CHAPTER 8

Sensation and Perception

PSYCHOLOGY Online

Chapter Overview
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PSYCHOLOGY JOURNAL

Were you ever in a crowded room and found yourself eavesdropping on another's conversation? In your journal, write down why you think this happened? ■

SECTION 1 Sensation

Reader's Guide

Main Idea

Sensations occur anytime a stimulus activates a receptor. Perceptions allow humans to react to their environment.

Vocabulary

- sensation
- perception
- psychophysics
- absolute threshold
- difference threshold
- Weber's law
- signal-detection theory

Objectives

- Describe the field of study known as psychophysics.
- Define and discuss threshold, Weber's law, and signal detection.

EXPLORING PSYCHOLOGY

Discovering a New World

Helen Keller had been blind and deaf since she was two years old. For the next four years, Helen was "wild and unruly." Then when she was six, Anne Sullivan, a teacher, entered her life. Using the sense of touch as the link between their two worlds, Anne tried again and again, by spelling words into Helen's hand, to make Helen grasp the connection between words and the things they stood for. The breakthrough came one day as Anne spelled the word *water* into Helen's hand as water from a spout poured over it. "I stood still, my whole attention fixed upon the motions of her fingers," Helen remembered. "Suddenly I felt . . . a thrill of returning thought; and somehow the mystery of language was revealed to me."

—adapted from *ABC's of the Human Mind*, Reader's Digest, 1990

From that day forward, Helen "saw" the world in a new way. She discovered new ways to experience her world. "Occasionally, if I am very fortunate, I place my hand gently on a small tree and feel the happy quiver of a bird in full song." Helen had entered a world of sensations after she began organizing the stimuli in her world. Try it yourself.

In the next few seconds, something peculiar will start hap pening to the material youa rereading. Iti soft ennotre alized howcom plext heprocess sof rea ding is.

As you can see, your success in gathering information from your environment, interpreting this information, and acting on it depends considerably on its being organized in ways you expect. In this chapter you will learn more about sensation and perception, both of which are necessary to gather and interpret information in our surroundings.

sensation: what occurs when a stimulus activates a receptor

perception: the organization of sensory information into meaningful experiences

psychophysics: the study of the relationships between sensory experiences and the physical stimuli that cause them

WHAT IS SENSATION?

The world is filled with physical changes—an alarm clock sounds; the flip of a switch fills a room with light; you stumble against a door; steam from a hot shower billows out into the bathroom, changing the temperature and clouding the mirror. Any aspect of or change in the environment to which an organism responds is called a *stimulus.* An alarm, an electric light, and an aching muscle are all stimuli for human beings.

A stimulus can be measured in many physical ways, including its size, duration, intensity, or wavelength. A **sensation** occurs anytime a stimulus activates one of your receptors. The sense organs detect physical changes in energy such as heat, light, sound, and physical pressure. The skin notes changes in heat and pressure, the eyes note changes in light, and the ears note changes in sound. Other sensory systems note the location and position of your body.

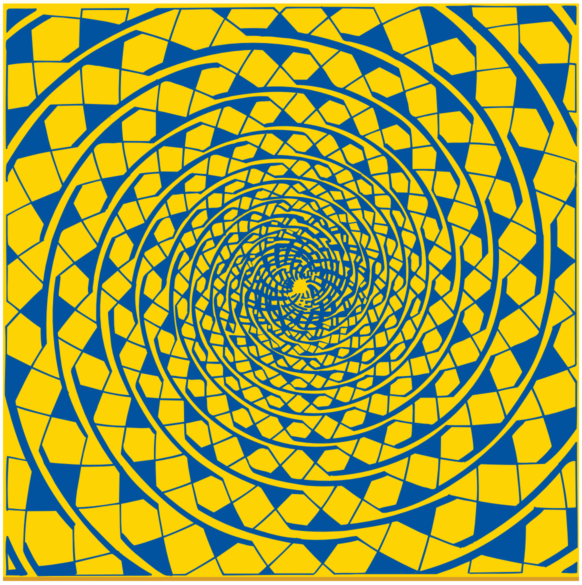
A sensation may be combined with other sensations and your past experience to yield a perception. A **perception** is the organization of sensory information into meaningful experiences (see Figure 8.1).

