primarily on three **semicircular canals** in the inner ear (see Figure 6.8 on page 194). These thin tubes are filled with fluid that moves and presses on hairlike receptors whenever the head rotates. The receptors initiate messages that travel through a part of the auditory nerve not involved in hearing.

Normally, kinesthesis and equilibrium work together to give us a sense of our own physical reality, something we take utterly for granted but should not. Oliver Sacks (1985) told the heartbreaking story of Christina, a young British woman who suffered irreversible damage to her kinesthetic nerve fibers because of a mysterious inflammation. At first, Christina was as floppy as a rag doll; she could not sit up, walk, or stand. Then, slowly, she learned to do these things, relying on visual cues and sheer willpower. But her movements remained unnatural; she had to grasp a fork with painful force or she would drop it. More important, despite her remaining sensitivity to light touch on the skin, she could no longer experience herself as physically embodied: "It's like something's been scooped right out of me, right at the centre . . . ."

semicircular canals Sense organs in the inner ear, which contribute to equilibrium by responding to rotation of the head.

With equilibrium, we come, as it were, to the end of our senses. Every second, millions of sensory signals reach the brain, which combines and integrates them to produce a model of reality from moment to moment. How does it know how to do this? Are our perceptual abilities inborn, or must we learn them? We turn next to this issue.

QUICK QUIZ

Can you make sense of the following sensory problems?

1. April always has trouble tasting foods, especially those with subtle flavors. What is the most likely explanation of her difficulty?
2. May has chronic shoulder pain. How might the gate-control theory and its revision explain her pain?
3. June, a rock musician, does not hear as well as she used to. What is a likely explanation?

Answers:

1. An impaired sense of smell, possibly due to disease, illness, or cigarette smoking 2. Nerve fibers that normally close the pain "gate" may have been damaged, or a matrix of cells in the brain may be producing abnormal activity 3. Hearing impairment has many causes, but in June's case, we might suspect that prolonged exposure to loud music has damaged the hair cells of her cochlea.

WHAT'S AHEAD

- Do babies see the world the way adults do?
- What psychological motives could cause people to "see" the face of a religious figure on a cinnamon bun?

Perceptual Powers: Origins and Influences

What happens when babies first open their eyes? Do they see the same sights, hear the same sounds, smell the same smells, taste the same tastes as an adult does? Are their strategies for organizing the world wired into their brains from the beginning? Or is an infant's world, as William James once suggested, only a "blooming, buzzing confusion," waiting to be organized by experience and learning? The truth lies somewhere between these two extremes.

Inborn Abilities

In human beings, most basic sensory abilities, and many perceptual skills, are inborn or develop quite early. Infants can distinguish salty from sweet and can discriminate among odors. They can distinguish a human voice from other sounds. They will startle to a loud noise and turn their heads toward its source, showing that they perceive sound as being

