Our biological need for sleep changes throughout our life span. The pie charts in this figure show the relative amounts of REM sleep, NREM sleep, and awake time the average person experiences as an infant, an adult, and an elderly person.



Culture and Dreams

Dreams about basic human needs and fears (like sex, aggression, and death) seem to be found in all cultures. Children around the world often dream about large, threatening monsters or wild animals. In addition, dreams around the world typically include more misfortune than good fortune, and the dreamer is more often the victim of aggression than the cause of it (Chang, 2012; Domhoff, 2003, 2007, 2010; Honig & Nealis, 2012; Yu, 2012).

Sleep–Wake Disorders

In any given year, an estimated 40 million Americans suffer from chronic sleep disorders, and another 30 million experience occasional sleep disorders serious enough to disrupt their daily activities (Purves & Piatt, 2012).

Judging by these statistics, and your own experiences, it's not surprising to learn that almost everyone has difficulty sleeping at some point in his or her lifetime. The most common or serious of these disorders are summarized in **Table 5.2**.

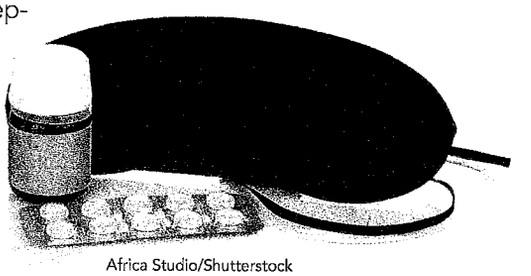
Although it's normal to have trouble sleeping before an exciting event, as many as 1 person in 10 may suffer from **insomnia**. Those who suffer from this disorder have persistent difficulty falling asleep, staying asleep, and/or waking up too early. Nearly everybody has insomnia at some time (Bastien, 2011; Colrain, 2011; Morin et al., 2013); a telltale sign is feeling poorly rested the next day. Most people with serious insomnia have other medical or psychological disorders as well (American Psychiatric Association, 2013; Boland & Alloy, 2013; Van Der Kloet, 2013).

Insomnia A sleep disorder characterized by persistent problems falling asleep, staying asleep, or awakening too early.

TABLE 5.2 SLEEP-WAKE DISORDERS

Label	Characteristics
Insomnia	Persistent difficulty falling asleep, maintaining sleep, or waking up too early
Narcolepsy	Sudden, irresistible onset of sleep during waking hours, characterized by sudden sleep attacks while standing, talking, or even driving
Breathing-Related Sleep Disorder (Sleep apnea)	Repeated interruption of breathing during sleep, causing loud snoring or poor-quality sleep and excessive daytime sleepiness
Nightmare	Bad dream that significantly disrupts REM sleep
NREM Sleep Arousal Disorder (Sleep terror)	Abrupt awakening with feelings of panic that significantly disrupts NREM sleep

realworldpsychology **The Hazards of Sleep Medication** To cope with insomnia, many people turn to nonprescription, over-the-counter sleeping pills, which generally don't work. In contrast, prescription tranquilizers and barbiturates do help people sleep, but they decrease Stage 4 and REM sleep, seriously affecting sleep quality. In the short term, limited use of drugs such as Ambien, Dalmane, Xanax, Halcion, and Lunesta may be helpful in treating sleep problems related to anxiety and acute, stressful situations. However, chronic users run the risk of psychological and physical drug dependence (Abadinsky, 2014; Farber & Banks, 2013). The hormone *melatonin* may provide a safer alternative. Some research suggests that taking even a relatively small dose (just .3 to .4 milligrams) can help people fall asleep and stay asleep (Brzezinski et al., 2005; Gooneratne et al., 2012).



Africa Studio/Shutterstock

FIGURE 5.5 NARCOLEPSY

Research on specially bred narcoleptic dogs has found degenerated neurons in certain areas of the brain (Siegel, 2000). Whether human narcolepsy results from similar degeneration is a question for future research. Note how this hungry puppy has lapsed suddenly from alert wakefulness to deep sleep even when offered his preferred food.

(Culebras, 2012; Emdin et al., 2013; Furukawa et al., 2010; Nieto et al., 2012; Nikolaou et al., 2011; Vitulano et al., 2013; Wheaton et al., 2012).

Treatment for sleep apnea depends partly on its severity. If the problem occurs only when you're sleeping on your back, sewing tennis balls to the back of your pajama top may help remind you to sleep on your side. Because obstruction of the breathing passages is related to obesity and heavy alcohol use (Roehrs & Roth, 2012; Sarkhosh et al., 2013), dieting and alcohol restriction are often recommended. For other sleepers, surgery, dental appliances that reposition the tongue, or machines that provide a stream of air to keep the airway open may provide help.

Recent findings suggest that even "simple" snoring (without the breathing stoppage characteristic of sleep apnea) can lead to heart disease and possible death (Jones & Benca, 2013; Li et al., 2012). Although occasional mild snoring is fairly normal, chronic snoring is a possible warning sign that should prompt people to seek medical attention.

Two additional sleep disturbances are **nightmares** and **sleep terrors (Figure 5.6)**. *Sleepwalking*, which sometimes accompanies sleep terrors, usually occurs during NREM sleep. (Recall that large muscles are paralyzed during REM sleep, which explains why sleepwalking normally occurs during NREM sleep.) An estimated 4% of U.S. adults—meaning over 8 million people—have at least one episode of sleepwalking each year (Ohayon et al., 2012). *Sleeptalking* can occur during any stage of sleep, but it appears to arise most commonly during NREM sleep. It can consist of single, indistinct words or long, articulate sentences. It is even possible to engage some sleep talkers in a limited conversation.

Nightmares Anxiety-arousing dreams that generally occur near the end of the sleep cycle, during REM sleep.

Sleep terrors Abrupt awakenings from NREM (non-rapid-eye-movement) sleep accompanied by intense physiological arousal and feelings of panic.

Nightmares, sleep terrors, sleepwalking, and sleeptalking are all more common among young children, but they can also occur in adults, usually during times of stress or major life events (Hiscock & Darvey, 2013; Hobson & Silvestri, 1999). Patience and soothing reassurance at the time of the sleep disruption are usually the only treatment recommended for both children and adults.

FIGURE 5.6 NIGHTMARE OR SLEEP TERROR?

Nightmares, or bad dreams, occur toward the end of the sleep cycle, during REM sleep. Less common but more frightening are sleep terrors, which occur early in the cycle, during Stage 3 or Stage 4 of NREM sleep. Like the child in this photo, the sleeper may sit bolt upright, screaming and sweating. They also may walk around, and talk incoherently and be almost impossible to awaken.

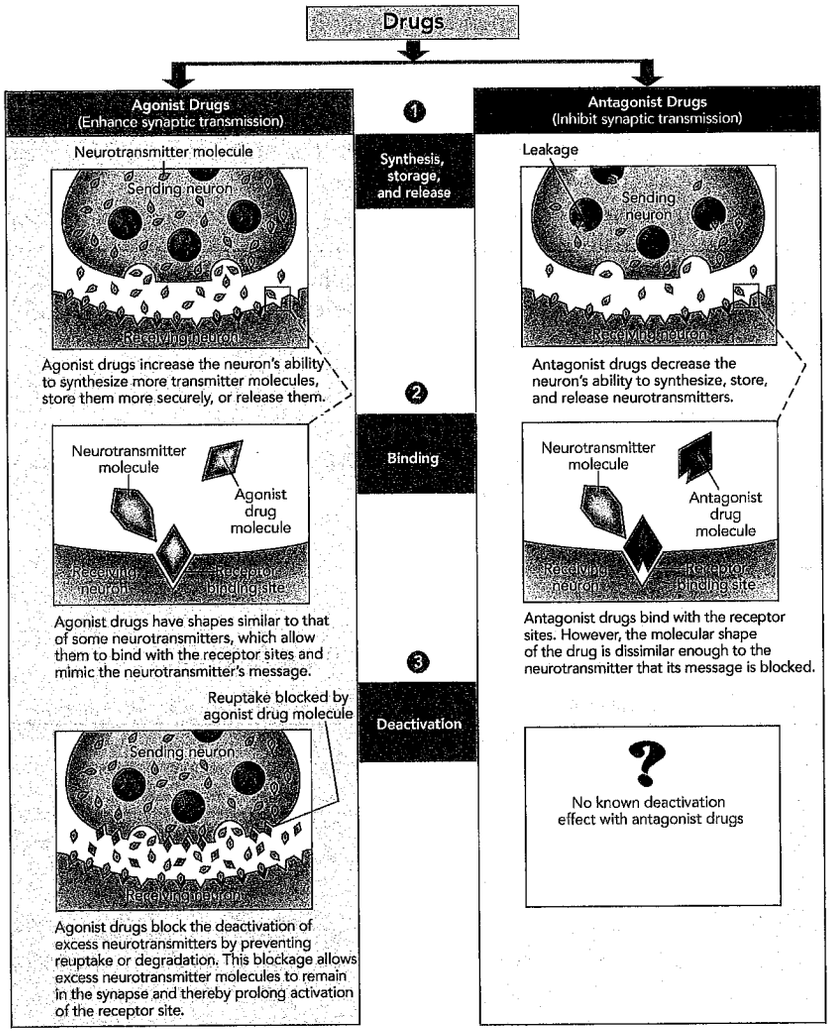


FIGURE 5.7 HOW DO AGONIST AND ANTAGONIST DRUGS PRODUCE THEIR PSYCHOACTIVE EFFECTS?

Most psychoactive drugs produce their mood, energy, and perception-altering effects by changing the body's supply of neurotransmitters. Note how they can alter the synthesis, storage, or release of neurotransmitters ❶. They also can change the neurotransmitters' effects on the receiving site of the receptor neuron ❷. After neurotransmitters carry their messages across the synapse, the sending neuron normally deactivates the excess, or leftover, neurotransmitter ❸. However, when agonist drugs block this process, excess neurotransmitters remain in the synapse, which prolongs the effect of the psychoactive drug.

Is drug abuse the same as drug addiction? The term **drug abuse** generally refers to drug taking that causes emotional or physical harm to oneself or others. Drug consumption among abusers is also typically compulsive, frequent, and intense. **Addiction** is a broad term that refers to a condition in which a person feels compelled to use a specific drug, or engage in almost any type of compulsive activity, from working to surfing the Internet (Potenza, 2013; Ross et al., 2010). In fact, the latest version of the *Diagnostic and Statistical Manual (DSM-5)*, which officially classifies mental disorders, now includes *gambling disorders* as part of their substance-related and addictive disorders category. But other disorders, like "sex addiction" or "exercise addiction" were not included due to insufficient evidence at this time (American Psychiatric Association, 2013).

Interestingly, some evidence shows that we can become addicted to Facebook and that risky trading in financial markets can create a high indistinguishable from that experienced in drug addiction (Andreassen et al., 2012; Zweig, 2007). Researchers in one study prompted people with a series of statements, such as "You feel an urge to use Facebook more and more," and "You become restless or troubled if you are prohibited from using Facebook" (Andreassen et al., 2012). The degree to which you agree with items like these may indicate that you are addicted, meaning that you feel unreasonably compelled to check and use Facebook throughout the day.

In addition to distinguishing between drug abuse and addiction, many researchers use the term **psychological dependence** to refer to the mental desire or craving to achieve a drug's effects. In contrast, **physical dependence** describes changes in bodily processes that make a drug necessary for minimum daily functioning. Physical dependence appears most clearly when the drug is withheld and the user undergoes **withdrawal** reactions, including physical pain and intense cravings.

Drug abuse Drug taking that causes emotional or physical harm to the drug user or others.

Addiction A broad term that describes a condition in which the body requires a drug (or specific activity) in order to function without physical and psychological reactions to its absence; it is often the outcome of tolerance and dependence.

Psychological dependence The psychological desire or craving to achieve a drug's effect.

Physical dependence The changes in bodily processes that make a drug necessary for minimal functioning.

Q3

Withdrawal The discomfort and distress, including physical pain and intense cravings, experienced after stopping the use of an addictive drug.

TABLE 5.4 ALCOHOL'S EFFECT ON THE BODY AND BEHAVIOR

Number of drinks[a] in two hours	Blood alcohol (content (%)[b]	Effect
(2) 🍺🍺	0.05	Relaxed state; increased sociability
(3) 🍺🍺🍺	0.08	Everyday stress lessened
(4) 🍺🍺🍺🍺	0.10	Movements and speech become clumsy
(7) 🍺🍺🍺🍺🍺🍺🍺	0.20	Very drunk; loud and difficult to understand; emotions unstable
(12) 🍺🍺🍺🍺🍺🍺 🍺🍺🍺🍺🍺🍺	0.40	Difficult to wake up; incapable of voluntary action
(15) 🍺🍺🍺🍺🍺🍺🍺🍺 🍺🍺🍺🍺🍺🍺🍺	0.50	Coma and/or death

[a]A drink refers to one 12-ounce beer, a 4-ounce glass of wine, or a 1.25-ounce shot of hard liquor.
[b]In America, the legal blood alcohol level for "drunk driving" varies from 0.05 to 0.12.

McPHOTO/Blickwinkel/Age Fotostock America, Inc.

Depressants, sometimes called "downers," act on the central nervous system to suppress or slow bodily processes and reduce overall responsiveness. Because tolerance and both physical and psychological dependence are rapidly acquired with these drugs, there is strong potential for abuse.

Depressant A drug that decreases bodily processes and overall responsiveness.

Although alcohol is primarily a depressant, at low doses it has stimulating effects, thus explaining its reputation as a "party drug." As consumption increases, symptoms of drunkenness appear. Alcohol's effects are determined primarily by the amount that reaches the brain **(Table 5.4)**. Because the liver breaks down alcohol at the rate of about 1 ounce per hour, the number of drinks and the speed of consumption are both very important. People can die after drinking large amounts of alcohol in a short period of time **(Figure 5.8)**. In addition, men's bodies are more efficient than women's at breaking down alcohol. Even after accounting for differences in size and muscle-to-fat ratio, women have a higher blood-alcohol level than men following equal doses of alcohol.

Alcohol should not be combined with any other drug; combining alcohol and barbiturates—both depressants—is particularly dangerous. Together, they can relax the diaphragm muscles to such a degree that the person suffocates.

Does this information surprise you? Take the quiz in *Psychology and You* to discover if some of your other ideas about alcohol are really misconceptions.

Kyle Bursaw/Daily Chronicle/AP

FIGURE 5.8 ALCOHOL IS FAR TOO OFTEN FATAL

On November 2, 2012, 19-year-old David Bogenberger, a finance major at Northern Illinois University, died of alcohol poisoning following hazing activities at his fraternity, Pi Kappa Alpha. His blood alcohol concentration was .35, which is five times the legal limit for driving in Illinois. Twenty-two members of his fraternity have been charged in his death.

Even legal stimulants can lead to serious problems. For example, the U.S. Public Health Service considers cigarette smoking the single most preventable cause of death and disease in the United States (Pearson et al., 2013). Researchers have found that nicotine activates the same brain areas as cocaine (Dandekar et al., 2011; David et al., 2013; Tronci & Balfour, 2011). Nicotine's effects—relaxation, increased alertness, and diminished pain and appetite—are so powerfully reinforcing that some people continue to smoke even after having a cancerous lung removed.

Opiates, or narcotics, which are derived from the opium poppy, are used medically to relieve pain (Connolly et al., 2013; Dalal & Bruera, 2013) because they mimic the brain's natural endorphins (Chapter 2), which numb pain and elevate mood. This creates a dangerous pathway to drug abuse, however. After repeated flooding with artificial opiates, the brain eventually reduces or stops the production of its own opiates. If the user later attempts to stop, the brain lacks both the artificial and normal level of painkilling chemicals, and withdrawal becomes excruciatingly painful **(Figure 5.10)**.

So far, we have discussed three of the four types of psychoactive drugs: depressants, stimulants, and opiates. One of the most intriguing alterations of consciousness comes from **hallucinogens**, drugs that produce sensory or perceptual distortions, including visual, auditory, and kinesthetic hallucinations. Some cultures have used hallucinogens for religious purposes, as a way to experience "other realities" or to communicate with the supernatural. In Western societies, most people use hallucinogens for their reported "mind-expanding" potential.

Hallucinogens are commonly referred to as *psychedelics* (from the Greek for "mind manifesting"). They include mescaline (derived from the peyote cactus), psilocybin (derived from mushrooms), phencyclidine (chemically derived), and LSD (lysergic acid diethylamide, derived from ergot, a rye mold).