Psychologists are interested in the relationship between physical stimuli and sensory experiences. In vision, for example, the perception of color corresponds to the wavelength of the light, whereas brightness corresponds to the intensity of this stimulus.

What is the relationship between color and wavelength? How does changing a light's intensity affect your perception of its brightness? The psychological study of such questions is called **psychophysics.** The goal of psychophysics is to understand how stimuli from the world (such as frequency and intensity) affect the sensory experiences (such as pitch and loudness) produced by them.

Figure 8.1 Fraser's Spiral

Fraser's spiral illustrates the difference between sensation and perception. Our perception of this figure is that of a spiral, but it is actually an illusion. Trace a circle carefully. Your finger will always come back to its starting point. ***How do we use sensation and perception together to understand our world?***



THRESHOLD

In order to establish laws about how people sense the external world, psychologists first try to determine how much of a stimulus is necessary for a person to sense it at all. How much energy is required for someone to hear a sound or to see a light? How much of a scent must be in the room before one can smell it?

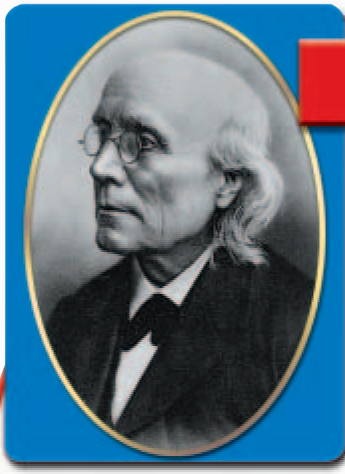
How much pressure must be applied to the skin before a person will feel it?

To answer such questions, a psychologist might set up the following experiment. First, a person (the participant) is placed in a dark room to dark-adapt. He is instructed to look at the wall and say "I see it" when he is able to detect a light. The psychologist then uses an extremely precise machine that can project a low-intensity beam of light against the wall.

The experimenter turns on the machine to its lowest light projection. The participant says nothing. The experimenter increases the light until finally the participant responds, "I see it." Then the experimenter begins another test in the opposite direction. He starts with a visible but faint light and decreases its intensity on each trial until the light seems to disappear. Many trials are completed and averaged. This procedure detects the **absolute threshold**—the weakest amount of a stimulus required to produce a sensation. The absolute threshold is the level of stimulus that is detected 50 percent of the time.

The absolute thresholds for the five senses in humans are the following: in vision—seeing a candle flame 30 miles away on a clear night; for hearing—hearing a watch ticking 20 feet away; for taste—tasting 1 teaspoon of sugar dissolved in 2 gallons of water; for smell—smelling 1 drop of perfume in a 3-room house; for touch—feeling a bee's wing falling a distance of 1 centimeter onto your cheek.

Profiles In Psychology



Gustav Theodor Fechner

1801–1887

"Imagine that you look at the sky through a tinted glass and pick out a cloud that is just noticeably different from the sky background. Now you use a much darker glass; the cloud does not vanish but is still just barely visible—because although the absolute levels of intensity are much lower through the darker glass, the ratio of intensities between cloud and sky has not changed."

Gustav Theodor Fechner started out as a young professor trying to demonstrate that every person, animal, and plant in the universe is composed of both matter and soul. He failed. At one point, in the midst of a depression, he painted his room black and remained in it day and night, seeing no one. When he finally emerged from his isolation, he walked through a garden, and the flowers looked brighter than he had ever seen them before.