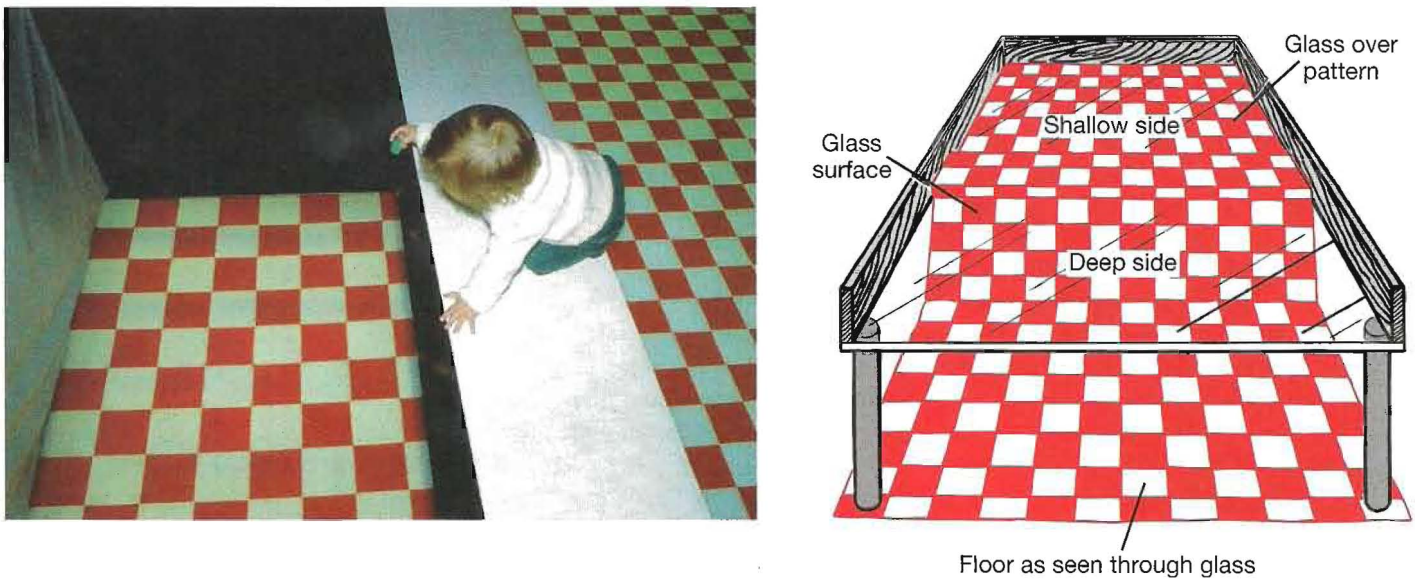


FIGURE 6.12
A Cliff-hanger
Infants as young as 6 months usually hesitate to crawl past the apparent edge of a visual cliff, which suggests that they are able to perceive depth.

localized in space. Many visual skills, too, are present at birth or develop shortly afterward. For example, human infants discriminate sizes and colors very early, possibly even right away. They can distinguish contrasts, shadows, and complex patterns after only a few weeks. And depth perception develops during the first few months.

Testing an infant's perception of depth requires considerable ingenuity. One clever procedure that was used for decades was to place infants on a device called a *visual cliff* (Gibson & Walk, 1960). The "cliff" is a pane of glass covering a shallow surface and a deep one (see Figure 6.12). Both surfaces are covered by a checkerboard pattern. The infant is placed on a board in the middle, and the child's mother tries to lure the baby across either the shallow or the deep side. Babies as young as 6 months of age will crawl across the shallow side but will refuse to crawl out over the "cliff." Their hesitation shows that they have depth perception.

Of course, by 6 months of age, a baby has had quite a bit of experience with the world. But infants younger than 6 months can also be tested on the visual cliff, even though they are unable to crawl. At only 2 months of age, babies show a drop in heart rate when placed on the deep side of the cliff, but no change when they are placed on the shallow side. A slowed heart rate is usually a sign of increased attention. Thus, although these infants may not be frightened the way an older infant would be, it seems they can perceive the difference between the "shallow" and the "deep" sides of the cliff (Banks & Salapatek, 1984).

Critical Periods

Although many perceptual abilities are inborn, experience also plays a vital role. If an infant misses out on certain experiences during a crucial window of time—a *critical period*—perception will be impaired. Innate abilities will not survive because cells in the nervous system will deteriorate, change, or fail to form appropriate neural pathways.

One way to study critical periods is to see what happens when the usual perceptual experiences of early life fail to take place. To do so, researchers often study animals whose sensory and perceptual systems are similar to our own. For example, like human beings, cats are born with the ability to detect horizontal and vertical lines and other spatial orientations; at birth, kittens' brains are equipped with the same kinds of feature-detector cells that adult cats have. But if they are deprived of normal visual experience, these cells deteriorate or change, and perception suffers (Crair, Gillespie, & Stryker, 1998; Hirsch & Spinelli, 1970).

In one famous study, kittens were exposed to either vertical or horizontal black and white stripes.

Special collars kept them from seeing anything else, even their own bodies. After several months, the kittens exposed only to vertical stripes seemed blind to all horizontal contours; they bumped into horizontal obstacles, and they ran to play with a bar that an experimenter held vertically but not to a bar held horizontally. In contrast, those exposed only to horizontal stripes bumped into vertical obstacles and ran to play with horizontal bars but not vertical ones (Blakemore & Cooper, 1970).

Critical periods for sensory development also seem to exist in human beings. When adults who have been blind from infancy have their vision restored, they may see, but often they do not see well. Their depth perception may be poor, causing them to trip constantly, and they cannot always make sense of what they see. To identify objects, they may have to touch or smell them. But if an infant's congenital blindness is corrected early—during a critical period during the first nine months or so—the prognosis is good. In one study, improvement started to occur after as little as one hour of visual experience (Maurer et al., 1999).

Similar findings apply to hearing. When adults who were born deaf, or who lost their hearing before learning to speak, receive cochlear implants (devices that stimulate the auditory nerve and allow auditory signals to travel to the brain), they tend to find sounds confusing. In fact, they sometimes ask to have the implants removed. But cochlear implants are more successful in children and in adults who became deaf late in life (Rauschecker, 1999). Young children presumably have not yet passed through the critical period for the processing of sounds, and adults have already had years of auditory experience.