LSD, or "acid," produces dramatic alterations in sensation and perception, including an altered sense of time, synesthesia (blending of the senses), and spiritual experiences. Perhaps because the LSD experience is so powerful, few people "drop acid" on a regular basis. Nevertheless, LSD can be an extremely dangerous drug. Bad LSD "trips" can be terrifying and may lead to accidents, deaths, or suicide. One 32-year-old man, with no known psychiatric disorder, intentionally removed his own testes after the first and single use of LSD combined with alcohol (Blacha et al., 2013)!

Marijuana, also called cannabis, is classified as a hallucinogen even though it has some properties of a depressant—it induces drowsiness and lethargy—and some of a narcotic—it acts as a weak painkiller. In low doses, marijuana produces mild euphoria; moderate doses lead to an intensification of sensory experiences and the illusion that time is passing slowly. High doses may produce hallucinations, delusions, and distortions of body image (Abadinsky, 2014; Gorelick et al., 2013; Hart & Ksir, 2013). The active ingredient in marijuana is THC, or tetrahydrocannabinol, which attaches to receptors that are abundant throughout the brain.

Kevin Winter/Getty Images

The high cost of drug abuse

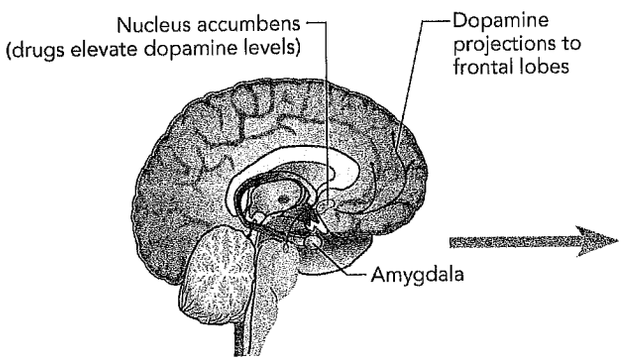
In July 2013, Cory Monteith, a 31-year-old actor who starred in the television show "Glee," died of an accidental overdose of heroin and alcohol. He struggled with addiction for years, and had recently undergone treatment for substance abuse addiction.

Opiate A drug derived from opium that numbs the senses and relieves pain.

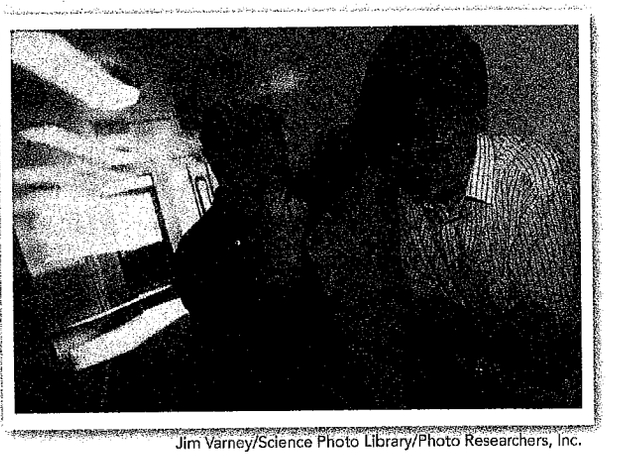
Hallucinogen A drug that produces sensory or perceptual distortions.

FIGURE 5.10 HOW OPIATES CREATE PHYSICAL DEPENDENCE

Psychoactive drugs such as opiates affect the brain and body in a variety of ways.



Ⓐ Most researchers believe that increased dopamine activity in this so-called *reward pathway* of the brain accounts for the reinforcing effects of most addictive drugs.



Jim Varney/Science Photo Library/Photo Researchers, Inc.

Ⓑ Absence of the drug triggers withdrawal symptoms (e.g., intense pain and cravings).

FIGURE 5.11 BEWARE OF CLUB DRUGS

Although club drugs can produce initially desirable effects, such as MDMA's reported feelings of great empathy and connectedness with others, almost all psychoactive drugs can cause serious health problems—in some cases, even death (Chamberlin & Saper, 2009; Jaehne et al., 2011; National Institute on Drug Abuse, 2012).

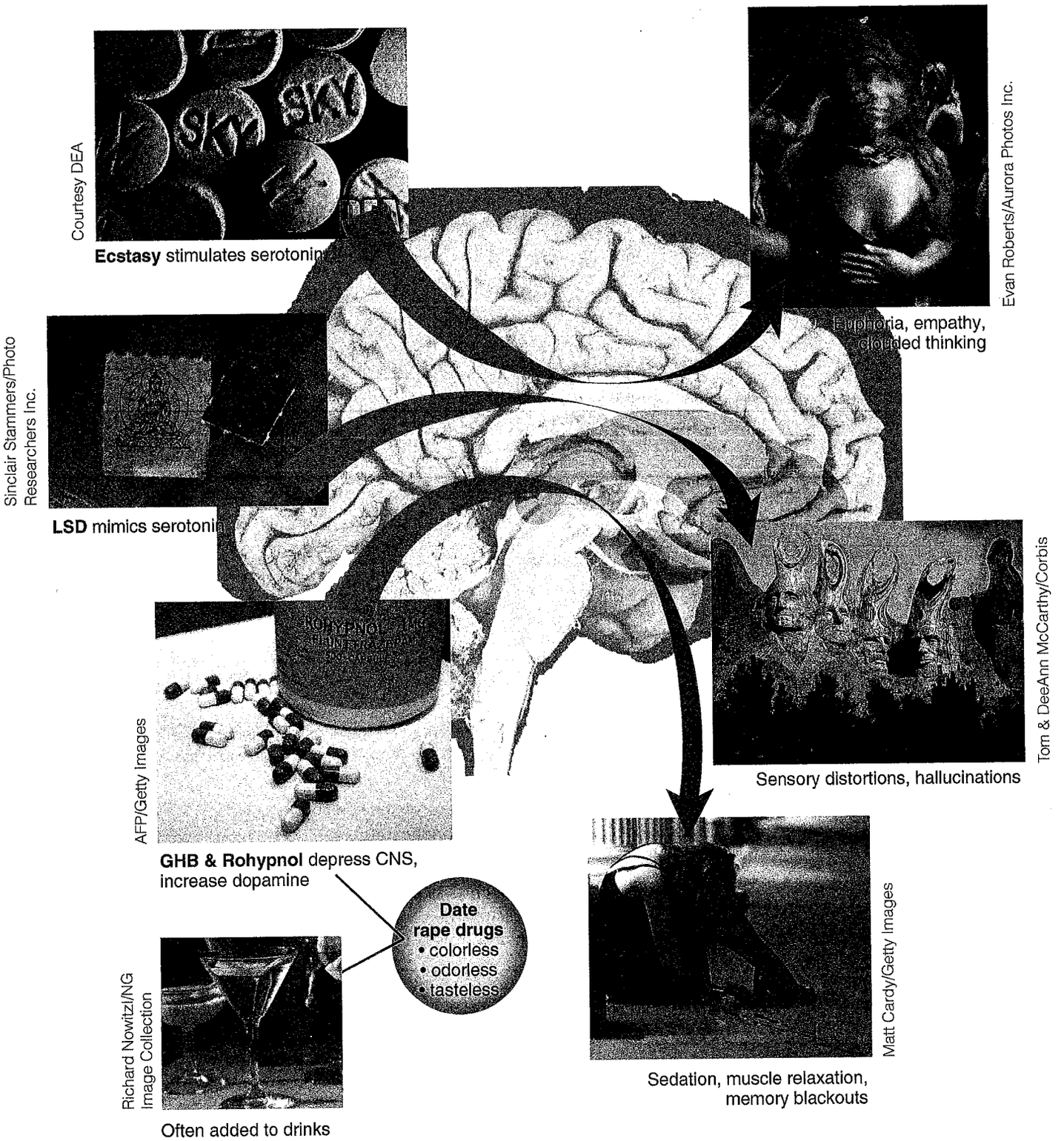
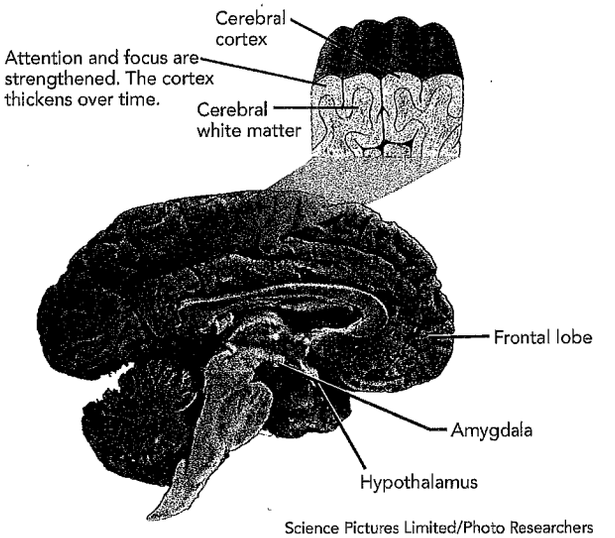


FIGURE 5.12 BENEFITS OF MEDITATION | psychology and you

A Some meditation techniques, such as tai chi and hatha yoga, include body movements and postures. In other techniques, the meditator remains motionless, chanting or focusing on a single point, like a candle flame.

Dan Dalton/Getty Images

B During meditation, the hypothalamus diminishes the sympathetic response and increases the parasympathetic response. Shutting down the fight-or-flight response in this way allows for deep rest, slower respiration, and overall relaxation.



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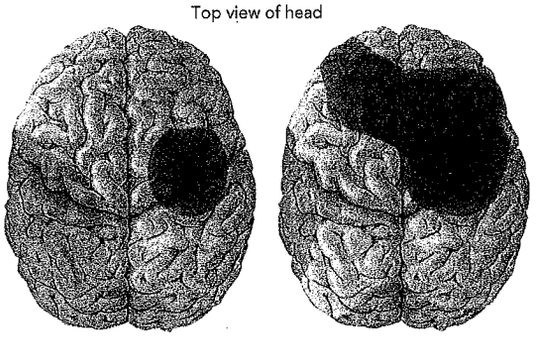

Before meditation During meditation

C Researchers have found that an increased area of the brain responds to sensory stimuli during meditation, suggesting that meditation enhances the coordination between the brain hemispheres (Kilpatrick et al., 2011; Lyubimov, 1992). Note how much the blue-colored areas enlarged and spread from the right to the left hemisphere during meditation.

How can we explain these effects? Brain imaging studies suggest that meditation's requirement to focus attention, block out distractions, and concentrate on a single object, emotion, or word, reduces the number of brain cells that must be devoted to the multiple, competing tasks normally going on within the brain's frontal lobes. This narrowed focus thus explains the feelings of timelessness and mild euphoria (Cvetkovic & Cosic, 2011; Wachholtz & Austin, 2013).

Research has also verified that meditation can produce dramatic changes in basic physiological processes, including heart rate, oxygen consumption, sweat gland responses, and brain activity. In addition, it's been somewhat successful in reducing pain, anxiety, and stress; lowering blood pressure; increasing creativity, and improving overall mental health (Colzato et al., 2012; Gans et al., 2013; Gordon et al., 2013; Grant et al., 2011). As you can see in **Figures 5.12b and c**, studies have also found that meditation can change the body's sympathetic and parasympathetic responses, and increase structural support for the sensory, decision-making, emotion regulation, and attention-processing centers of the brain (Libby et al., 2012; Lo & Chang, 2013; Malinowski, 2013; Tang & Posner, 2013; Urry et al., 2012).

Interestingly, one study provided participants with eight weeks of training in meditation and examined brain activation in response to upsetting images both before and after the training (Desbordes et al., 2012). Results indicated that after training participants showed lower levels of activation in the amygdala (a part of the brain that responds to emotion), even if they were not meditating at the time.

degree of anxiety, fear, and misinformation. For example, some studies have found that women who use hypnosis in labor and childbirth experience lower levels of pain and a shorter duration of labor (Madden et al., 2012). Because tension and anxiety strongly affect pain, any technique that helps the patient relax is medically useful. Q5

In psychotherapy, hypnosis can help patients relax, recall painful memories, and reduce anxiety. Despite the many myths about hypnosis, it has been used with modest success in the treatment of phobias and in helping people to lose weight, stop smoking, and improve study habits (Amundson & Nuttgens, 2008; Robertson, 2013; Smith, 2011).

One final note

Before going on to the next chapter, we'd like to take an unusual step for authors. We'd like to offer you, our reader, a piece of caring, personal and professional advice about alternate states of consciousness (ASCs). The core problem while you're in any ASC is that you're less aware of external reality, which places you at high risk. This applies to both men and women. Interestingly, we all recognize these dangers while sleeping and dreaming, and we've developed standard ways to protect ourselves. For example, when we're driving on a long trip and start to feel sleepy, we stop for coffee, walk around, and/or rent a hotel room before allowing ourselves to fall asleep.

Our simple advice to you is to follow this same "sleepy driver" logic and standards. If you decide to use drugs, meditate, undergo hypnosis, or engage in any other form of altered consciousness, research the effects and risks of your ASC and plan ahead for the best options for dealing with it—just like you set up a designated driver before drinking. Take care and best wishes,

Karen R. Huffman Colin A. Barnhardt

RETRIEVAL PRACTICE: MEDITATION AND HYPNOSIS

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. Alternate states of consciousness (ASCs) can be achieved in which of the following ways?

a. during sleep and dreaming
b. via chemical channels
c. through hypnosis and meditation
d. all these options

2. _____ is a group of techniques designed to focus attention, block out all distractions, and produce an alternate state of consciousness (ASC).

a. Hypnosis
b. MDMA
c. Parapsychology
d. Meditation

3. _____ is occasionally used in surgery and for the treatment of chronic pain and severe burns.

a. Parasomnia
b. Meditation
c. Hypnosis
d. Parapsychology

4. _____ is an alternate state of heightened suggestibility characterized by deep relaxation and a trance-like state.

a. Meditation
b. Amphetamine psychosis
c. Hypnosis
d. Daydreaming

Think Critically

1. Why is it almost impossible to hypnotize an unwilling participant?
2. Describe the possible health benefits of hypnosis and meditation.

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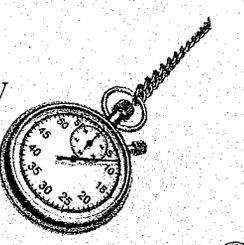
Can hypnosis decrease the pain of childbirth?

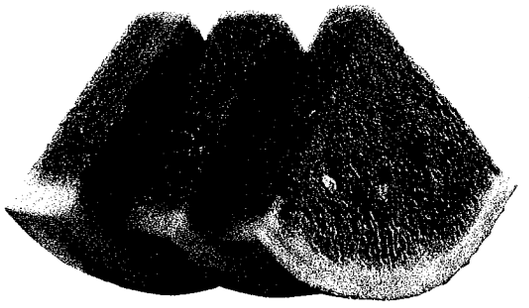


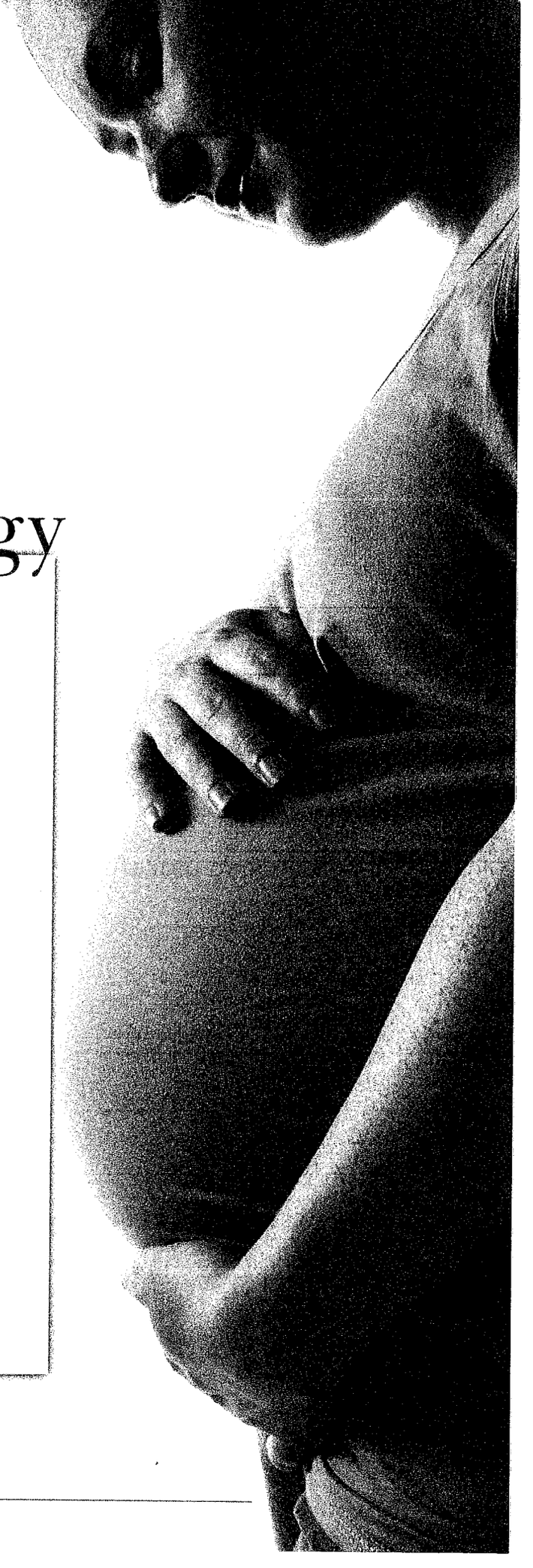
HINT: LOOK IN THE MARGIN FOR Q5

Key Terms

RETRIEVAL PRACTICE Write a definition for each term before turning back to the referenced page to check your answer.