On the morning of October 22, 1850, as Fechner lay in bed, a thought occurred to him. He arrived at the conclusion that a systemic relationship between bodily and mental experience could be demonstrated if a person were asked to report changes in sensations as a physical stimulus was varied. While testing these ideas, Fechner created the area of psychology known as psychophysics. Fechner's methods of sensory measurement inspired experimental research on the subject and revolutionized experimental psychology.

absolute threshold: the weakest amount of a stimulus that a person can detect half the time

Figure 8.2 The Human Senses

This chart lists the fundamental features that make up the human sensory system. ***What is our vestibular sense?***

Sense	Stimulus	Sense Organ	Receptor	Sensation
Sight	Light waves	Eye	Rods and cones of retina	Colors, patterns, textures, motion, depth in space
Hearing	Sound waves	Ear	Hair cells located in inner ear	Noises, tones
Skin sensations	External contact	Skin	Nerve endings in skin	Touch, pain, warmth, cold
Smell	Volatile substances	Nose	Hair cells of olfactory membrane	Odors (musky, flowery, burnt, minty)
Taste	Soluble substances	Tongue	Taste buds of tongue	Flavors (sweet, sour, salty, bitter)
Vestibular sense	Mechanical and gravitational forces	Inner ear	Hair cells of semicircular canals and vestibule	Spatial movement, gravitational pull
Kinesthesis	Body movement	Muscles, tendons, and joints	Nerve fibers in muscles, tendons, and joints	Movement and position of body parts

While these thresholds may seem impressive, we respond to very little of the sensory world. We cannot see X rays or microwaves. Dogs can hear a dog whistle, while we cannot. Humans hear only 20 percent of what a dolphin can hear. Some animals, such as bats and dolphins, have a superior sense of hearing. Other animals, such as hawks, have extremely sharp vision; still others, such as bloodhounds, possess a superior sense of smell. Humans sense a somewhat limited range of the physical phenomena in the everyday world.

SENSORY DIFFERENCES AND RATIOS

difference threshold: the smallest change in a physical stimulus that can be detected half the time

Another type of threshold is the **difference threshold.** The difference threshold refers to the minimum amount of difference a person can detect between two stimuli half the time. To return to our example of the person tested in a dark room, a psychologist would test for the difference threshold by gradually increasing the intensity of a visible light beam until the person says, “Yes, this is brighter than the light I just saw.” With this technique, it is possible to identify the smallest increase in light intensity that is noticeable to the human eye.

A related concept is the *just noticeable difference,* or *JND.* This refers to the smallest increase or decrease in the intensity of a stimulus that a person is able to detect half the time. A particular sensory experience depends more on *changes* in the stimulus than on the absolute size or amount of the stimulus. For example, if you put a 3-pound package of food into an empty backpack, the perceived weight will be greatly increased. If you add the same amount to a backpack with a 100-pound weight in it, however, your perception of the weight will hardly increase at all. This is because the perception of the added weight reflects a proportional change, and 3 pounds does not provide much change in a 100-pound load.

This idea is known as **Weber's law:** the larger or stronger a stimulus, the larger the change required for a person to notice that anything has happened to it. By experimenting in this way with variations in sounds, temperatures, pressures, colors, tastes, and smells, psychologists are learning more about how each sense responds to change. Some senses produce huge increases in sensation in response to small increases in energy. For instance, the pain of an electric shock can be increased more than eight times by doubling the voltage. On the other hand, the intensity of a light must be increased many times to double its perceived brightness.

Some people are more sensitive to these changes than others. For example, people who can detect small differences in sensation work as food tasters, wine tasters, smell experts, perfume experts, and so on.

Quick Lab

Can you detect changes in stimuli?
What would it take for you to notice a difference in the weight of your backpack?

Procedure

1. Fill your backpack with materials so that it weighs 10 pounds, and put it on your back.
2. Assemble a collection of objects that weigh about 4 ounces (113 g) each, such as apples or oranges.
3. Ask a friend to insert the objects one at a time while you are seated, with the weight of your backpack off your back. Be sure you cannot see which object is being placed in the pack.

Analysis

1. After each object is placed in the pack, stand and report whether or not the backpack feels heavier.
2. Record the point at which you notice the difference in the weight of the pack.
3. Use the concept of difference threshold to explain your results.

See the Skills Handbook, page 622, for an explanation of designing an experiment.

SENSORY ADAPTATION

Psychologists have focused on people's responses to changes in stimuli because they have found that the senses are tuned to change. Senses are most responsive to increases and decreases, and to new events rather than to ongoing, unchanging stimulation. We are able to respond to changes in our environment because our senses have an ability to adapt, or adjust themselves, to a constant level of stimulation. They get used to a new level and respond only to deviations from it (see Figure 8.3).