In sum, our perceptual powers are both "wired in" and dependent on experience. Because neurological connections in infants' brains and sensory systems are not completely formed, their senses are far less acute than an adult's. It takes time and experience for their sensory abilities to develop fully. But an infant's world is clearly not the blooming, buzzing confusion that William James took it to be.

Psychological and Cultural Influences on Perception

The fact that some perceptual processes appear to be innate does not mean that all people perceive the world in the same way. Because we care about what we see, hear, taste, smell, and feel, psychological factors can influence what we perceive and how we perceive it. Here are a few of these factors:

1 *Needs.* When we need something, have an interest in it, or want it, we are especially likely to perceive it. For example, hungry individuals are faster than others at seeing words related to hunger when the words are flashed briefly on a screen (Wispé & Drambarean, 1953).

2 *Beliefs.* What we hold to be true about the world can affect our interpretation of ambiguous sensory signals. When the World Trade Center was attacked, many people thought they saw the face of the devil (or some said Osama bin Laden) in the smoke billowing from the towers. In a Nashville coffee shop, a cinnamon bun was shellacked and enshrined because people thought they saw a likeness of the famous nun Mother Teresa in it. Images that remind people of a crucified Jesus have been reported on walls, dishes, and plates of spaghetti, causing great excitement among those who believe that divine messages can be found on everyday objects—until other explanations emerge. In California, an image of Jesus on a garage door drew large crowds; it turned out to be caused by two streetlights that merged the shadows of a bush and a "For Sale" sign in the yard.

People often see what they expect or need to see. If you saw this famous image of smoke billowing from the World Trade Center, did you notice a "face" in it? Whose?

3 *Emotions.* Emotions can also influence our interpretation of sensory information. A small child afraid of the dark may see a ghost instead of a robe hanging on the door, or a monster instead of a beloved doll. Pain, in particular, is affected by emotion. Soldiers who are seriously wounded often deny being in much pain, even though they are alert and are not in shock. Their relief at being alive may offset the anxiety and fear that contribute so much to pain (although distraction and the body's own pain-fighting mechanisms may also be involved). Conversely, negative emotions such as anger, fear, sadness, or depression can prolong and intensify a person's pain (Fernandez & Turk, 1992; Fields, 1991).

perceptual set
A habitual way of perceiving, based on expectations.

4 *Expectations.* Previous experiences often affect how we perceive the world (Lachman, 1996). The tendency to perceive what you expect is called a **perceptual set.** Perceptual sets can come in handy; they help us fill in words in sentences, for example, when we haven't really heard every one. But perceptaul sets can also cause misperceptions. In Center Harbor, Maine, local legend has it that veteran newscaster Walter Cronkite was sailing into port one day when he heard a small crowd on shore shouting, "Hello, Walter . . . Hello, Walter." Pleased, he waved and took a bow. Only when he ran aground did he realize what they had really been shouting: "Shallow water . . . shallow water!"

By the way, the previous paragraph has a misspelled word. Did you catch it? If not, probably it was because you expected all the words in this book to be spelled correctly.

Our needs, emotions, expectations, and beliefs are all affected, in turn, by the culture we live in. Different cultures give people practice with different environments. In a classic study done in the 1960s, researchers found that members of some African tribes were much less likely to be fooled by the Müller–Lyer illusion and other geometric illusions than were Westerners. In the West, the researchers observed, people live in a "carpentered" world, full of rectangular structures built with the aid of straightedges and carpenter's squares. Westerners are also used to interpreting two-dimensional photographs and perspective drawings as representations of a three-dimensional world. Therefore, they interpret the kinds of angles used in the Müller–Lyer illusion as right angles extended in space—just the sort of habit that would increase susceptibility to the illusion. The rural Africans in the study, living in a less carpentered environment and in round huts, seemed more likely to take the lines in the figures literally, as two-dimensional, which could explain why they were less susceptible to the illusion (Segall, Campbell, & Herskovits, 1966; Segall et al., 1999).

Culture also affects perception by shaping our stereotypes, directing our attention, and telling us what is important to notice and what is not. Westerners, for example, tend to focus mostly on the figure when viewing a scene, and much less on the ground. East Asians, in contrast, tend to pay attention to the overall context of the scene because of a cultural inclination to see the world holistically (Nisbett, 2003). When Japanese and Americans were shown underwater scenes containing fish that were larger and moving faster than other objects in the scene, they reported the same number of details about the fish, but the Japanese reported more details about everything else in the background (Masuda & Nisbett, 2001). One of the researchers, Richard Nisbett, commented, "If it ain't moving, it doesn't exist for an American" (quoted in Shea, 2001).

QUICK QUIZ

Direct your perceptual attention now to this quiz.