- activation–synthesis hypothesis of dreams 132
- adaptation/protection theory of sleep 131
- addiction 137
- agonist drug 136
- alternate state of consciousness (ASC) 124
- antagonist drug 136
- circadian rhythm 126
- cognitive view of dreams 132
- consciousness 124
- depressant 139
- drug abuse 137
- growth/development theory of sleep 131
- hallucinogen 141
- hypnosis 146
- insomnia 133
- latent content of dreams 132
- learning/memory theory of sleep 131
- manifest content of dreams 132
- meditation 144
- narcolepsy 134
- nightmares 135
- non-rapid-eye-movement (NREM) sleep 130
- opiate 141
- physical dependence 137
- psychoactive drug 136
- psychological dependence 137
- rapid-eye-movement (REM) sleep 129
- repair/restoration theory of sleep 131
- sleep apnea 134
- sleep terrors 135
- stimulant 140
- tolerance 138
- wish-fulfillment view of dreams 132
- withdrawal 137





realworldpsychology

THINGS YOU'LL LEARN IN CHAPTER 6

Q1 **Why can simply hearing the drill in a dentist's office—even if that drill is nowhere near you—make you feel anxious?**

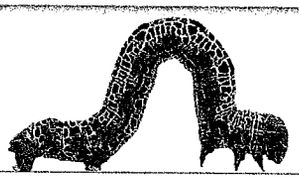
Q2 **How can decreasing the cost of fruit and vegetables lead to healthier eating?**

Q3 **Why do gamblers have such trouble quitting, even when they continue to lose money?**

Q4 **Does watching sex on TV increase the risk of teen pregnancies?**

Q5 **Why can even young children recognize a picture of a snake much faster than a picture of a frog or caterpillar?**

THROUGHOUT THE CHAPTER, MARGIN ICONS FOR Q1–Q5 INDICATE WHERE THE TEXT ADDRESSES THESE QUESTIONS.



"unscheduled" salivation. He realized that the dogs were not only responding on the basis of hunger (a biological need), but also as a result of experience or learning.

Excited by this accidental discovery, Pavlov and his students conducted several experiments, including sounding a tone on a tuning fork just before food was placed in the dogs' mouths. After several pairings of the tone and food, dogs in the laboratory began to salivate on hearing the tone alone.

Pavlov and later researchers found that many things can become conditioned stimuli for salivation if they are paired with food—a bell, a buzzer, a light, and even the sight of a circle or triangle drawn on a card. This type of learning, in which a neutral stimulus (such as the tone on a tuning fork) comes to elicit a response after repeated pairings with a naturally occurring stimulus (like food), is now known as **classical conditioning**.

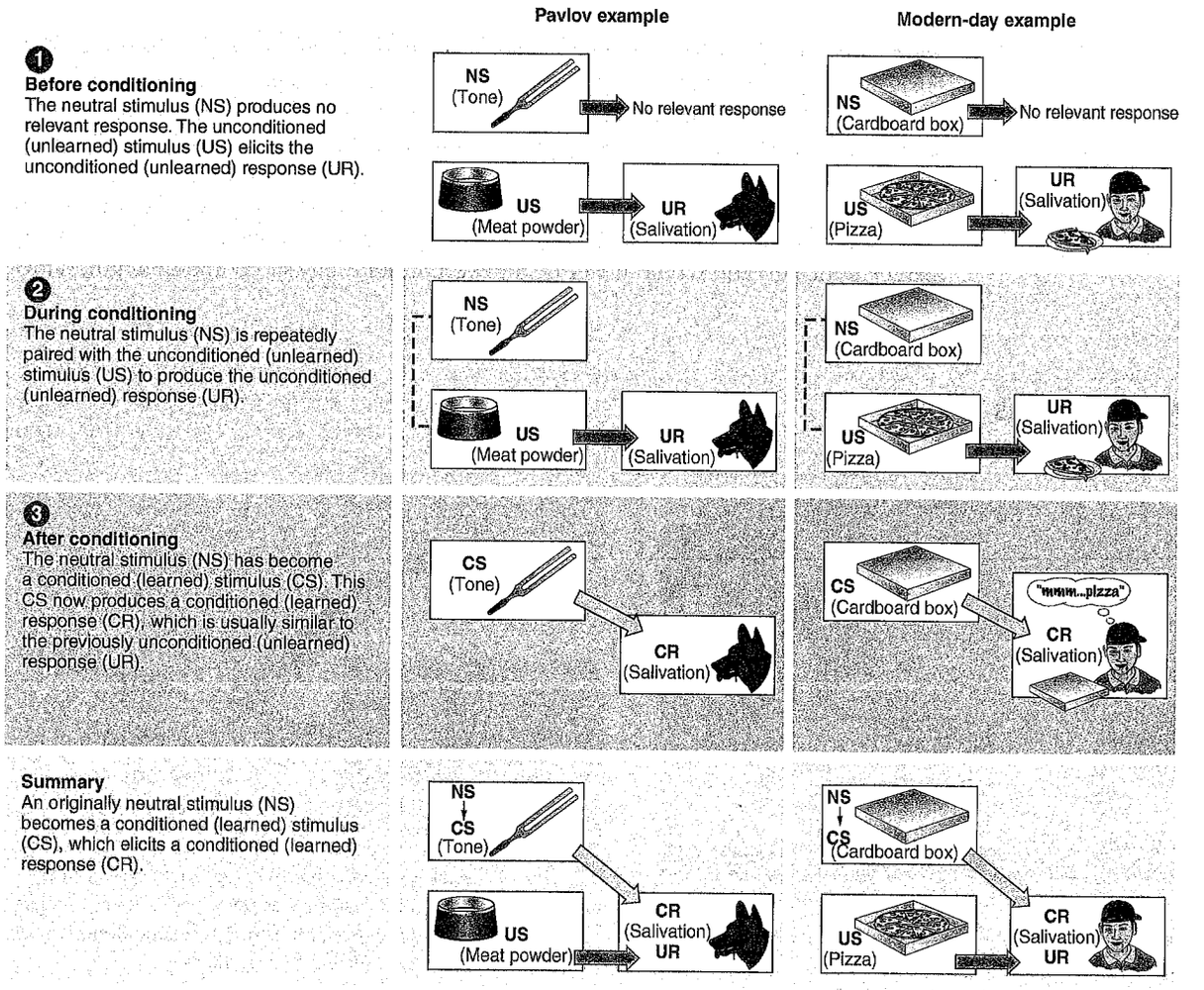
To fully understand classical conditioning, and how it applies to our everyday life, the first step is to recognize that **conditioning** is simply another word for learning. Next, we need to explain that classical conditioning is a three-step process—*before*, *during*, and *after conditioning*. This process is explained in detail below, and visually summarized in **Figure 6.2**.

Classical conditioning A type of learning that develops through paired associations; a previously neutral stimulus (NS) is paired (associated) with an unconditioned stimulus (US) to elicit a conditioned response (CR).

Conditioning The process of learning associations between stimuli and behavioral responses.

FIGURE 6.2 THE BEGINNINGS AND A MODERN APPLICATION OF CLASSICAL CONDITIONING

Although Pavlov's initial experiment used a metronome, a ticking instrument designed to mark exact time, his best-known method (depicted here) involved a tone from a tuning fork. As you can see, the basic process of classical conditioning is simple. Just as you've been classically conditioned to respond to your cell phone's tones, or possibly to just the sight of a pizza box, Pavlov's dogs learned to respond to the tuning fork's tone. Unfortunately, many students get confused by these technical terms. So here's a tip that might help: The actual stimuli (tone and meat) remain the same—only their names change from neutral to conditioned or from unconditioned to conditioned. A similar name change happens for the response (salivation)—from unconditioned to conditioned.



(Ethical Principles of Psychologists, 2010; Fridlund et al., 2012; Ollendick et al., 2012; Paul & Blumenthal, 1989). The research procedures used by Watson and Rayner violated several ethical guidelines for scientific research (Chapter 1). They not only deliberately created a serious fear in a child, but they also ended their experiment without *extinguishing* (removing) it. In addition, the researchers have been criticized because they did not measure Albert's fear objectively. Their subjective evaluation raises doubt about the degree of fear conditioned.

Despite such criticisms, this study of Little Albert showed us that many of our likes, dislikes, prejudices, and fears are examples of *conditioned emotional responses (CERs)*. For example, if your romantic partner always uses the same shampoo, simply the smell of that shampoo may soon elicit a positive response. In Chapter 13, you'll discover how Watson's research later led to powerful clinical tools for eliminating exaggerated and irrational fears of a specific object or situation, known as *phobias* (Cal et al., 2006; Field, 2006; Schachtman & Reilly, 2011; Schweckendiek et al., 2011). For more examples of how classical conditioning impacts everyday life, see **Figure 6.4**.

FIGURE 6.4 CLASSICAL CONDITIONING IN EVERYDAY LIFE realworldpsychology

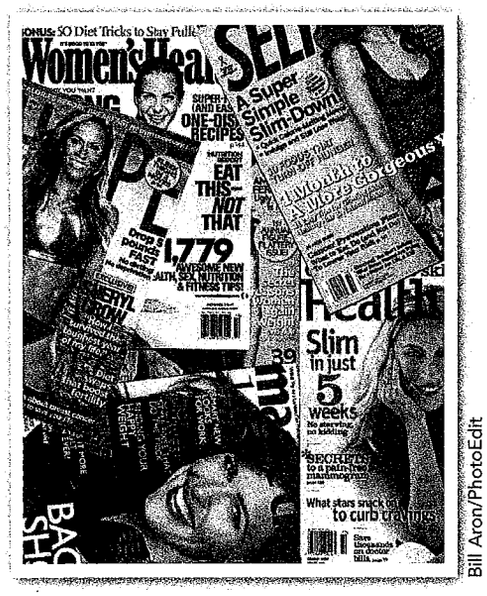
A Prejudice

How do children, like the one holding the KKK sign in this photo, develop prejudice at such an early age? As shown in the diagram, children are naturally upset and become afraid (UR) when they see that their parents are upset and afraid (US). Over time, they may learn to associate their parents' reaction with all members of a disliked group (CS), thus becoming prejudiced like their parents.

Randy Olsen/NG Image Collection

B Advertising

Magazine ads, TV commercials, and business promotions often use higher-order classical conditioning to pair their products or company logo, the neutral stimulus (NS), with previously conditioned pleasant images, like attractive models and celebrities, the conditioned stimulus (CS). These attractive models then trigger desired behaviors, the conditioned response (CR), such as purchasing their products (Krugman, 2013; Miller & Allen, 2012; Sweldens et al., 2010).



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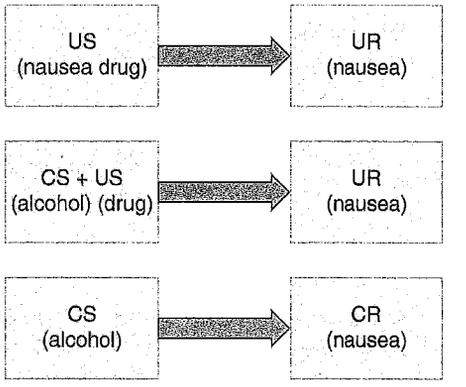


C Medicine

Classical conditioning also is used in the medical field. For example, a treatment designed for alcohol-addicted patients pairs alcohol with a nausea-producing drug. Afterward, just the smell or taste of alcohol makes the person sick. Some, but not all, patients have found this treatment helpful.

Voices from the Classroom

Stimulus Discrimination in Childhood Growing up, there was a park at the end of the street where I lived. After finishing my homework, I would join the neighborhood kids down at the park to play until dinner time. Our dads would all whistle to signal when it was time for us to come home for dinner. At first, I ran home when I heard any whistle (stimulus generalization). Then, I learned the sound of MY dad's whistle (stimulus discrimination). This enabled me to be able to play longer as my dinner time was often a half hour later than some of my friends.

Professor Amy Beeman
San Diego Mesa College
San Diego, California

Extinction, Spontaneous Recovery, and Higher-Order Conditioning

What do you think happened when Pavlov repeatedly sounded the tone without presenting food? The answer is that the dogs' salivation gradually declined, a process Pavlov called **extinction**—the gradual weakening of a conditioned response (CR).

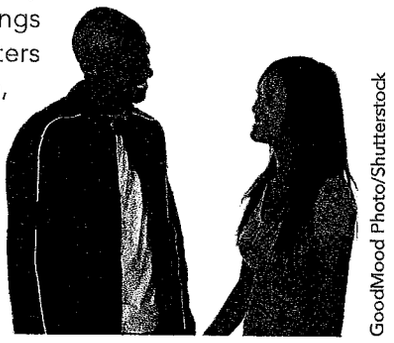
Once extinguished, is a conditioned response (CR) gone for good? Extinction is not unlearning—it does not "erase" the learned connection between the stimulus and the response (Bouton et al., 2012; Storsve et al., 2012). Pavlov found that sometimes, after a conditioned response had apparently been extinguished, if he sounded the tone once again the dogs would salivate. This reemergence of a previously extinguished conditioned response (CR) after a period of rest is called **spontaneous recovery** (see *Psychology and You*).

Extinction The gradual disappearance of a conditioned response (CR); it occurs when an unconditioned stimulus (US) is withheld whenever the conditioned stimulus (CS) is presented.

Spontaneous recovery The sudden, reappearance of a previously extinguished conditioned response (CR) after a rest period.

psychology and you **Spontaneous Recovery** Have you ever felt renewed excitement at the sight of a former girlfriend or boyfriend, even though years have passed, you have a new partner, and extinction has occurred? This may be an example of spontaneous recovery. It also may help explain why people might misinterpret a sudden flare-up of feelings and be tempted to return to unhappy relationships. To make matters worse, when a conditioned stimulus is reintroduced after extinction, the conditioning occurs much faster the second time around—a phenomenon known as *reconditioning*.

The good news is that those who have taken general psychology (or read this book) are far less likely to make this mistake. Looking at **Figure 6.5**, you can see that even if you experience spontaneous recovery, your sudden peak of feelings for the old love partner will gradually return to their previously extinguished state. So don't overreact.



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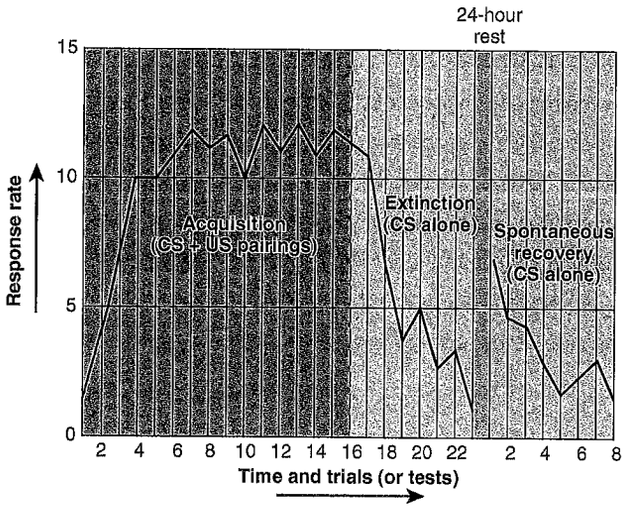


FIGURE 6.5 THREE KEY PRINCIPLES OF CLASSICAL CONDITIONING

During acquisition, the strength of the conditioned response (CR) rapidly increases and then levels off near its maximum. During extinction, the CR declines erratically until it is extinguished. After a "rest" period in which the organism is not exposed to the conditioned stimulus (CS), spontaneous recovery may occur, and the CS will once again elicit a (weakened) CR.