A good example of this sensory adaptation is the increase in visual sensitivity that you experience after a short time in a darkened movie theater. At first you see only blackness, but after a while your eyes adapt to the new level, and you can see seats, faces, and so forth. Adaptation occurs for the other senses as well. Receptors in your skin adapt to the cold water when you go for a swim; disagreeable odors in a lab seem to disappear after a while; street noises cease to bother you after you have lived in a city for a time. Without sensory adaptation, you would feel the

Weber's law: the principle that for any change ($\triangle$s) in a stimulus to be detected, a constant proportion of that stimulus (s) must be added or subtracted

Reading Check According to Weber's law, how much must a strong stimulus change for a person to notice the change?

constant pressure of the clothes on your body, and other stimuli would seem to be bombarding all your senses at the same time.

Sensory adaptation allows us to notice differences in sensations and react to the challenges of different or changing stimuli. This principle is helpful when performing many activities, such as the work of police, security guards, and home inspectors. These people may notice minute changes and act appropriately.

SIGNAL-DETECTION THEORY

signal-detection theory: the study of people's tendencies to make correct judgments in detecting the presence of stimuli

There is no sharp boundary between stimuli that you can perceive and stimuli you cannot perceive. The **signal-detection theory** studies the relations between motivation, sensitivity, and decision making in detecting the presence or absence of a stimulus (Green & Swets, 1966). Detection thresholds involve recognizing some stimulus against a background of competing stimuli. A radar operator must be able to detect an airplane on a radar screen even when the plane's blip is faint and difficult to distinguish from blips caused by flocks of birds or bad weather, which can produce images that are like visual "noise." The radar operator's judgment will be influenced by many factors, and different operators appear to have different sensitivities to blips. Moreover, a specific individual's apparent sensitivity seems to fluctuate, depending on the situation. For example, a radar operator may be able to ignore other stimuli as long as she is motivated to keep focused, just as you may be motivated to complete your reading assignment no matter what distractions you encounter.