1. Animal studies suggest that newborns and infants (a) have few perceptual abilities, (b) need visual experiences during a critical period for vision to develop normally, (c) see as well as adults.
2. On the visual cliff, 6-month-old babies (a) go right across because they cannot detect depth, (b) cross even though they are afraid, (c) will not cross because they can detect depth, (d) cry or get bored.
3. "Have a nice . . . " says Dewey, but then he gets distracted and doesn't finish the thought. Yet Clarence is sure he heard Dewey wish him a nice *day.* Why?

Answers:

1. b 2. c 3. perceptual set due to expectations

WHAT'S AHEAD

- Can "subliminal perception" tapes help you lose weight or reduce your stress?
- Why are most psychologists skeptical about ESP?

Puzzles of Perception

We come, finally, to two intriguing questions about perception that have captured the public's imagination for years. First, can we perceive what is happening in the world without being conscious of doing so? Second, can we pick up signals from the world or from other people without using our usual sensory channels at all?

Subliminal Perception

As we saw earlier in our discussion of the "cocktail party phenomenon," even when people are oblivious to speech sounds, they are processing and recognizing those sounds at some level. But these sounds are above people's absolute thresholds. Is it also possible to perceive and respond to messages that are *below* the absolute threshold—too quiet to be consciously heard, or too brief or dim to be consciously seen?

Perceiving Without Awareness First, a simple visual stimulus *can* affect your behavior even when you are unaware that you saw it. For example, people subliminally exposed to a face tended to prefer that face over one they did not "see" in this way (Bornstein, Leone, & Galley, 1987). In some studies, researchers have flashed words subliminally in a person's visual field while the person focuses on the middle of a screen. When the words are related to some personality trait, such as honesty, people are more likely later on to judge someone they read about as having that trait. They have been "primed" to evaluate the person in a certain way (Bargh, 1999).

Findings such as these have convinced many psychologists that people often know more than they know they know. In fact, nonconscious processing appears to occur not only in perception, but also in memory, thinking, and decision making, as we will see in Chapters 7 and 8. However, even in the laboratory, where researchers have considerable control, the phenomenon can be hard to demonstrate. The strongest evidence comes from studies using simple stimuli (faces or single words, such as *bread*), rather than complex stimuli such as sentences ("Eat whole-wheat bread, not white bread").

Perception Versus Persuasion If subliminal priming can affect judgments and preferences, can it be used to manipulate people's attitudes and behavior? Subliminal persuasion techniques were a hot topic back in the 1950s, when an advertising executive claimed to have increased popcorn and Coke sales at a theater by secretly flashing the words EAT POPCORN and DRINK COKE on the movie screen. The claim turned out to be a hoax, devised to save the man's struggling advertising company. Ever since, scientists have been skeptical, and the few attempts to demonstrate subliminal persuasion have been disappointing.

Thinking Critically About Subliminal Persuasion

Here is an area, however, where the critical-thinking guideline "tolerate uncertainty" seems to apply. Three Canadian psychologists have suggested that previous efforts at subliminal persuasion left out an important ingredient: the person's motivation to pursue a particular goal. Instead of trying to prime a message like "Drink Coke," these researchers used priming to create a state of thirst, using the words *thirst* and *dry*. Later, when given a chance to drink, the primed participants did in fact

Zits

drink more than controls did—as long as they were already moderately thirsty. Primed participants also found an ad for a thirst-quenching sports drink to be more persuasive than controls did—again, as long as they were already thirsty (Strahan, Spencer, & Zanna, 2002).

Does this mean that advertisers can seduce us into buying soft drinks or voting for political candidates by slipping subliminal slogans and images into television and magazine ads? Fears of subliminal persuasion resurfaced in the 2000 presidential compaign; in a pro-Republican ad, the word DEMOCRATS was moved across the screen and the RATS part of it was briefly, subliminally highlighted; the intention was apparently to associate Democrats with vermin in the minds of the viewers. Given the many negative findings on subliminal persuasion, and the subtlety of the effects that do occur, we think there's little cause for worry about subliminal manipulation. But the Canadian research will no doubt renew the debate and lead to further research.

As for those subliminal tapes that promise to help you lose weight, stop smoking, relieve stress, read faster, boost your motivation, lower your cholesterol, stop biting your nails, overcome jet lag, or stop taking drugs—all without any effort on your part—here we can be more definite. In study after study, placebo tapes—tapes that do not contain the messages that participants think they do—are just as "effective" as subliminal tapes (Eich & Hyman, 1992; Merikle & Skanes, 1992; Moore, 1992, 1995). In one typical study, people listened to tapes labeled "memory" or "self-esteem," but some heard tapes that were incorrectly labeled. About half of the participants showed improvement in the area specified by the label, *whether it was correct or not;* the improvement was due to expectations alone (Greenwald et al., 1991). So if you want to improve yourself or your life, you'll have to do it the old-fashioned way: by working at it.