RETRIEVAL PRACTICE: CLASSICAL CONDITIONING

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. _____ conditioning occurs when a neutral stimulus becomes associated with an unconditioned stimulus to elicit a conditioned response.

   a. Reflex
   b. Instinctive
   c. Classical
   d. Basic

2. The process of learning associations between environmental stimuli and behavioral responses is known as _____.

   a. maturation
   b. contiguity learning
   c. conditioning
   d. latent learning

3. In John Watson's demonstration of classical conditioning with Little Albert, the unconditioned stimulus was _____.

   a. symptoms of fear
   b. a rat
   c. a bath towel
   d. a loud noise

4. A baby is bitten by a small dog and then is afraid of all small animals. This is an example of _____.

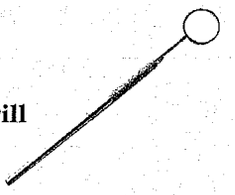
   a. stimulus discrimination
   b. extinction
   c. reinforcement
   d. stimulus generalization

Think Critically

1. How might Watson and Rayner, who conducted the famous "Little Albert" study, have designed a more ethical study of conditioned emotional responses (CERs)?
2. Most classical conditioning is involuntary. Considering this, is it ethical for politicians and advertisers to use classical conditioning to influence our thoughts and behavior? Why or why not?

realworldpsychology

Why can simply hearing the drill in a dentist's office—even if that drill is nowhere near you—make you feel anxious?



HINT: LOOK IN THE MARGIN FOR Q1

OPERANT CONDITIONING

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** Thorndike's and Skinner's contributions to operant conditioning research.
2. **EXPLAIN** how reinforcement and punishment influence behavior.
3. **SUMMARIZE** how shaping and schedules of reinforcement affect behavior.

LEARNING OBJECTIVES

As we've just seen, classical conditioning is based on what happens *before* we *involuntarily* respond: Something happens to us, and we learn a new response. In contrast, **operant conditioning** is based on what happens *after* we *voluntarily* perform a behavior: We do something and learn from the consequences **(Figure 6.7)**.

Note that *consequences* are the heart of operant conditioning. In classical conditioning, consequences are irrelevant—Pavlov's dogs still got to eat whether they salivated or not. But in operant conditioning, the organism voluntarily performs a behavior (an *operant*) that produces a consequence—either reinforcement or punishment. **Reinforcement** strengthens the response, making it more likely to recur. **Punishment** weakens the response, making it less likely to recur.

Operant conditioning Learning through voluntary behavior and its subsequent consequences; reinforcement increases behavioral tendencies, whereas punishment decreases them.

Reinforcement The adding or taking away of a stimulus following a response, which increases the likelihood of that response being repeated.

Punishment The adding or taking away of a stimulus following a response, which decreases the likelihood of that response being repeated.

B. F. Skinner (1904–1990) extended Thorndike's law of effect to more complex behaviors. He also emphasized that reinforcement and punishment should always be presented *after* the behavior of interest has occurred. This was because Skinner believed that the only way to know how we have influenced someone's behavior is to check whether it increases or decreases. As he pointed out, we too often think we're reinforcing or punishing behavior when we're actually doing the opposite (see *Psychology and You*).

psychology and you **The Challenge of Reinforcement** A professor may think she is encouraging shy students to talk by repeatedly praising them each time they speak up in class. But what if you are one of those shy students and are embarrassed by this extra attention? If so, you may actually decrease the number of times you talk in class. Can you see why it's important to always remember that what is reinforcing or punishing for one person may not be so for another?

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Reinforcement and Punishment

Reinforcers, which strengthen a response, can be a powerful tool in all parts of our lives. Psychologists group them into two types, primary and secondary. **Primary reinforcers** satisfy an intrinsic, unlearned biological need (like food, water, and sex). **Secondary reinforcers** are not intrinsic; the value of this reinforcer is learned (like money, praise, and attention). Each type of reinforcer can produce **positive reinforcement** or **negative reinforcement**, depending on whether certain stimuli are added or taken away **(Table 6.2)**.

Primary reinforcers Any stimuli that increase the probability of a response because of their innate, biological value, such as food and water.

Secondary reinforcers Any stimuli that increase the probability of a response because of their learned value, such as money and material possessions.

Positive reinforcement The adding (or presenting) of a stimulus, thereby strengthening a response and making it more likely to recur.

Negative reinforcement The taking away (or removing) of a stimulus, thereby strengthening a response and making it more likely to recur.

TABLE 6.2 HOW REINFORCEMENT INCREASES (OR STRENGTHENS) BEHAVIOR | psychology and you

	POSITIVE REINFORCEMENT Stimulus added (+) and behavior increases	NEGATIVE REINFORCEMENT Stimulus taken away (–) and behavior increases
PRIMARY REINFORCERS *Satisfy biological needs*	You hug your baby and he smiles at you. The "addition" of his smile increases the likelihood that you will hug him again. You do a favor for a friend and she buys you lunch in return, which makes it more likely that you'll do more favors for your friend in the future.	Your baby is crying, so you hug him and he stops crying. The "removal" of crying increases the likelihood that you will hug him again when he cries. You take an aspirin for your headache, which takes away the pain, and makes it more likely that you'll take an aspirin again when you have future pains.
SECONDARY REINFORCERS *Satisfy learned needs*	You increase profits and receive $200 as a bonus. The "addition" of the bonus increases the likelihood that you'll work hard in the future to increase profits. You study hard and receive a good grade on your psychology exam, which makes it more likely that you'll study hard in the future.	After high sales, your boss says you won't have to work on weekends. The "removal" of having to work on weekends makes it more likely that you'll work harder for high sales in the future. You're allowed to skip the final exam because you did so well on your unit exams, which makes it more likely that you'll work hard to do well on unit exams in the future.

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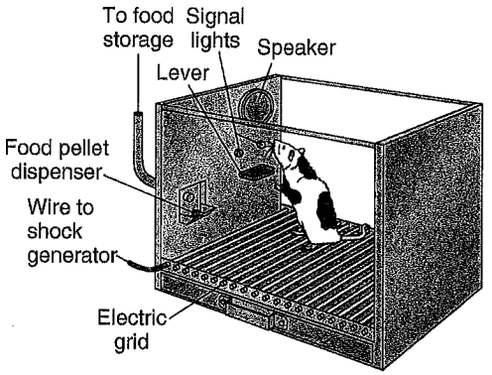
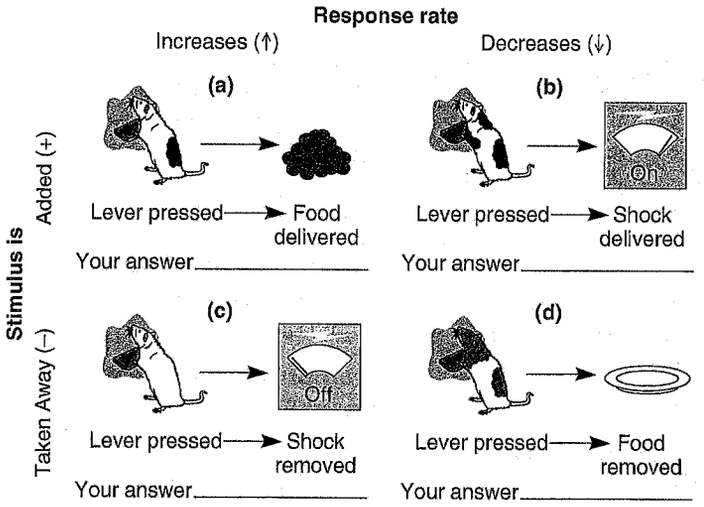
FIGURE 6.9 USING THE "SKINNER BOX" FOR BOTH REINFORCEMENT AND PUNISHMENT

To test his behavioral theories, Skinner used an animal, usually a pigeon or a rat, and an apparatus that has come to be called a *Skinner Box.*



A In Skinner's basic experimental design, an animal (such as a rat) could press a lever and food pellets or shocks (administered through an electric grid on the cage floor) could be used to give the animal reinforcement or punishment.

B Are these examples of positive reinforcement, negative reinforcement, positive punishment, or negative punishment? Fill in the appropriate learning principle in the space provided.



Answers: (a) positive reinforcement, (b) positive punishment, (c) negative reinforcement, (d) negative punishment

the behavior does not decrease, it's NOT punishment! So it's always important to watch the actual behavior and not what you think should happen. Thus, if parents ignore all the A's on their child's report card ("taking away" encouraging comments) and ask repeated questions about the B's and C's, they may unintentionally be punishing the child's excellent grade achievement and weakening the likelihood of future A's. Similarly, dog owners who yell at or spank their dogs for finally coming to them ("adding" verbal or physical aggression) after being called several times are actually punishing the desired behavior—coming when called.

In addition to these problems with punishment, to be effective it should always be *clear*, *direct*, *immediate*, and *consistent*. However, in the real world, this is extremely hard to do. Police officers cannot stop every driver each and every time they speed. To make matters worse, when punishment is not immediate, during the delay, the behavior is likely to be reinforced on a partial schedule, which makes it highly resistant to extinction.

Think about gambling. It should be a punishing situation; gamblers usually lose far more than they win. However, the fact that they occasionally win keeps gamblers "hanging in there." Furthermore, some research demonstrates that pathological gamblers are less able to make an association between negative events, such as losing lots of money, and the stimuli that cause those events, such as gambling (Brunborg et al., 2012).

Even if punishment immediately follows the misbehavior, the recipient may only learn what *not* to do, but not necessarily what he or she *should* do. It's much more efficient to teach someone by giving him or her clear examples of correct behavior than to simply punish the incorrect behavior.

Voices from the Classroom

Operant Conditioning and Driving with Kids I have two children, who used to fight like cats and dogs, especially in the confined area of the car. Rather than punish them, I decided to ignore their bickering (as long as no arms or legs flew out the window). If we made it all the way to the shopping mall without an argument, I immediately praised them highly, showed excitement, and told them how great I felt. Another time when they made it to the mall without bickering, I stopped and we had ice cream on the way home. (Trips with bickering were ignored; no reinforcement.) Happily, within about five or six trips to the mall, there was virtually no bickering. It was awesome!

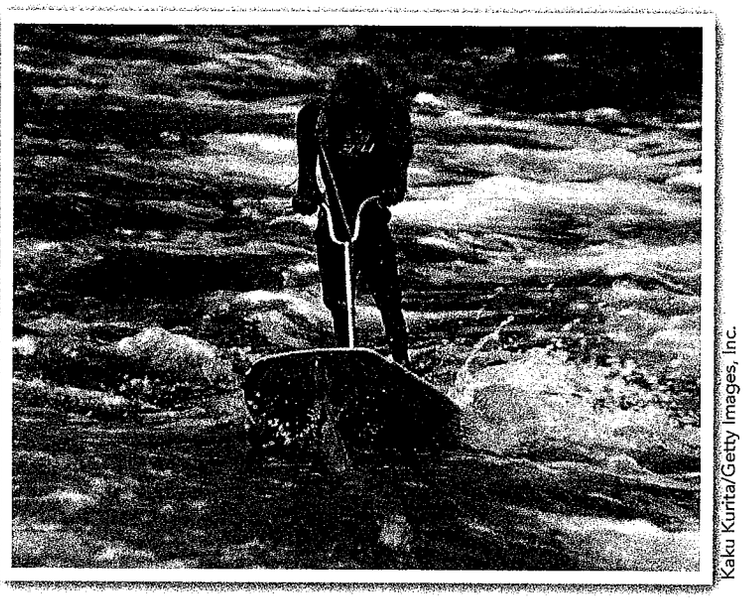
Professor Barbara Kennedy
Brevard Community College
Palm Bay, Florida

Shaping and Maintaining Behavior

It's easy to see how reinforcement is better than punishment for teaching and learning of most things, but how would you teach someone complex behaviors, like how to play the piano or to speak a foreign language? How do seals in zoos and amusement parks learn how to balance beach balls on their noses, or how to clap their flippers together on command from the trainers?

For new and complex behaviors such as these, which aren't likely to occur naturally, **shaping** is the key. Skinner believed that shaping, or *rewarding successive approximations*, explains a variety of abilities that each of us possesses, from eating with a fork to playing a musical instrument. Parents, athletic coaches, teachers, therapists, and animal trainers all use shaping techniques (Heinicke et al., 2013; Lefrancois, 2012; McDougall, 2013).

For example, Momoko, a female monkey, is famous in Japan for her water-skiing, deep-sea diving, and other amazing abilities **(Figure 6.10)**. Her animal trainers used the successive steps of shaping to teach her these skills. First, they reinforced Momoko (with a small food treat) for standing or sitting on the water ski. Then they reinforced her each time she accomplished a successive step in learning to water-ski.



Kaku Kurita/Getty Images, Inc.

FIGURE 6.10 CAN SHAPING TEACH A MONKEY TO WATERSKI?

Now that we've discussed how we learn complex behaviors through shaping, you may want to know how to maintain it. When Skinner was training his animals, he found that learning was most rapid if the response was reinforced every time it occurred—a pattern called **continuous reinforcement**.

As you have probably noticed, however, real life seldom provides continuous reinforcement. Instead, most of our responses are reinforced only sometimes—a pattern called **partial (or intermittent) reinforcement**. Think of how parents or spouses keep nagging one another even when they're only occasionally reinforced, how telemarketers keep calling even when most people hang up on them, and how children keep whining even when parents only occasionally give in! The fact that these behaviors are only intermittently reinforced explains why they're so persistent—and so resistant to extinction! On a happier note, partial (intermittent) reinforcement also encourages productive, desirable behaviors like business owners who keep revising their product and students who keep plugging away at their college classes until they graduate. For better or worse, persistence pays off!

Keep in mind that a continuous schedule is best used in the initial stages of learning. However, once a task is well learned, you'll want to move on to a partial (intermittent) schedule—thanks to its strong resistance to extinction.

When using partial reinforcement, it's also important to note that some partial **schedules of reinforcement** are better suited for maintaining or changing behavior than others. As you can see in **Table 6.4**, there are four schedules—**fixed ratio (FR)**, **variable ratio (VR)**, **fixed interval (FI)**, and **variable interval (VI)**.

Before going on, **Figure 6.11** offers even more examples of how operant conditioning applies to everyday life. In addition, if you're feeling a bit overwhelmed with all the terms and concepts for both classical and operant condtioning, carefully study the summary provided in **Table 6.5**. Also, note that while it's convenient to divide classical and operant conditioning into separate categories, almost all behaviors result from a combination of both forms of conditioning.

Shaping A training method where reinforcement is delivered for successive approximations of the desired response.

Continuous reinforcement A reinforcement pattern in which every correct response is reinforced.

Partial (intermittent) reinforcement A reinforcement pattern in which some, but not all, correct responses are reinforced.

Schedules of reinforcement Specific patterns of reinforcement (either fixed or variable) that determine when a behavior will be reinforced.

Fixed ratio (FR) schedule A schedule of reinforcement in which a reinforcer is delivered for the first response made after a fixed number of responses.

Variable ratio (VR) schedule A schedule of reinforcement in which a reinforcer is delivered for the first response made after a variable number of responses whose average is predetermined.

Fixed interval (FI) schedule A schedule of reinforcement in which a reinforcer is delivered for the first response made after a fixed period of time.

Variable interval (VI) schedule A schedule of reinforcement in which a reinforcer is delivered for the first response made after a variable period of time whose average is predetermined.

TABLE 6.5 COMPARING CLASSICAL AND OPERANT CONDITIONING

	Classical Conditioning	Operant Conditioning
Example	Cringing at the sound of a dentist's drill	A baby cries and you pick her up
Pioneers	Ivan Pavlov	Edward Thorndike
	John B. Watson	B. F. Skinner
Key Terms	Neutral stimulus (NS)	Reinforcers and punishers (primary/secondary)
	Unconditioned stimulus (US)	Reinforcement (positive/negative)
	Conditioned stimulus (CS)	Punishment (positive/negative)
	Unconditioned response (UR)	Superstition
	Conditioned response (CR)	Shaping
	Conditioned emotional response (CER)	Schedules of reinforcement (continuous/partial)
Major Similarities	Acquisition	Acquisition
	Generalization	Generalization
	Discrimination	Discrimination
	Extinction	Extinction
	Spontaneous recovery	Spontaneous recovery
	Higher-order conditioning	Higher-order conditioning
Major Differences	Subject is passive; learning based on involuntary responses and pairing of NS with US	Subject is active; learning based on voluntary responses and their consequences
	Order of effects (most effective when NS comes *before* US)	Order of effects (most effective when reinforcement or punishment come *after* behavior)

RETRIEVAL PRACTICE: OPERANT CONDITIONING

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. Learning in which voluntary responses are controlled by their consequences is called _____.

a. self-efficacy
b. operant conditioning
c. classical conditioning
d. involuntary pairing

2. An employer who gives his or her employees a cash bonus after they've done a good job is an example of _____.

a. positive reinforcement
b. incremental conditioning
c. classical conditioning
d. bribery

3. _____ reinforcers normally satisfy an unlearned biological need.

a. Positive
b. Negative
c. Primary
d. none of these options

4. The most effective way to decrease the probability of your teenager engaging in undesired behaviors is to use _____.

a. punishment and negative reinforcement
b. modeling and extinction
c. extinction and negative reinforcement
d. all of these options

picked up the stick and maneuvered the banana to within its grasp (Köhler, 1925). Köhler called this *insight learning* because some internal mental event, which he could only describe as "insight," went on between the presentation of the banana and the use of the stick to retrieve it. (See **Figure 6.12** for another example of how Köhler's chimps solved a similar "out-of-reach banana" problem.)

Like Köhler, Edward C. Tolman (1898–1956) believed that previous researchers underestimated human and nonhuman animals' cognitive processes and cognitive learning. He noted that, when allowed to roam aimlessly in an experimental maze with no food reward at the end, rats seemed to develop a **cognitive map**, or mental representation of the maze.

To further test the idea of cognitive learning, Tolman allowed one group of rats to aimlessly explore a maze, with no reinforcement. A second group was reinforced with food whenever they reached the end of the maze. The third group was not rewarded during the first 10 days of the trial, but starting on day 11, they found food at the end of the maze.

As expected from simple operant conditioning, the first and third groups were slow to learn the maze, whereas the second group, which had reinforcement, showed fast, steady improvement. However, when the third group started receiving reinforcement (on the 11th day), their learning quickly caught up to the group that had been reinforced every time (Tolman & Honzik, 1930). This showed that the nonreinforced rats had been thinking and building cognitive maps of the area during their aimless wandering and that their **latent learning** only showed up when there was a reason to display it (the food reward).

Cognitive maps and latent learning are not limited to rats. For example, a chipmunk will pay little attention to a new log in its territory (after initially checking it for food). When a predator comes along, however, the chipmunk heads directly for and hides beneath the log. Recent experiments provide additional clear evidence of latent learning and the existence of internal, cognitive maps in both human and nonhuman animals (Lew, 2011; Nadel, 2013; Redish & Ekstrom, 2013). See **Figure 6.13**.

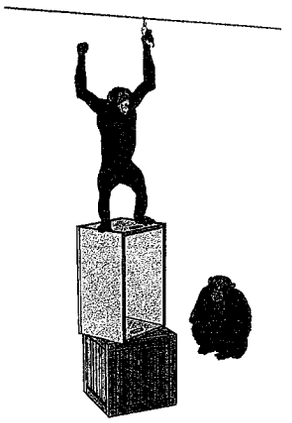


FIGURE 6.12 COGNITIVE-SOCIAL LEARNING

In a second Köhler experiment, chimpanzees were placed in a room with several scattered boxes, none of which was high enough to enable them to reach the banana. They initially ran around and unproductively jumped for the banana. Then, all of a sudden, they saw the solution—they stacked the boxes and used them to climb up and grab the banana! (Also, note how the chimp in the background is engaged in observational learning, our next topic.)

Cognitive map A mental image of a three-dimensional space that an organism has navigated.

Latent learning Hidden learning that exists without behavioral signs.

Observational learning The learning of new behaviors or information by watching and imitating others (also known as social learning or modeling).

Observational Learning

In addition to classical and operant conditioning and cognitive processes (such as insight and latent learning), we also learn many things through **observational learning**. From birth to death, observational learning is very important to our

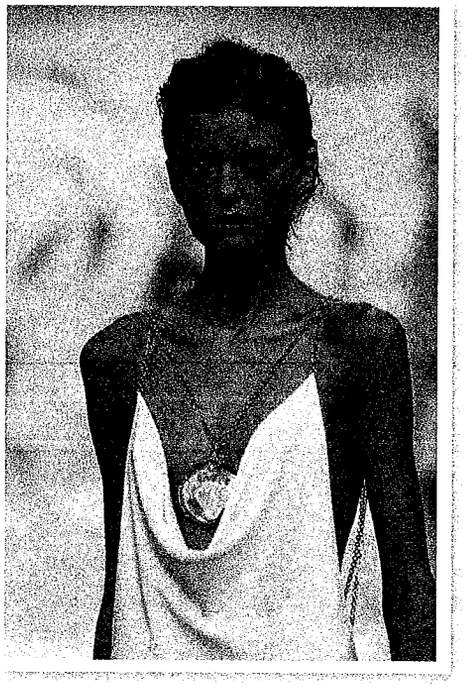
Ty Milford/Masterfile

FIGURE 6.13 COGNITIVE MAPS IN HUMANS

This young woman rides through her neighborhood for fun, without a specific destination. However, she is developing her own internal cognitive maps, and she could probably easily return to the local park even though she might not be able to give specific directions. Can you think of examples of similar cognitive maps from your own life?

PSYCHSCIENCE

THE (SCARY) POWER OF OBSERVATIONAL LEARNING



Karl Prouse/Catwalking/Getty Images

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What do we learn from images like these? Researchers in one study wanted to know whether the preference for the thin ideal is seen even in very young children, who should have little exposure to this type of media image of women (Harriger et al., 2010). To examine this question, these researchers asked preschool girls (ages 3 to 5) to play a game of either Candy Land or Chutes and Ladders with them. The girls were told they could select which of three game piece characters they wanted to be. Unlike the women in the photos above, these game piece characters were exactly the same, except in terms of their body size (one character was thin, one was average, one was fat).

If the girls had no preference for a particular body type, then about 33% of the girls should have randomly chosen each of the three figures. However, the researchers found that the girls showed an overwhelming preference for the character with the thin figure:

- 69% chose the thin figure.
- 20% chose the average figure.
- Only 11% chose the fat figure.

When asked to explain why they chose a particular figure, many of the girls expressed negative attitudes about the fat figure. For example, one girl said, "I hate her because she has a fat stomach." Another girl said, "I don't want to be her; she's fat and ugly." This research sadly suggests that this preference for the thinness norm emerges very early in life.

RESEARCH CHALLENGE

1. Based on the information provided, did this study (Harriger et al., 2010) 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.

FIGURE 6.16 ENVIRONMENTAL ENRICHMENT AND THE BRAIN | realworldpsychology

For humans and nonhuman animals alike, environmental conditions play an important role in enabling learning. How might a classroom rich with stimulating toys, games, and books foster intellectual development in young children?

PhotoDisc Green/Getty Images

Top-Pet-Pics/Alamy

structures, including the cortex, cerebellum, hippocampus, hypothalamus, thalamus, and amygdala.

Evidence that learning changes brain structure first emerged in the 1960s, from studies of animals raised in enriched versus deprived environments. Compared with rats raised in a stimulus-poor environment, those raised in a colorful, stimulating "rat Disneyland" had a thicker cortex, increased nerve growth factor (NGF), more fully developed synapses, more dendritic branching, and improved performance on many tests of learning and memory (Hamilton et al., 2012; Harati et al., 2011; Lorez-Arnaiz et al., 2007; Speisman et al., 2013).

Admittedly, it is a big leap from rats to humans, but research suggests that the human brain also responds to environmental conditions **(Figure 6.16)**. For example, older adults who are exposed to stimulating environments generally perform better on intellectual and perceptual tasks than those who are in restricted environments (Daffner, 2010; Petrosini et al., 2013; Schaie, 1994, 2008).

Similarly, babies who spend their early weeks and months of life in an orphanage, and receive little or no one-on-one care or attention, show deficits in the cortex of the brain, indicating that early environmental conditions may have a lasting impact on cognitive development (Almas et al., 2012; Sheridan et al., 2012). The good news, however, is that children who are initially placed in an orphanage but later move on to foster care—where they receive more individual attention—show some improvements in brain development.

Mirror Neurons and Imitation

Recent research has identified another neurological influence on learning processes, particularly imitation. When an adult models a facial expression, even very young infants will respond with a similar expression **(Figure 6.17)**. At 9 months, infants will imitate facial actions a full day after first seeing them (Heimann & Meltzoff, 1996).

How can newborn infants so easily imitate the facial expressions of others? Using fMRIs and other brain-imaging techniques,

FIGURE 6.17 INFANT IMITATION—EVIDENCE OF MIRROR NEURONS?

In a series of well-known studies, Andrew Meltzoff and M. Keith Moore (1977, 1985, 1994) found that newborns could imitate such facial movements as tongue protrusion, mouth opening, and lip pursing.

From: A.N. Meltzoff & M.K. Moore, "Imitation of facial and manual gestures by human neonates." Science, 1977, 198, 75–78.

recovering from the illness, the rats refused to drink the sweetened water (CS) because of the conditioned taste aversion. Remarkably, however, Garcia also discovered that only certain neutral stimuli could produce the nausea. Pairings of a noise (NS) with the shock (US) produced no taste aversion.

Similarly, perhaps because of the more "primitive" evolutionary threat posed by snakes, darkness, spiders, and heights, people tend to more easily develop phobias of these stimuli, compared to guns, knives, and electrical outlets. Research also shows that both adults and very young children have an innate ability to very quickly identify the presence of a snake, whereas they are less able to quickly identify other (non-life-threatening) objects, including a caterpillar, flower, or toad (LoBue & DeLoache, 2008; Young et al., 2012). We apparently inherit a built-in (innate) readiness to form associations between certain stimuli and responses—but not others. This is known as **biological preparedness**.

Q5

Biological preparedness The built-in (innate) readiness to form associations between certain stimuli and responses.

Just as Garcia couldn't produce classically conditioned noise–nausea associations, other researchers have found that an animal's natural behavior pattern can interfere with operant conditioning. For example, early researchers tried to teach a chicken to play baseball (Breland & Breland, 1961). Through shaping and reinforcement, the chicken first learned to pull a loop that activated a swinging bat and then learned to actually hit the ball. But instead of running to first base, it would chase the ball as if it were food. Regardless of the lack of reinforcement for chasing the ball, the chicken's natural behavior took precedence. This type of biological behavior is known as **instinctive drift**.

Instinctive drift The tendency for conditioned responses to revert (drift back) to innate response patterns.

In this chapter, we've discussed three general types of learning, classical, operant, and cognitive-social. We've also examined the biological effect on learning. As humans, we also have the capacity to learn and change thanks to our ability to remember, think, and to use language, as well as our individual forms of intelligence. Each of these exciting topics are discussed in the next two chapters.

RETRIEVAL PRACTICE: BIOLOGY OF 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. _____ neurons may be responsible for human empathy and imitation.

a. Motor
b. Sensitivity
c. Empathy
d. Mirror

2. Rebecca's story of becoming nauseated and vomiting after eating a spoiled candy bar is a good example of _____.

a. a biological imperative
b. a taste aversion
c. learned empathy
d. negative reinforcement

3. Being innately predisposed to form associations between certain stimuli and responses is called _____.

a. prejudice
b. vicarious learning
c. superstitious priming
d. biological preparedness

4. A biological constraint where an animal's conditioned responses tend to shift toward innate response patterns is called _____.

a. biological preparedness
b. reflexes
c. instinctive drift
d. taste aversion

Think Critically

1. If mirror neurons explain human empathy, could they also explain why first responders (like police and firefighters) are more vulnerable to job burnout? Why or why not?
2. Do you have any taste aversions? If so, how would you use information in this chapter to remove them?

realworldpsychology

Why can even young children recognize a picture of a snake much faster than a picture of a frog or caterpillar?

HINT: LOOK IN THE MARGIN FOR Q5

Key Terms

RETRIEVAL PRACTICE Write a definition for each term before turning back to the referenced page to check your answer.

- acquisition 156
- biological preparedness 175
- classical conditioning 153
- cognitive map 169
- cognitive-social learning theory 168
- conditioned emotional response (CER) 154
- conditioned response (CR) 154
- conditioned stimulus (CS) 154
- conditioning 153
- continuous reinforcement 165
- extinction 157
- fixed interval (FI) schedule 165
- fixed ratio (FR) schedule 165
- higher-order conditioning 158
- insight 168
- instinctive drift 175
- latent learning 169
- law of effect 160
- learning 152
- mirror neurons 174
- negative punishment 162
- negative reinforcement 161
- neutral stimulus (NS) 154
- observational learning 169
- operant conditioning 159
- partial (intermittent) of reinforcement 165
- positive punishment 162
- positive reinforcement 161
- Premack principle 162
- primary punishers 162
- primary reinforcers 161
- punishment 159
- reinforcement 159
- schedules of reinforcement 165
- secondary punishers 162
- secondary reinforcers 161
- shaping 165
- spontaneous recovery 157
- stimulus discrimination 156
- stimulus generalization 156
- taste aversion 174
- unconditioned response (UR) 154
- unconditioned stimulus (US) 154
- variable interval (VI) schedule 165
- variable ratio (VR) schedule 165

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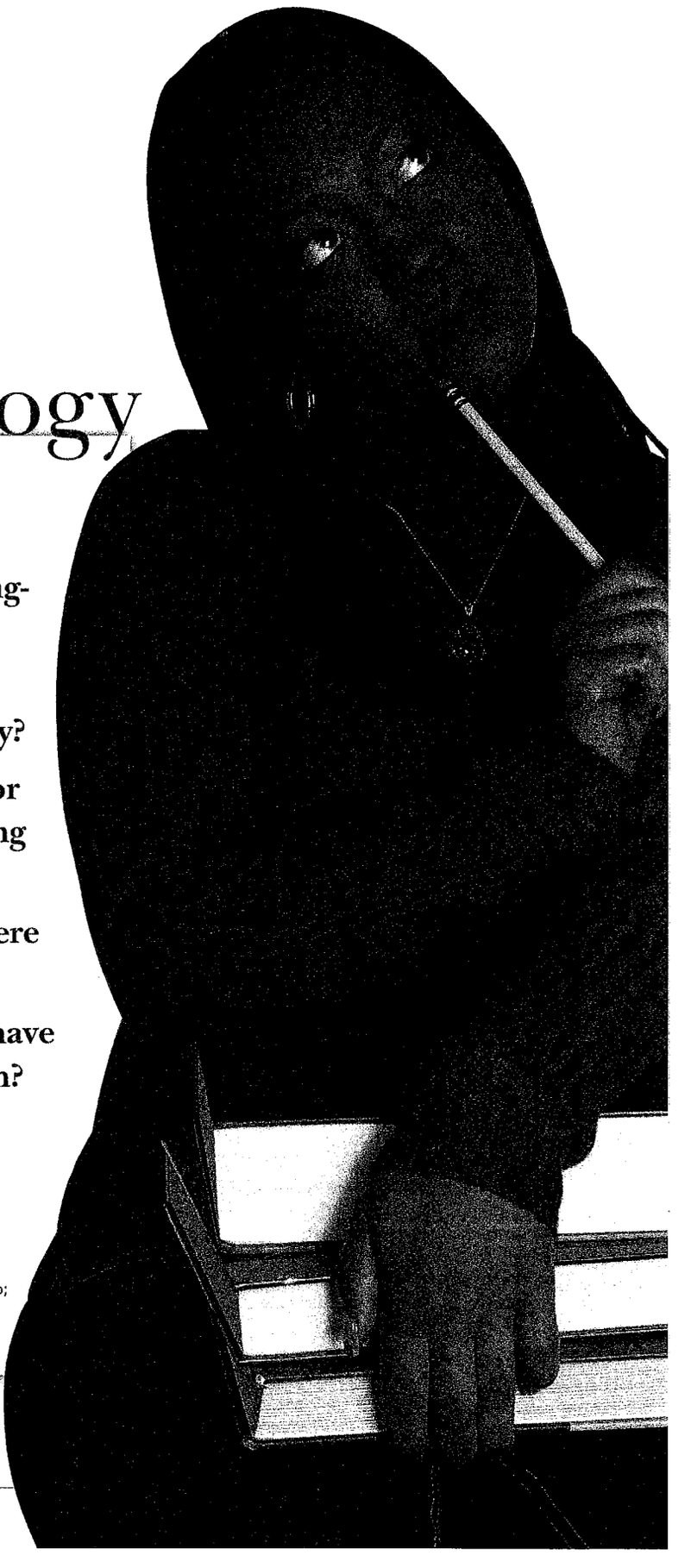


THINGS YOU'LL LEARN IN CHAPTER 7

Q1 **Do daydreamers actually have better working-memory skills than people who don't daydream?**

Q2 **How can taking a nap improve your memory?**

Q3 **Can merely imagining engaging in a behavior create a false memory of actually performing that behavior?**

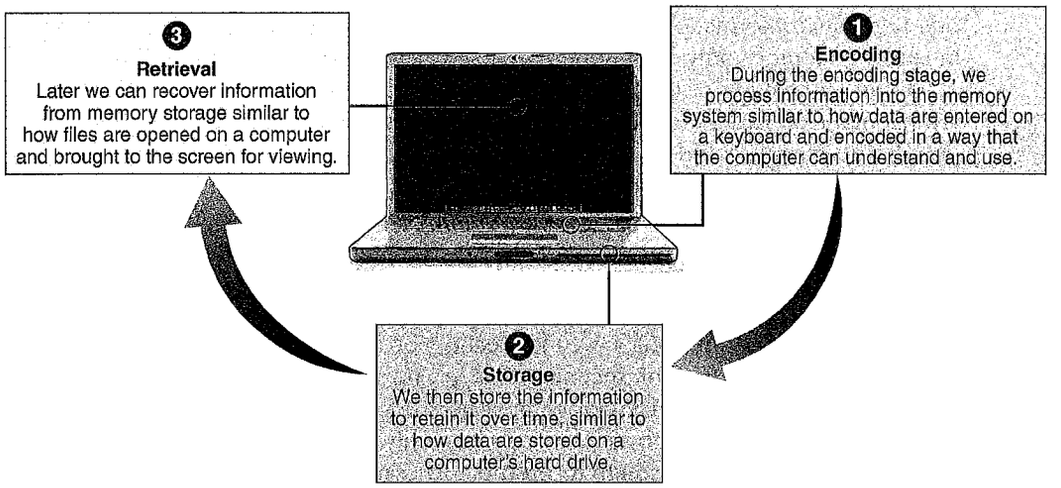
Q4 **Why might exposure to pornography interfere with memory?**

Q5 **Does accuracy increase when eyewitnesses have only a few seconds to make an identification?**

THROUGHOUT THE CHAPTER, MARGIN ICONS FOR Q1–Q5 INDICATE WHERE THE TEXT ADDRESSES THESE QUESTIONS.