Extrasensory Perception: Reality or Illusion?

Eyes, ears, mouth, nose, skin—we rely on these organs for our experience of the external world. Some people, however, claim they can send and receive messages about the world without relying on the usual sensory channels, by using *extrasensory perception (ESP).* Reported ESP experiences involve things like telepathy, the direct communication of messages from one mind to another without the usual sensory signals, and precognition, the perception of an event that has not yet happened.

parapsychology
The study of purported psychic phenomena such as ESP and mental telepathy.

Most ESP claims challenge everything we currently know to be true about the way the world and the universe operate. A lot of people are ready to accept these claims. Should they?

Thinking Critically About ESP

Much of the "evidence" for extrasensory perception comes from anecdotal accounts. But people are not always reliable reporters of their own experiences. They often embellish and exaggerate, or recall only part of what happened. They also tend to forget incidents that don't fit their beliefs, such as "premonitions" of events that fail to occur. Many ESP experiences could merely be unusual coincidences that are memorable because they are dramatic. What passes for telepathy or precognition could also be based on what a person knows or deduces through ordinary means. If Joanne's father has had two heart attacks, her premonition that her father will die shortly (followed, in fact, by her father's death) may not be so impressive.

The scientific way to establish a phenomenon is to produce it under controlled conditions. Extrasensory perception has been studied extensively by researchers in the field of **parapsychology.** But ESP studies have often been poorly designed, with inadequate precautions against fraud and improper statistical analysis. After an exhaustive review, the National Research Council concluded that there was "no scientific justification . . . for the existence of parapsychological phenomena" (Druckman & Swets, 1988).

"What do you mean you didn't know that we were having a pop quiz today?"

The issue has not gone away, however. Many people *really, really* want to believe that ESP exists. James Randi, a famous magician who is dedicated to educating the public about psychic deception, has for years offered a million dollars to anyone who can demonstrate ESP or other paranormal powers under close observation. Many have taken up the challenge; no one has succeeded. The most recent contender is Natalia Lulova, a 12-year-old Russian immigrant who says that she can psychically "see" colors and objects presented to her when she is blindfolded. The trouble is, Natalia can perform only in the presence of her teacher, a New York cab driver, using a blindfold that he provides. Moreover, she only "sees" objects that are below rather than at eye level, and she tilts her head while "seeing," leaving the distinct impression that she's peeking. When she put on a blindfold provided by Randi, her "powers" left her. Natalia hasn't given up, but we think Randi's money is safe.

The history of research on psychic phenomena has been one of initial enthusiasm because of apparently positive results (Dalton et al., 1996; Bem & Honorton, 1994), followed by disappointment when the results cannot be replicated (Milton & Wiseman, 1999, 2001). The thousands of studies done since the 1940s have failed to make a convincing case for ESP. One researcher who tried for 30 years to establish the reality of psychic phenomena finally gave up in defeat. "I found no psychic phenomena," she wrote, "only wishful thinking, self-deception, experimental error, and even an occasional fraud. I became a skeptic" (Blackmore, 2001).

QUICK QUIZ

ESP won't help you answer these questions.

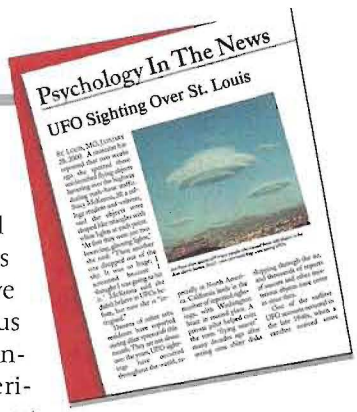
1. Based on current evidence, which of these subliminal efforts to get you to drink a soda is most likely to be successful? (a) flashing subliminal DRINK COKE messages as you watch a film, (b) having you listen to subliminal messages saying "You are getting thirsty" while you're sleeping, (c) subliminally exposing you to words associated with thirst

2. What human perceptual processes might explain why so many people interpret unexplained sensations as evidence of ESP, telepathy, or other psychic phenomena?

Answers:

1. c 2. psychological and cultural factors, such as perceptual sets, needs, emotions, wishes, and beliefs

Psychology IN THE NEWS *REVISITED*


Psychology In The News

UFO Sighting Over St. Louis

The great Greek philosopher Plato once said that "knowledge is nothing but perception." But simple perception is not always the best path to knowledge. As we have seen throughout this chapter, we do not passively register the world "out there"; we mentally construct it. If we are critical thinkers, therefore, we will be aware of how our beliefs and assumptions shape our perceptions.