FIGURE 7.1 ENCODING, STORAGE, AND RETRIEVAL

The encoding, storage, and retrieval model of memory is often compared to a computer's information processing system.



Finally, information must be **retrieved**, or taken out of storage. We retrieve stored information by going to files on our computer or to "files" in our brain. Keep this model in mind. To do well in college, or almost any other pursuit, you must successfully encode, store and retrieve a large amount of facts and concepts. Throughout this chapter, we'll discuss ways to improve your memory during each of these processes.

Retrieval The recovery of information from memory storage.

Three-Stage Memory Model

Since the late 1960s, the most highly researched and widely used memory model has been the **three-stage memory model** (Atkinson & Shiffrin, 1968; Eichenbaum, 2013; Nairne & Neath, 2013). It remains the leading paradigm in memory research because it offers a convenient way to organize the major findings. According to this model, three different storage "boxes," or memory stages, hold and process information. Each stage has a different purpose, duration, and capacity **(Figure 7.2)**. Let's discuss each stage in more detail.

Three-stage memory model A memory model which suggests that memory storage requires passage of information through three stages (sensory, short-term, and long-term memory).

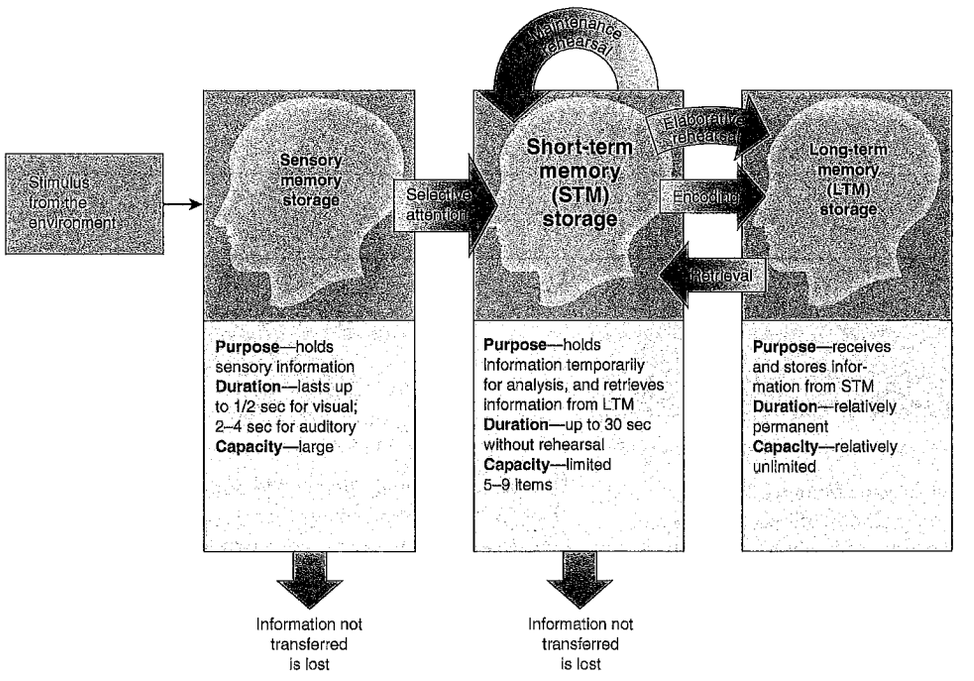


FIGURE 7.2 THE TRADITIONAL THREE-STAGE MEMORY MODEL

Each "box" represents a separate memory system that differs in purpose, duration, and capacity. When information is not transferred from sensory memory or short-term memory, it is assumed to be lost. Information stored in long-term memory can be retrieved and sent back to short-term memory for use.

by hyphens? The reason is that it's easier to remember numbers in chunks rather than as a string of single digits.

Chunking also helps in football. What do you see when you observe this arrangement of players from a page of a football playbook **(Figure 7.5)**? To the inexpert eye, it looks like a random assembly of lines and arrows, and a naive person generally would have little or no understanding or appreciation of the skills required in football. But experienced players and seasoned fans generally recognize many or all of the standard plays. To them, the scattered lines form meaningful patterns—classic arrangements that recur often. Just as you group the letters of this sentence into meaningful words and remember them long enough to understand the meaning of the sentence, expert football players group the different football plays into easily recalled patterns (or chunks).

You can also extend the *duration* of your STM almost indefinitely by consciously "juggling" the information—a process called **maintenance rehearsal**. You are using maintenance rehearsal when you look up a phone number and repeat it over and over until you key in the number.

People who are good at remembering names also know how to take advantage of maintenance rehearsal. They repeat the name of each person they meet, aloud or silently, to keep it active in STM. They also make sure that other thoughts (such as their plans for what to say next) don't intrude.

As you can see in **Figure 7.6**, short-term memory is more than just a passive, temporary "holding area." Given that active processing of information also occurs in STM, many researchers prefer the term **working memory** (Baddeley, 1992, 2007; Barrouillet & Camos, 2012; Brady & Tenenbaum, 2013; Thornton & Conway, 2013). All our conscious thinking occurs in this "working memory," and the manipulation of information that occurs here helps explain some of the memory errors and false constructions described in this chapter.

Interestingly, people who daydream while completing simple tasks may show even higher working-memory capabilities (Levinson et al., 2012). Researchers in one study first tested participants on their level of working memory, meaning how much information they could hold in their minds at one time. The participants then completed relatively mindless tasks, such as pressing a button each time a certain letter appeared on a computer screen. Participants were asked periodically whether their minds were focused on the assigned task or were wandering to other thoughts. People with higher working-memory scores reported more mind wandering during the mindless task, presumably because they needed to spend less attention on the simple task. These findings suggest that having better working-memory skills may allow for more daydreaming!

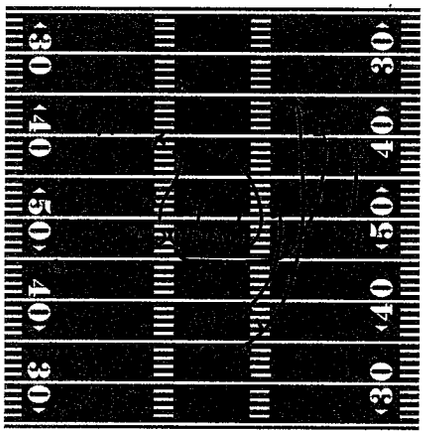


FIGURE 7.5 CHUNKING IN FOOTBALL

Maintenance rehearsal The memory-improvement technique of repeating information over and over to maintain it in short-term memory (STM).

Working memory An alternate term for short-term memory (STM), which emphasizes the active processing of information.

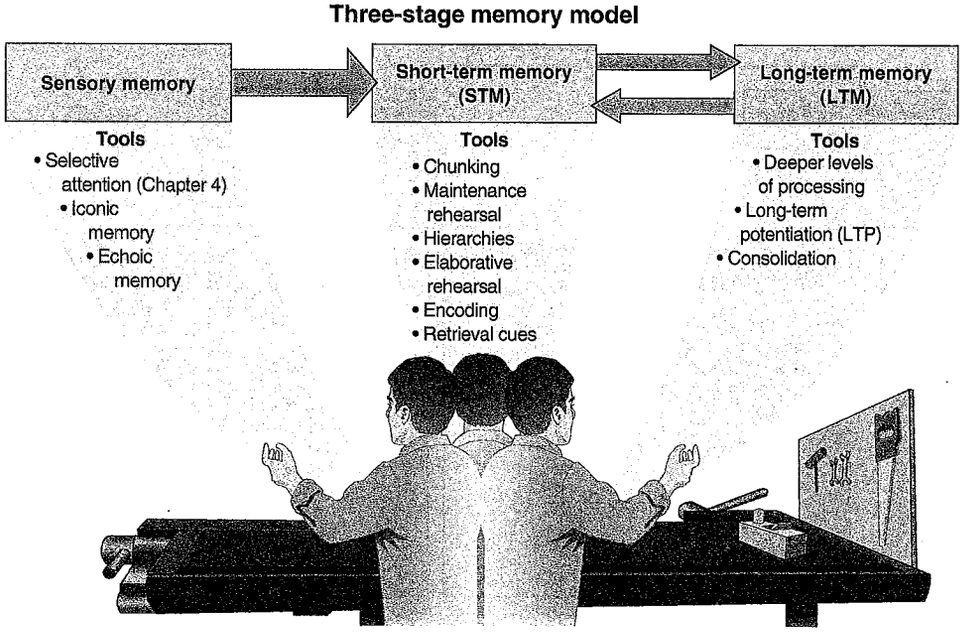


FIGURE 7.6 HOW WORKING MEMORY MIGHT WORK

Given that short-term memory (STM) is active, or *working*, it helps to picture STM as a "workbench," with a "worker" at the bench who selectively attends to certain sensory information and also sends and retrieves it from long-term memory (LTM). The worker also manipulates the incoming, transferred, and retrieved information. Note the various "tools" the "worker" uses during the three stages of processing.

Implicit/nondeclarative memory also includes **priming**, in which prior exposure to a stimulus (*prime*) facilitates or inhibits the processing of new information (McKoon & Ratcliff, 2012; Northup & Mulligan, 2013; Schmitz & Wentura, 2012). Priming often occurs even when we do not consciously remember being exposed to the prime.

Priming A process in which a prior exposure to a stimulus (or prime) facilitates or inhibits the processing of new information, even when one has no conscious memory of the initial learning and storage.

psychology and you **How Our Moods Are Primed** Have you ever felt nervous being home alone while reading a Stephen King novel, experienced sadness after hearing about a tragic event in the news, or developed amorous feelings while watching a romantic movie? These are all examples of how the situation we are in may influence our mood, in conscious or unconscious ways. Given this new insight into how priming can "set you up" for certain emotions, can you see how those who haven't studied psychology might be more likely to mislabel or overreact to their emotions?

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Improving Long-Term Memory

There are several ways we can improve long-term memory. These include *organization*, *rehearsal* (or *repetition*), and *retrieval*.

One additional trick for giving your memory a boost is to use **mnemonic** devices to encode items in a special way (see *Improving Your Memory Using Mnemonic Devices* on the next page). However, these devices take practice and time, and some students find that they get better results using the other well-researched principles discussed throughout this chapter.

Mnemonic A strategy or device that uses familiar information during the encoding of new information to enhance subsequent access to the information in memory.

Organization

To successfully encode information for LTM, we need to *organize* material into hierarchies. This means arranging a number of related items into broad categories that we further divide and subdivide. (This organizational strategy for LTM is similar to the strategy of chunking material in STM.) For instance, by grouping small subsets of ideas together (as subheadings under larger, main headings and within diagrams, tables, and so on), we hope to make the material in this book more understandable and *memorable*.

Admittedly, organization takes time and work. But you'll be happy to know that some memory organization and filing is done automatically while you sleep (Groch et al., 2013; Payne et al., 2012; Stickgold & Walker, 2013; Verleger et al., 2011). In fact, research shows that people who rest and close their eyes for as little as 10 minutes show greater memory for details of a story they've just heard (Dewar et al., 2012). Unfortunately, despite claims to the contrary, research shows that we can't recruit our sleeping hours to memorize new material, such as a foreign language.

Q2

Rehearsal

Like organization, *rehearsal* also improves encoding for both STM and LTM. If you need to hold information in STM for longer than 30 seconds, you can simply keep repeating it (maintenance rehearsal). But storage in LTM requires *deeper levels of processing*, called **elaborative rehearsal**.

The immediate goal of elaborative rehearsal is to *understand*—not to memorize. Fortunately, this attempt to understand is one of the best ways to encode new information into long-term memory.

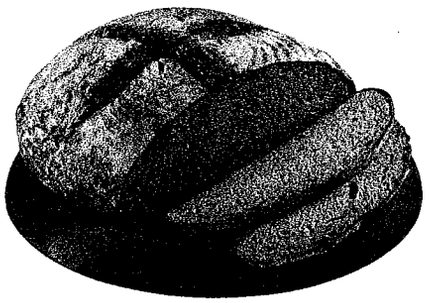
Elaborative rehearsal A technique for improving memory by linking new information to previously stored material; also known as deeper levels of processing.

Retrieval

Finally, effective *retrieval* is critical to improving long-term memory. There are two types of **retrieval cues (Figure 7.8)**. *Specific* cues require you only to *recognize* the correct response. *General* cues require you to *recall* previously learned material by searching through all possible matches in LTM—a much more difficult task.

Retrieval cue A prompt or stimulus that aids recall or retrieval of a stored piece of information from long-term memory (LTM).

psychology and you **The Power of Retrieval Cues** Whether cues require recall or only recognition is not all that matters. Imagine that while house hunting, you walk into a stranger's kitchen and are greeted with the unmistakable smell of freshly baked bread. Instantly, the aroma transports you to your grandmother's kitchen, where you spent many childhood afternoons doing your homework. You find yourself suddenly thinking of the mental shortcuts your grandmother taught you to help you learn your multiplication tables. You hadn't thought about these little tricks for years, but somehow a whiff of baking bread brought them back to you. Why?



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In this imagined baking bread episode, you have stumbled upon the **encoding-specificity principle** (Tulving & Thompson, 1973). In most cases, we're able to remember better when we attempt to recall information in the *same* context in which we learned it (Lin et al., 2013; Unsworth et al., 2012). Have you noticed that you tend to do better on exams when you take them in the same seat and classroom in which you originally studied the material? This happens because the matching location acts as a retrieval cue for the information.

Encoding-specificity principle The principle that retrieval of information is improved if cues received at the time of recall are consistent with those present at the time of encoding.

People also remember information better if their moods during learning and retrieval match (Forgas & Eich, 2013; Howe & Malone, 2011). This phenomenon, called *mood congruence*, occurs because a given mood tends to evoke memories that are consistent with that mood. When you're sad (or happy or angry), you're

FIGURE 7.8 RECALL VERSUS RECOGNITION

Can you *recall*, in order, the names of the planets in our solar system? If not, it's probably because recall, like questions on an essay exam, requires retrieval using only general, nonspecific cues—like naming the planets. In contrast, a recognition task only requires you to identify the correct response, like a multiple-choice exam. Note how much easier it is to *recognize* the names of the planets when you're provided a specific retrieval cue, in this case the first three letters of each planet: Mer-, Ven-, Ear-, Mar-, Jup-, Sat-, Ura-, Nep-, Plu-. (Note that in 2006, Pluto was officially declassified as a planet and is now considered a "dwarf planet.")