This means that we should maintain a healthy skepticism when people report seeing spaceships and aliens, as in the story that started this chapter. Some people, as we have noted, are habitual yea-sayers who, because of their expectations, are quick to think they saw something that wasn't there. All of us, even those of us who are not usually gullible, have needs and beliefs that can fool us into seeing things that we want to see. And all of us occasionally read meanings into sensory experiences that are not inherent in the experience itself. Who has not seen nonexistent water on a hot highway, or felt a nonexistent insect on the skin after merely thinking about bugs?

Many forces conspire to encourage epidemics of UFO sightings. Some come from the popular

media, which generate a lot of money by promoting movies, TV shows, and talk-show accounts about extraterrestrials—and which usually portray skeptics as nerds or narrow-minded debunkers. Other forces are inherent in human psychology, including the fallibility of memory and the power of suggestion after an initial report of a sighting. And some reasons for UFO sightings can be traced to normal distortions of perception: When you are looking up at the sky, where there are few points of reference, it is difficult to judge how far away or how big an object is.

Whenever impartial investigators have looked into UFO reports, they have found that what people really saw were weather balloons, rocket launchings, swamp gas, military aircraft, or (in the vast majority of cases) ordinary celestial bodies, such as planets and meteors. The strange objects in the photo accompanying our news story, which look so much like flying saucers, are really lenticular (lens-shaped) clouds. And the "alien bodies" reported in Roswell were simply test dummies made of rubber, which the Air Force was dropping from high-altitude balloons before subjecting human beings to jumps from the same height. But even capable, intelligent people can be fooled. One astronomer who investigates UFO reports says, "I've been with Air Force pilots who thought they were seeing a UFO. But it was actually the moon. I've seen people look at Venus and say they could see portholes on a spaceship" (quoted in Ratcliffe, 2000).

None of this means that the only real world is the mundane one we see in everyday life. Because our sense organs evolved for particular purposes, our sensory windows on the world are partly shuttered. But we can use reason, ingenuity, and science to pry open those shutters. Ordinary perception tells us that the sun circles the earth, but the great astronomer Copernicus was able to figure out nearly five centuries ago that the opposite is true. Ordinary perception will never let us see ultraviolet and infrared rays directly, but we know they are there, and we can measure them. If science can enable us to overturn the everyday evidence of our senses, who knows what surprises science has in store for us?

TAKING PSYCHOLOGY WITH YOU

Living with Pain

Temporary pain is an unpleasant but necessary part of life, a warning of disease or injury. Chronic pain is another matter, a serious problem in itself. Back injuries, arthritis, migraine headaches, serious illnesses such as cancer—all can cause unrelieved misery to pain sufferers and their families. Chronic pain can also impair the immune system, putting patients at risk of further complications from their illnesses (Page et al., 1993).

At one time, the only way to combat pain was with drugs or surgery, which were not always effective. Today, we know that pain is affected by attitudes, actions, emotions, and circumstances, and that treatment must take these influences into account. Even social roles can influence a person's response to pain. For example, although women tend to report greater pain than men do, a real-world study of people who were in pain for more than six months found that men suffered more psychological distress than women did, possibly because the male role made it hard for them to admit their pain (Snow et al., 1986).

Many pain-treatment programs encourage patients to manage their pain themselves instead of relying entirely on health-care professionals. Usually, these programs combine several strategies:

- **Painkilling medication.** Doctors often worry that patients will become addicted to painkillers or will develop a tolerance to the drugs. The physicians will therefore give a minimal dose and wait until the patient is once again in agony before giving more. This approach is based on outdated notions about addiction. In reality, people who take painkillers to control their pain rarely become addicted. The method now recommended by experts (although doctors and hospitals do not always follow the advice) is to give pain sufferers a continuous dose of painkiller in whatever amount is necessary to keep them pain-free, and to allow them to do this for themselves when they leave the hospital. This strategy leads to reduced dosages rather than larger ones and rarely leads to drug dependence (Hill et al., 1990; Portenoy, 1994).
- **Involvement by family and friends.** When a person is in pain, friends and relatives understandably tend to sympathize and to excuse the sufferer from regular responsibilities. The sufferer takes to bed, avoids physical activity, and focuses on the pain. But focusing on pain tends to increase it, and inactivity can lead to shortened muscles, muscle spasms, and fatigue. So sympathy and attention can backfire and may actually prolong the suffering (Flor, Kerns, & Turk, 1987). One recent study found that the mere presence of a concerned and attentive spouse can increase the brain's response to pain and make the suffering worse (Flor et al., 2002). For this reason, many pain experts now encourage family members to reward activity, distraction, and wellness instead of simply offering sympathy. This approach, however, must be used carefully, preferably under the direction of a medical or mental-health professional, because a patient's complaints about pain are an important diagnostic tool for the physician.

- **Self-management.** Patients can learn to identify how, when, and where their pain occurs. This knowledge helps them determine whether the pain is being maintained by external events or is most intense at a certain time of day, and tells them what they might need to do to reduce their pain. Just having a sense of control can have a powerful pain-reducing effect (Cioffi & Holloway, 1993).

- **Relaxation, hypnosis, and acupuncture.** A blue-ribbon panel of experts concluded that relaxation techniques, such as meditating or focusing on reducing tension in specific muscle groups, can help reduce chronic pain from a variety of medical conditions; and hypnosis can reduce pain due to cancer and may help in other conditions as well (NIH Technology Assessment Panel, 1996). Some studies find that acupuncture also helps to reduce some kinds of pain (Holden, 1997), but the best-designed studies have not found such an effect, so many experts remain skeptical.

- **Cognitive–behavioral therapy.** When pain is chronic, we may begin to define ourselves in terms of our misery ("I am an ill, suffering person"), which can add to our distress and make the management of our pain more difficult (Pincus & Morley, 2001). Cognitive–behavioral therapy teaches people to recognize the connections among thoughts, feelings, and pain; substitute adaptive thoughts for negative ones; increase feelings of control; and use distraction, relabeling of sensations, and imagery to alleviate suffering (see Chapter 12).

For further information, you can contact pain clinics or services in teaching hospitals and medical schools. There are many reputable clinics around the country, some specializing in specific disorders, such as migraines or back injuries. But take care: There are also many untested therapies and quack practitioners who only prey on people's pain.

SUMMARY

- *Sensation* is the detection and direct experience of physical energy as a result of environmental or internal events. *Perception* is the process by which sensory impulses are organized and interpreted.

Our Sensational Senses

- Sensation begins with the *sense receptors*, which convert the energy of a stimulus into electrical impulses that travel along nerves to the brain. Separate sensations can be accounted for by *anatomical codes* (as set forth by the *doctrine of specific nerve energies*) and *functional codes* in the nervous system. In a rare condition called *synesthesia*, sensation in one modality evokes a sensation in another modality, but these experiences are the exception, not the rule.

- Psychologists specializing in *psychophysics* have studied sensory sensitivity by measuring *absolute* and *difference thresholds*. *Signal-detection theory*, however, holds that responses in a detection task consist of both a sensory process and a decision process and will vary with the person's motivation, alertness, and expectations.

- Our senses are designed to respond to change and contrast in the environment. When stimulation is unchanging, *sensory adaptation* occurs. Too little stimulation can cause *sensory deprivation*. Too much stimulation can cause sensory overload, which is why we exercise *selective attention*.

Vision

- Vision is affected by the wavelength, intensity, and complexity of light, which produce the psychological dimensions of visual experience—*hue*, *brightness*, and *saturation*. The visual receptors—*rods* and *cones*—located in the *retina* of the eye send signals (via other cells) to the *ganglion cells* and ultimately to the *optic nerve*, which carries visual information to the brain. Rods are responsible for vision in dim light; cones are responsible for color vision. *Dark adaptation* occurs in two stages.

- Specific aspects of the visual world, such as lines at various orientations, are detected by *feature-detector cells* in the visual areas of the brain. Some of these cells respond maximally to complex patterns, and even faces. In general, however, the brain takes in fragmentary information about lines, angles, shapes, motion, brightness, texture, and other features of what we see and comes up with a unified view of the world.

- The *trichromatic* and *opponent-process* theories of color vision apply to different stages of processing. In the first stage, three types of cones in the retina respond selectively to different wavelengths of light. In the second, opponent-process cells in the retina and the thalamus respond in opposite fashion to short and long wavelengths of light.

- Perception involves the active construction of a model of the world from moment to moment. The *Gestalt principles* (e.g., *figure and ground*, *proximity*, *closure*, *similarity*, and *continuity*) describe visual strategies used by the brain to perceive forms.

- We localize objects in visual space by using both *binocular* and *monocular cues* to depth. Binocular cues include *convergence* and *retinal disparity*. Monocular cues include *interposition, linear perspective,* and other cues. *Perceptual constancies* allow us to perceive objects as stable despite changes in the sensory patterns they produce. *Perceptual illusions* occur when sensory cues are misleading or when we misinterpret cues.

Hearing

- Hearing (*audition*) is affected by the intensity, frequency, and complexity of pressure waves in the air or other transmitting substance, corresponding to the experience of *loudness, pitch,* and *timbre* of the sound. The receptors for hearing are *hair cells* (*cilia*) embedded in the *basilar membrane,* located in the *organ of Corti,* in the interior of the *cochlea.* These receptors pass signals along to the auditory nerve. The sounds we hear are determined by patterns of hair-cell movement, which produce different neural codes. When we localize sounds, we use as cues subtle differences in how pressure waves reach each of our ears.