Antonio M. Rosario/Photographer's Choice/Getty Images

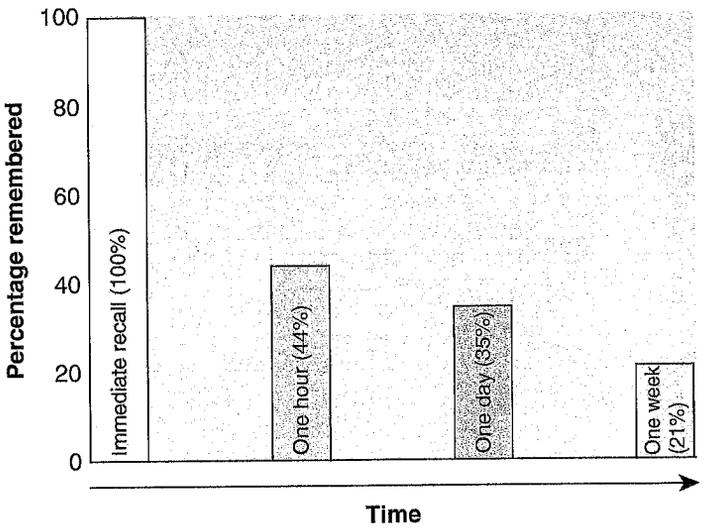


FIGURE 7.9 HOW QUICKLY WE FORGET

Using himself as a subject, Ebbinghaus calculated how long it took to learn a list of three-letter *nonsense syllables*, such as *SIB* and *RAL*. He found that one hour after he knew a list perfectly, he remembered only 44% of the syllables. A day later he recalled 35%, and a week later only 21%.

Although Ebbinghaus's research showed a dramatic drop in his previously learned material, keep in mind that meaningful material is much more memorable than nonsense syllables. Furthermore, after some time had passed and Ebbinghaus thought he had completely forgotten the list, he discovered that *relearning* it took less time than the initial learning took. Similarly, if your college requires you to repeat some of the math or foreign language courses you took in high school, you'll be happily surprised by how much you recall and how much easier it is to relearn the information the second time around.

More recent research based on Ebbinghaus's discoveries has identified an ideal time to practice something you have just learned. Practicing too soon is a waste of time, but if you practice too late, you will already have forgotten what you learned. The ideal time to practice is when you are about to forget.

Polish psychologist Piotr Wozniak used Ebbinghaus's insight regarding the ideal practice time to create a software program called SuperMemo. The program can be used to predict the future state of an individual's memory and help the person schedule reviews of learned information at the optimal time. So far the program has been applied mainly to language learning, helping users retain huge amounts of vocabulary. But Wozniak hopes that someday programs like SuperMemo will tell people when to wake and when to exercise, help them remember what they have read and whom they have met, and remind them of their goals (Wolf, 2008).

Theories of Forgetting

Although we all sometimes wish we had complete recall of everything we've learned, if we truly couldn't forget, our minds would be filled with meaningless data, such as what we ate for breakfast every morning and every conversation we've ever had. Similarly, think of the pain we'd continuously endure if we couldn't distance ourselves from tragedy through forgetting. The ability to forget is essential to the proper functioning of memory, and psychologists have developed several theories to explain why forgetting occurs **(Figure 7.10)**: *decay*, *interference*, *motivated forgetting*, *encoding failure*, and *retrieval failure*. Each theory focuses on a different stage of the memory process or a particular type of problem in processing information.

In *decay theory*, memory is processed and stored in a physical form—for example, in a network of neurons. Connections between neurons probably deteriorate over time, leading to forgetting. This theory explains why skills and memory degrade if they go unused ("use it or lose it").

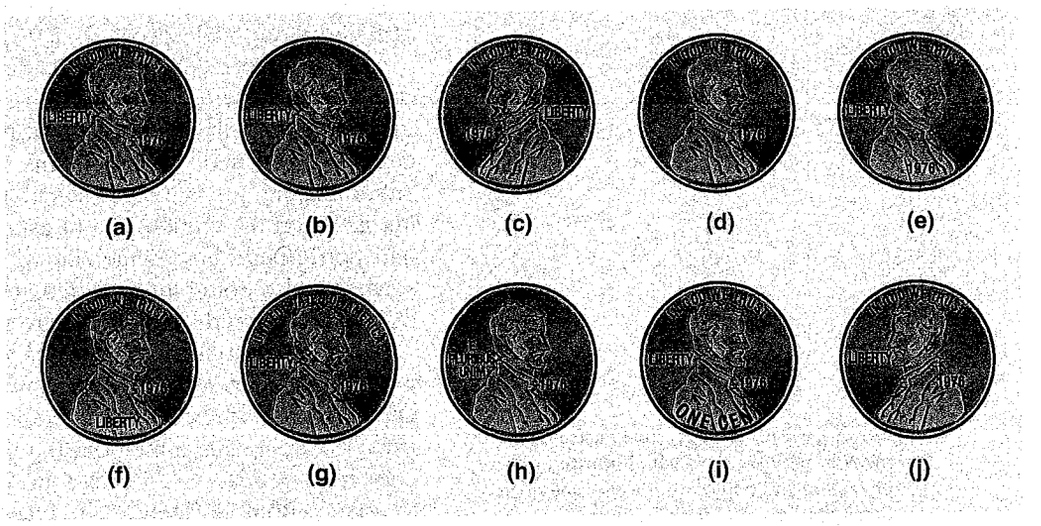
In *interference theory*, forgetting is caused by two competing memories, particularly memories with similar qualities. At least two types of interference exist: *retroactive* and *proactive* **(Figure 7.11)**. When new information leads to forgetting old material, it is called **retroactive interference** (acting backward in time). Learning your new phone number may cause you to forget your old phone number (old,

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

TEST YOURSELF: WHICH IS THE REAL PENNY?

psychology and you

If you want a simple (but fascinating) example of *encoding failure*, try to identify the correct penny among this sample of 10. Despite having seen a real penny thousands of times in our lives, most of us have difficulty recognizing the details. The U.S. penny has eight easily distinguishing characteristics (Lincoln's head, the date it was minted, which way Lincoln is facing, and so on). However, the average person can only remember three characteristics (Nickerson & Adams, 1979). Because we can easily recognize pennies by their size and color, we don't encode the fine details and pass them on for storage in LTM. Can you see how this applies to reading a textbook? You can't read a text the way you read a novel. You need to pay close attention to details in order to "recognize" the correct answers on exams!



According to *retrieval failure theory*, memories stored in LTM aren't forgotten. They're just momentarily inaccessible. For example, the **tip-of-the-tongue (TOT) phenomenon**—the feeling that a word or an event you are trying to remember will pop out at any second—is known to result from interference, faulty cues, and high emotional arousal.

Tip-of-the-tongue (TOT) phenomenon Feeling that specific information is stored in your long-term memory but being temporarily unable to retrieve it.

Factors Involved in Forgetting

Since Ebbinghaus's original research, scientists have discovered numerous factors that contribute to forgetting. Six of the most important are the *misinformation effect*, the *serial- position effect*, *source amnesia*, the *sleeper effect*, *spacing of practice*, and *culture*.

Misinformation effect A memory distortion that results from misleading post-event information.

Many people (who haven't studied this chapter or taken a psychology course) believe that when they're recalling an event, they're remembering it as if it were a kind of instant replay. However, as you know, our memories are highly fallible and filled with personal constructions that we create during encoding and storage. Research on the **misinformation effect** shows that information that occurs *after an event* may further alter and revise those constructions.

For example, in one study, participants completed an interview in one room and then answered questions about it in another room (Morgan et al., 2012). Participants who received neutral questions like "Was there a telephone in the room?" answered accurately for the most part, making errors on only 10% of the questions. However, other participants were asked questions such as "What color was the telephone?" which falsely implied that there had been a telephone in the room. Of these respondents, 98% "remembered" a telephone. Other

Voices from the Classroom

"False Daughter" Memories One of the co-authors of this book, Karen Huffman, is a dear friend of mine and we've co-taught intro psych for many years. During our times together in the classroom, we've often told stories about our own children to provide real-life examples of various psychological principles. Ironically, in the chapter on memory, we suddenly realized that some of the stories we were currently telling our students about our respective daughters were becoming blended in our own minds. We couldn't remember whether certain events happened to one of my three daughters or to Karen's only daughter! For us, this became a perfect, personal example of both the *constructive* nature of memory, as well as *source amnesia*!

Professor Katie Townsend-Merino
Palomar College
San Marcos, CA

(c) Ferdinando Scianna/MagnumPhotos, Inc.

FIGURE 7.12 CULTURE AND MEMORY

In many societies, tribal leaders pass down vital information through orally related stories. As a result, children living in these cultures have better memories for information that is related through stories than do other children. Can you think of other ways in which culture might influence memory?

RETRIEVAL PRACTICE: FORGETTING

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. According to the _____ theory of forgetting, memory is processed and stored in a physical form, and connections between neurons deteriorate over time.

a. decay
b. interference
c. motivated forgetting
d. retrieval failure

2. The _____ theory suggests that forgetting is caused by two competing memories, particularly memories with similar qualities.

a. decay
b. interference
c. motivated forgetting
d. encoding failure

3. Which of the following is *not* one of the six factors that contribute to forgetting outlined in the text?

a. misinformation effect
b. serial-position effect
c. consolidation
d. source amnesia

4. Distributed practice is a learning technique in which _____.

a. students are distributed (spaced) equally throughout the room
b. learning periods alternate with nonlearning rest periods
c. learning decays faster than it can be distributed
d. several students study together, distributing various subjects according to their individual strengths

Think Critically

1 Briefly describe an example from your own life of source amnesia and the sleeper effect.

2 Why might advertisers of shoddy services or products benefit from channel surfing, especially if the television viewer is skipping from news programs to cable talk shows to infomercials?

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Can merely imagining engaging in a behavior create a false memory of actually performing that behavior?

HINT: LOOK IN THE MARGIN FOR Q3

Further evidence comes from research with genetically engineered "smart mice," which have extra receptors for a neurotransmitter named NMDA (N-methyl-d-aspartate). These mice perform significantly better on memory tasks than do normal mice (Brim et al., 2013; Mohamad et al., 2013; Tang et al., 2001; Tsien, 2000).

Although it is difficult to generalize from sea slugs and mice, research on long-term potentiation (LTP) in humans also supports the idea that LTP is one of the major biological mechanisms underlying learning and memory (Berger et al., 2008; Kullmann & Lamsa, 2011; Shin et al., 2010).

Hormonal Changes and Emotional Arousal

When stressed or excited, we naturally produce hormones that arouse the body, such as *epinephrine* and *cortisol* (Chapter 3). These hormones in turn affect the amygdala (a brain structure involved in emotion), which then stimulates the hippocampus and cerebral cortex (parts of the brain that are important for memory storage). Research has shown that these hormones can interfere with, as well as enhance how we encode, store, and retrieve our memories (Baucom et al., 2012; Guenzel et al., 2013; Hupbach & Fieman, 2012; Jurado-Berbel et al., 2010; McIntyre et al., 2012; Morgan et al., 2012; Schilling et al., 2013).

For example some research suggests that exposure to pornography can disrupt memory. Researchers in one study asked men to view a series of both pornographic and nonpornographic images and judge whether they had previously seen each image (Laier et al., 2013). Men who saw the nonsexual images gave 80% correct answers, whereas men who saw the pornographic images gave only 67% correct answers. Can you see how sexual arousal interferes with working memory and how it may help explain these findings? Q4

The enhancing effect of hormones on memory also can be seen in what are known as **flashbulb memories (FBMs)**—vivid, detailed, and near-permanent images associated with surprising or strongly emotional events (Brown & Kulik, 1977). In such situations, we secrete a flood of hormones when we initially experience or learn of the event, and then we replay the event in our minds again and again, actions that both make for stronger memories. In addition to widely shared public events, such as the Boston Marathon bombings on April 15, 2013, your personal flashbulb memories might include your first kiss, the birth of your first child, or the loss of a loved one.

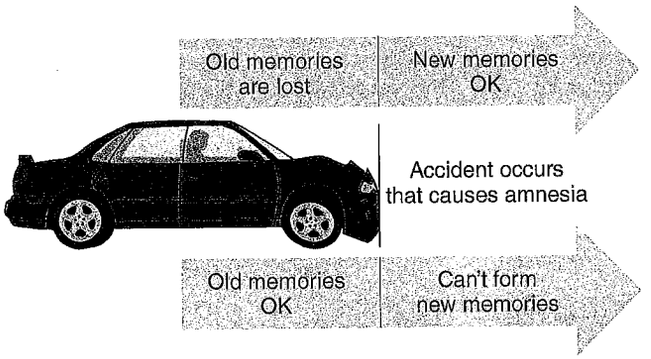
Flashbulb memory (FBM) A recall of vivid, detailed, and near-permanent images associated with surprising or strongly emotional events; it may or may not be accurate.

Despite their intensity, flashbulb memories may not be as accurate as you might think (Kvavilashvili et al., 2010; Lanciano et al., 2010; Schmidt, 2012). For example, when asked how he heard the news of the September 11, 2001, attacks, President George W. Bush's answers contained several errors (Greenberg, 2004). Our flashbulb memories for specific details (particularly the time and place the emotional event occurred) are fairly accurate (Rimmele et al., 2012). But, overall, flashbulb memories, like all other memories, are not perfect recordings of events. What separates them from ordinary, everyday memories is their vividness and our subjective confidence in their accuracy. Keep in mind that confidence is not the same as accuracy—an important point we'll return to in the last part of this chapter.

Where Are Memories Located?

Early memory researchers believed that memory was *localized*, or stored in a particular brain area. Later research suggests that, in fact, memory tends to be localized not in a single area but in many separate areas throughout the brain **(Figure 7.14)**.

FIGURE 7.15 TWO TYPES OF AMNESIA



Ⓐ Retrograde amnesia
The person loses memories of events that occurred *before* the accident, yet has no trouble remembering things that happened afterward (old, "retro" memories are lost).

Ⓑ Anterograde amnesia
The person cannot form new memories for events that occur *after* the accident. Anterograde amnesia also may result from a surgical injury or from diseases such as chronic alcoholism.

lobes often take the heaviest hit because they directly collide with the bony ridges inside the skull.

Loss of memory as a result of brain injury or trauma is called *amnesia*, and there are two major types—*retrograde* and *anterograde* **(Figure 7.15)**. In **retrograde amnesia** (acting backward in time), the person has no memory (is amnesic) for events that occurred *before* the brain injury because those memories were never stored in LTM. However, the same person has no trouble remembering things that happened after the injury. As the name implies, only the old, "retro," memories are lost.

Retrograde amnesia The loss of memory for events before a brain injury; backward-acting amnesia.

Consolidation The process by which neural changes associated with recent learning become durable and stable.

Anterograde amnesia The inability to form new memories after a brain injury; forward-acting amnesia.

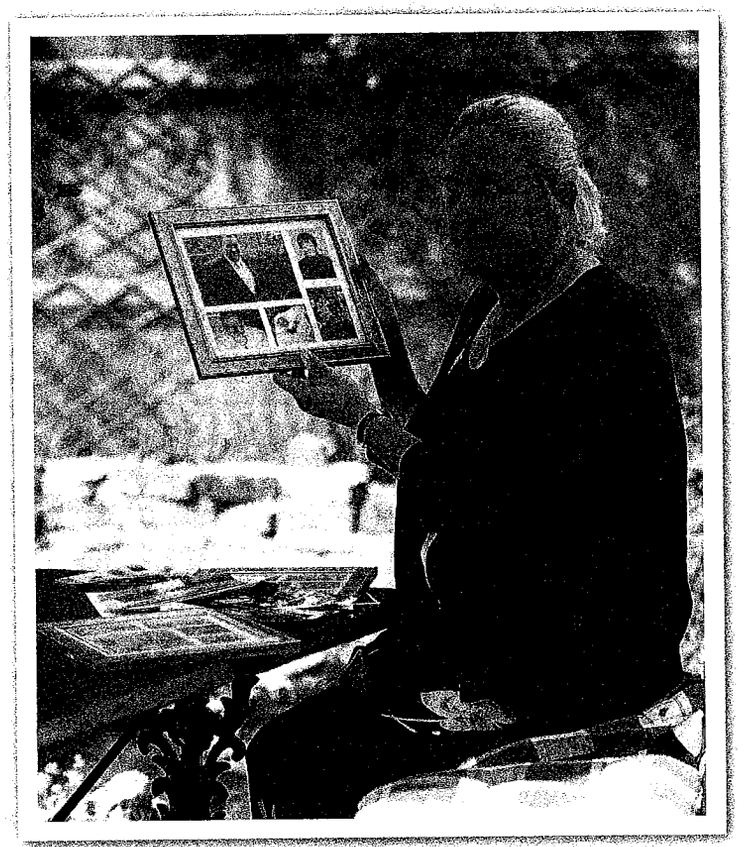
What causes retrograde amnesia? In cases where the individual is only amnesic for the events right before the brain injury, the cause may be a failure of consolidation. We learned earlier that during long-term potentiation (LTP), our neurons change to accommodate new learning. We also know that it takes a certain amount of time for these neural changes to become fixed and stable in long-term memory, a process known as **consolidation**. Like heavy rain on wet cement, the brain injury "wipes away" unstable memories because the cement has not had time to harden (*retrograde amnesia*).