Other Senses

- Taste (*gustation*) is a chemical sense. Elevations on the tongue, called *papillae,* contain many *taste buds,* which in turn contain the taste receptors. There are four basic tastes—salty, sour, bitter, and sweet—and possibly a fifth, *umami,* although its inclusion is somewhat controversial. Responses to a particular taste depend in part on genetic differences among individuals; for example, some people are "supertasters." Taste preferences are also affected by culture and learning, and by the texture, temperature, and smell of food.

- Smell (*olfaction*) is also a chemical sense. No basic odors have been identified, and up to a thousand different receptor types exist. But researchers have discovered that distinct odors activate unique combinations of receptor types, and they have started to identify those combinations. Cultural and individual differences also affect people's responses to particular odors.

- The skin senses include touch (pressure), warmth, cold, and pain, and variations such as itch and tickle. Except in the case of pressure, it has been difficult to identify specialized receptors for these senses, but researchers have reported a receptor for one kind of itching and a possible receptor for cold.

- Pain is both a skin sense and an internal sense. According to the *gate-control theory,* the experience of pain depends on whether neural impulses get past a "gate" in the spinal cord and reach the brain. According to a revised version of this theory, a matrix of neurons in the brain can generate pain even in the absence of signals from sensory neurons, which may explain the puzzling phenomenon of *phantom pain.* No one theory, however, completely explains the many varieties of pain.

- *Kinesthesis* tells us where our body parts are located, and *equilibrium* tells us the orientation of the body as a whole. Together, these two senses provide us with a feeling of physical embodiment.

Perceptual Powers: Origins and Influences

- Many fundamental perceptual skills are inborn or acquired shortly after birth. By using the *visual cliff,* for example, psychologists have learned that babies have depth perception by the age of 6 months and probably even earlier. However, without certain experiences during *critical periods* early in life, cells in the nervous system deteriorate or change, or fail to form appropriate neural pathways, and perception is impaired.

- Psychological influences on perception include needs, beliefs, emotions, and expectations (which produce *perceptual sets*). These influences are affected by culture, which gives people practice with certain kinds of experiences and influences what they attend to. Because psychological factors affect the way we construct the perceptual world, the evidence of our senses is not always reliable.

Puzzles of Perception

- In the laboratory, simple visual subliminal messages can "prime" certain behaviors, judgments, and motivational states, such as thirst. However, there is no evidence that complex behaviors can be altered by "subliminal perception" tapes or similar subliminal techniques.

- *Extrasensory perception (ESP)* refers to paranormal abilities such as telepathy and precognition. Years of research have failed to produce convincing evidence for ESP.

Psychology In The News, Revisited

- Human perception does not merely capture objective reality but also reflects our needs, biases, and beliefs. Thus our eyes and our ears (and especially our brains) can play tricks on us, as the frequent "sightings" of UFOs illustrate.

KEY TERMS

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LOOKING BACK

- What kind of code in the nervous system helps explain why a pinprick and a kiss feel different? (p. 177)
- Why does your dog hear a "silent" doggie whistle when you can't? (p. 178)
- What kind of bias can influence whether you think you hear the phone ringing when you're in the shower? (pp. 178–179)
- What happens when people are deprived of all external sensory stimulation? (p. 180)
- How does the eye differ from a camera? (p. 184)
- Why can we describe a color as bluish green but not as reddish green? (p. 186–187)
- If you were blind in one eye, why might you misjudge the distance of a painting on the wall but not of buildings a block away? (p. 189)
- As a friend approaches, her image on your retina grows larger; why do you continue to see her as the same size? (p. 189)
- Why are perceptual illusions so valuable to psychologists? (p. 190)
- Why does a note played on a flute sound different from the same note on an oboe? (p. 193)
- If you habitually listen to loud music through headphones, what kind of hearing impairment are you risking? (p. 194)
- To locate the source of a sound, why does it sometimes help to turn or tilt your head? (p. 195)
- Why do saccharin and caffeine taste bitter to some people but not to others? (p. 197)
- Why do you have trouble tasting your food when you have a cold? (p. 197)
- Why do people often continue to "feel" limbs that have been amputated? (p. 200)
- Do babies see the world the way adults do? (p. 203)
- What psychological motives could cause people to "see" the face of a religious figure on a cinnamon bun? (p. 203)
- Can "subliminal perception" tapes help you lose weight or reduce your stress? (p. 206)
- Why are most psychologists skeptical about ESP? (pp. 206–207)