In contrast to retrograde amnesia, in which people lose memories for events *before* a brain injury, some people lose memory for events that occur *after* a brain injury, which is called **anterograde amnesia** (acting forward in time). This type of amnesia generally results from a surgical injury or from diseases, such as chronic alcoholism. Continuing our analogy with cement, anterograde amnesia would be like having permanently hardened cement, which prevents the laying down of long-term memories.

Keep in mind that retrograde amnesia is normally temporary. Unfortunately, anterograde amnesia is most often permanent, but patients show surprising abilities to learn and remember implicit/nondeclarative tasks (such as procedural motor skills like mowing a lawn).

Another way to understand these two forms of amnesia is to compare them to the functions of a computer. Experiencing retrograde amnesia would be like having your latest stored data (memories) erased from your hard drive. In contrast, having anterograde amnesia would be similar to disconnecting your hard drive from the computer—no new data (memories) could be stored.

Amnesia at work
Fifty-five-year-old Kay Delaney slipped and hit her head at work, which led to severe memory loss. Sadly, she now believes she's only 34 and has no memory of the past 21 years, including raising her three children. Is this an example of retrograde or anterograde amnesia?



Casey Gutteridge/SWNS

RETRIEVAL PRACTICE: BIOLOGICAL BASES 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. The long-lasting increase in neural excitability believed to be a biological mechanism for learning and memory is called _____.

a. maintenance rehearsal
b. adrenaline activation
c. long-term potentiation
d. the reverberating response

2. Your vivid memory of what you were doing when you were first informed about your parents' impending divorce is an example of _____.

a. encoding specificity
b. long-term potentiation
c. latent learning
d. a flashbulb memory

3. Ralph can't remember anything that happened to him before he fell through the floor of his tree house. His lack of memory of events before his fall is called _____ amnesia.

a. retroactive
b. proactive
c. anterograde
d. retrograde

4. A progressive mental deterioration characterized by severe memory loss that occurs most commonly in elderly people is called _____.

a. retrieval loss syndrome deterioration
b. prefrontal cortex
c. Alzheimer's disease
d. age-related amnesia

Think Critically

1. What might be the evolutionary benefit of flashbulb memories?
2. How might anterograde amnesia affect a person's relationships with others?

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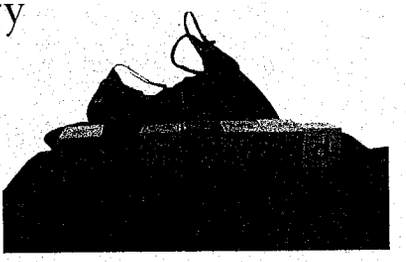
Why might exposure to pornography interfere with memory?

HINT: LOOK IN THE MARGIN FOR Q4



MEMORY DISTORTIONS

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.

LEARNING OBJECTIVES

1. **EXPLAIN** why our memories sometimes become distorted.
2. **DESCRIBE** problems with using eyewitnesses in the criminal justice system.
3. **DISTINGUISH** between false and repressed memories.

At this point in your life, you've undoubtedly experienced a painful breakup of a serious love relationship and/or witnessed similar breakups among your close friends. During these breakups, did you wonder how the reported experiences of two people in the same partnership could be so different? Why would each partner reconstruct his or her own personal memory of the relationship?

There are several reasons why we shape, rearrange, and distort our memories. One of the most common is our need for *logic* and *consistency*. When we're initially forming new memories or sorting through old ones, we fill in missing pieces, make "corrections," and rearrange information to make it logical and consistent with our previous experiences or personal desires. For example, if you

potential clients, or recalling where we left our house keys, our brains are not as well-equipped.

Memory and the Criminal Justice System

When our memory errors come into play in the criminal justice system, they may lead to wrongful judgments of guilt or innocence with possible life or death consequences!

In the past, one of the best forms of trial evidence a lawyer could have was an *eyewitness*—"I was there; I saw it with my own eyes." Unfortunately, research has identified several problems with eyewitness testimony (Cutler & Kovera, 2013; Herve et al., 2013; Loftus, 2000, 2001, 2007, 2011). One of the most serious is that it's relatively easy to create false memories (Fazio et al., 2013; Frenda et al., 2011; Loftus & Cahill, 2007; Strange et al., 2011; Wright et al., 2013).

Even more troubling is the finding that once false memories have been formed, they can multiply over time and last for years. Researchers in one study showed participants pictures of an event, such as a girl's wallet being stolen (Zhu et al., 2012). Participants then read a series of statements about the event, which included both accurate information (for instance, the person who took the girl's wallet was a man) and false information (the person who took the girl's wallet put it in his pants pocket, when in reality the picture showed him hiding the wallet in his jacket). Initially, after reading these statements, participants identified only 31% of the false events as having occurred. However, when participants were asked 1½ years later which events had occurred, they identified 39% of the false statements as true, indicating that false memories not only last, but can even multiply over time. What might be the implications of this research for eyewitness testimony in court?

Recall our earlier discussion of the misinformation effect and how experimenters created a false memory of seeing a telephone in a room (page 191). Participants who were asked neutral questions, such as "Was there a telephone in the room?" made errors on only 10% of the queries (Morgan et al., 2013). In contrast, when participants were asked "What color was the telephone?" falsely implying that a telephone had been in the room, 98% "remembered" it being there. The *Psych Science* box further describes how our biases can influence our "memory" of an event.

Problems with eyewitness recollections are so well established that judges now allow expert testimony on the unreliability of eyewitness testimony and routinely instruct jurors on its limits (Cutler & Kovea, 2013; Pezdek, 2012). If you serve as a member of a jury or listen to accounts of crimes in the news, remind yourself of these problems. Also, keep in mind that research participants in eyewitness studies generally report their inaccurate memories with great self-assurance and strong conviction (Douglass & Pavletic, 2012; Goodwin et al., 2013; Jaeger et al., 2012). Eyewitnesses to an actual crime may similarly identify an innocent person as the perpetrator with equally high confidence **(Figure 7.17)**. In one experiment, participants watched people committing a staged crime. Only an hour later, 20% of the eyewitnesses identified innocent

FIGURE 7.17 THE DANGERS OF EYEWITNESS TESTIMONY
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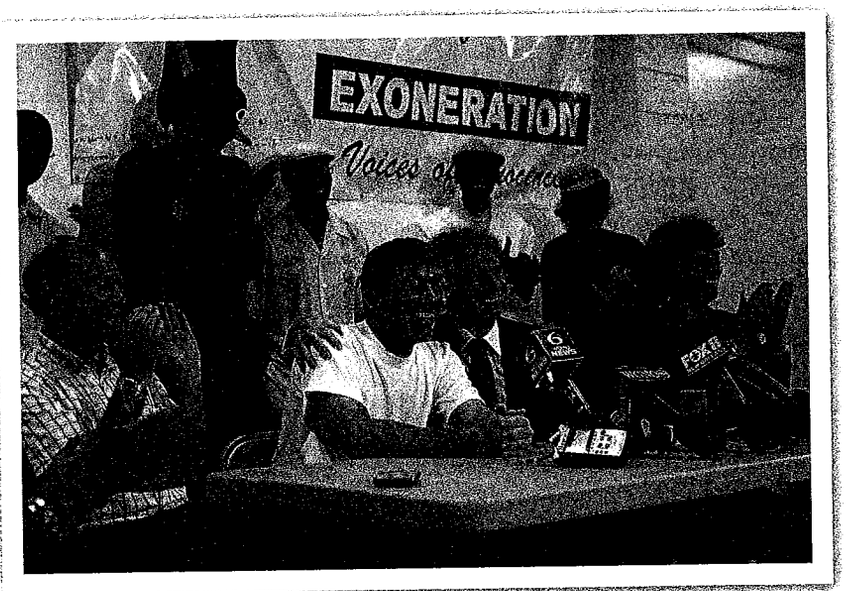
Damon Thibodeaux served 15 years in prison for killing his step-cousin before being released on September 28, 2012, after he was officially cleared via DNA testing. He was convicted at age 22 based in part on testimony by two eyewitnesses.



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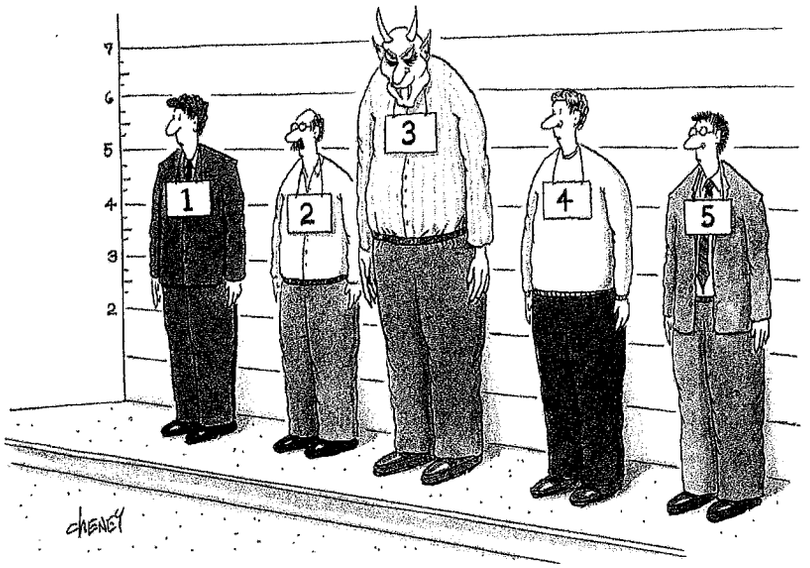

"Thank you, gentlemen—you may all leave except for No. 3."

FIGURE 7.18 EYEWITNESSES AND POLICE LINEUPS

As humorously depicted in this cartoon, officials now recommend that suspects should never "stand out" from the others in a lineup. Witnesses also are cautioned to not assume that the real criminal is in the lineup, and they should never "guess" when asked to make an identification.

False Versus Repressed Memories

Like eyewitness testimony, false memories can have serious legal, personal, and social implications. Consider this true story of psychologist Elizabeth Loftus, one of modern psychology's most famous memory scientists.

When Elizabeth was 14, her mother drowned in the family's pool. Decades later, a relative told Elizabeth that she, Elizabeth, had been the one to find her mother's body. Despite her initial shock, Elizabeth's memories slowly started coming back. Her recovery of these gruesome childhood memories, although painful, initially brought great relief. It also seemed to explain why she had always been fascinated by the topic of memory.

Then her brother called to say there had been a mistake! The relative who told Elizabeth that she had been the one to discover her mother's body later remembered—and other relatives confirmed—that it had actually been Aunt Pearl, not Elizabeth. Loftus, an expert on memory distortions, had unknowingly created her own *false memory*.

Creating false memories may be somewhat common, but can we recover true memories that are buried in childhood? *Repression* is the supposed unconscious coping mechanism by which we prevent anxiety-provoking thoughts from reaching consciousness. According to some research, repressed memories are *actively* and *consciously* "forgotten" in an effort to avoid the pain of their retrieval (Anderson et al., 2004; Boag, 2012). Others suggest that some memories are so painful that they exist only in an *unconscious* corner of the mind, making them inaccessible to the individual (Haaken, 2010; Mancia & Baggott, 2008). In these cases, therapy supposedly would be necessary to unlock the hidden memories.

Repression is a complex and controversial topic in psychology. No one doubts that some memories are forgotten and later recovered. What some question is the idea that *repressed memories* of painful experiences (especially childhood sexual abuse) are stored in the unconscious mind (Klein, 2012; Lambert et al., 2010; Loftus & Cahill, 2007).

Critics suggest that most people who have witnessed or experienced a violent crime or are adult survivors of childhood sexual abuse have intense, persistent memories. They have trouble *forgetting*, not remembering. Some critics also wonder whether therapists sometimes inadvertently create false memories in their clients during therapy. Some worry that if a clinician even suggests the possibility of abuse, the client's own *constructive processes* may lead him or her to create a false memory. The client might start to incorporate portrayals of abuse from movies and books into his or her own memory, forgetting their original sources and eventually coming to see them as reliable.

This is not to say that all psychotherapy clients who recover memories of sexual abuse (or other painful incidents) have invented those memories. For example, some research suggests that children may remember experiencing sexual abuse but not understand or recognize those behaviors as abuse until adulthood (McNally, 2012).

- Six factors that contribute to forgetting are the **misinformation effect**, the **serial-position effect** (primacy and recency effects), **source amnesia**, the **sleeper effect**, spacing of practice as in **distributed** versus **massed practice**, and culture.

3 BIOLOGICAL BASES OF MEMORY 194

- Learning modifies the brain's neural networks through **long-term potentiation (LTP)**, strengthening particular synapses and affecting the ability of neurons to release their neurotransmitters.
- Stress hormones affect the amygdala, which stimulates brain areas that are important for memory storage. Heightened arousal from these hormones also can increase the encoding and storage of new information and the formation of **flashbulb memories (FBMs)**.
- Research using advanced techniques, such as fMRI, has indicated that several brain regions are involved in memory storage.
- Two major types of amnesia are **retrograde** and **anterograde amnesia**. Traumatic brain injuries and disease, such as **Alzheimer's disease (AD)**, can cause memory loss.

4 MEMORY DISTORTIONS 199

- People shape, rearrange, and distort memories in order to create logic, consistency, and efficiency. Despite all their problems and biases, our memories are normally fairly accurate and usually serve us well.
- When memory errors occur in the context of the criminal justice system, they can have serious legal and social consequences. Problems with eyewitness recollections are well established. Judges often allow expert testimony on the unreliability of eyewitnesses.
- False memories are well-established phenomenon, which are relatively common and easy to create. However, memory *repression* (especially of childhood sexual abuse) is a complex and controversial topic.

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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. Many people think they can perfectly recall elaborate memories about how they felt or what they said when they first learned about devastating events, like the Boston Marathon bombings. What do you recall about this particular event? Do your memories fit with what flashbulb memory (FBM) research suggests?
2. Despite documented errors with FBMs, most people are very confident in their personal accuracy. What problems might result from this overconfidence?
3. Human memory is often compared to the workings of a computer. Based on your own experience, what are the advantages and limits of this comparison?
4. Amnesia is a common theme for Hollywood movies and television. How might these portrayals, which are often inaccurate, negatively influence the public's perception?
5. What memory improvement techniques described in this chapter have you found to be helpful in your everyday life? What new strategies do you plan to try?

Boston Globe/Getty Images

Key Terms

RETRIEVAL PRACTICE Write a definition for each term before turning back to the referenced page to check your answer.

- Alzheimer's disease (AD) 198
- anterograde amnesia 197
- chunking 182
- consolidation 197
- constructive process 180
- distributed practice 192
- elaborative rehearsal 185
- encoding 180
- encoding-specificity principle 187
- encoding, storage, and retrieval (ESR) model 180
- episodic memory 184
- explicit/declarative memory 184
- flashbulb memory (FBM) 195
- implicit/nondeclarative memory 184
- long-term memory (LTM) 184
- long-term potentiation (LTP) 194
- maintenance rehearsal 183
- massed practice 192
- memory 180
- misinformation effect 191
- mnemonic 185
- priming 185
- proactive interference 190
- retrieval 181
- retrieval cue 187
- retroactive interference 189
- retrograde amnesia 197
- semantic memory 184
- sensory memory 182
- serial-position effect 192
- short-term memory (STM) 182
- sleeper effect 192
- source amnesia 192
- storage 180
- three-stage memory model 181
- tip-of-the-tongue (TOT) phenomenon 191
- working memory 183