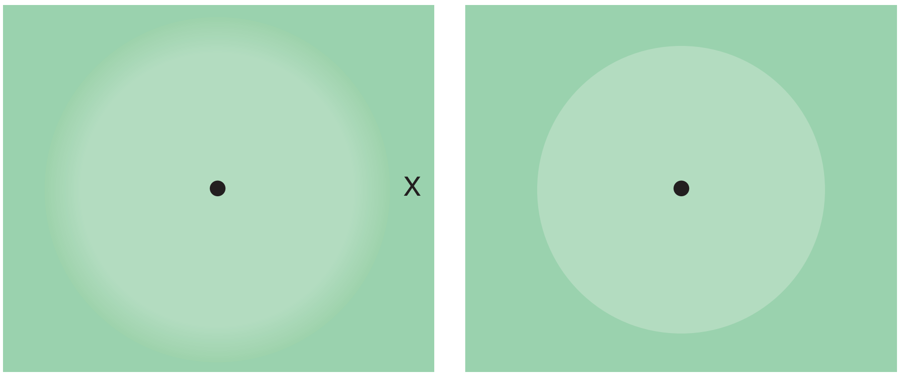


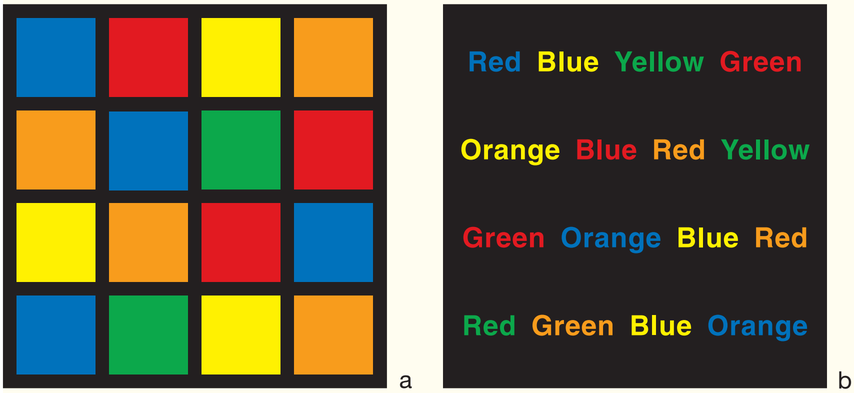
Figure 8.3 The Disappearing Circle

Sensation depends on change and contrast in the environment. Hold your hand over one eye and stare at the dot in the middle of the circle on the right. You should have no trouble maintaining the image of the circle. If you do the same with the circle on the left, however, the image will fade. The gradual change from light to dark does not provide enough contrast to keep the visual receptors in your eye firing at a steady rate. The circle reappears only if you close and reopen your eye or you shift your gaze to the X. **What is the purpose of sensory adaptation?**

In studying the difficulties faced by radar operators, psychologists have reformulated the concept of absolute threshold to take into account the many factors that affect detection of minimal stimuli. As a result, signal-detection theory abandons the idea that there is a single true absolute threshold for a stimulus. Instead, it is based on the notion that the stimulus, here called a signal, must be detected in the presence of competing stimuli, which can interfere with detection of the signal.

Psychologists have identified two different types of processing stimuli, or signals. *Preattentive*

Figure 8.4 **The Stroop Effect**



Try to name the colors of the boxes in *a* as fast as you can. Then try to read the words in *b* as fast as you can. Finally, try to name the colors of the words in *b* as fast as you can. You probably proceeded more slowly when naming the colors in *b*. ***Why was it more difficult to name the colors in b?***

process is a method for extracting information automatically and simultaneously when presented with stimuli. *Attentive process* is a procedure that considers only one part of the stimuli presented at a time. For example, when looking at Figure 8.4 *(b),* the Stroop interference effect, preattentive, or automatic, processing acts as an interference. The tendency is to read the word instead of saying the color of the ink. Apparently people find it almost impossible not to read color names that appear before their eyes, because the name interferes with the response of naming the ink color when the two are different. In summary, we notice some things automatically in spite of distracting information. However, it requires more careful attention to notice other, less distinct items. This difference, though, is one of degree—all tasks require attention, but some require more attention than others.

SECTION 1 Assessment

1. **Review the Vocabulary** What is the difference between sensation and perception?
2. **Visualize the Main Idea** Complete the chart below by listing the five senses and their absolute thresholds.

Sense	Absolute Threshold
Sight	

3. **Recall Information** How does the signal-detection theory explain how you may be able to study while others are watching television in the same room?
4. **Think Critically** Why do you think we do not respond to all stimuli present in our environment?
5. **Application Activity** Place a watch or clock in an empty room. Move across the room to a point where you do not hear the ticking. Approach the clock one step at a time and mark the spot at which you first hear ticking. Repeat this experiment 10 times, alternately approaching and backing away. What are your conclusions? Write a brief analysis.

SECTION 2

The Senses

Reader's Guide

Main Idea

The sense organs—the eyes, ears, tongue, nose, skin, and others—are the receptors of sensations.

Vocabulary

- pupil
- lens
- retina
- optic nerve
- binocular fusion
- retinal disparity
- auditory nerve
- vestibular system
- olfactory nerve
- kinesthesis

Objectives

- Describe the nature and functioning of the sense organs.
- Identify the skin and body senses and explain how they work.

EXPLORING PSYCHOLOGY

Seeing in the Dark

Sit yourself in total darkness, a space so dark you cannot see your hand before your face. Now hold your hand before your face and move it from side to side. You see your hand in motion.

—from ***A Second Way of Knowing: The Riddle of Human Perception*** **by Edmund Blair Bolles, 1991**

Why did you see your hand moving even though it was totally dark while doing the experiment above? You have just experienced kinesthesis—one of the senses. Although people are thought to have five senses, there are actually more. In addition to vision, hearing, taste, smell, and touch, there are several skin senses and two internal senses: *vestibular* and *kinesthetic.*

Each type of sensory receptor takes some sort of external stimulus—light, chemical molecules, sound waves, and pressure—and converts it into a chemical-electrical message that can be transmitted by the nervous system and interpreted by the brain. So far, we know most about these processes in vision and hearing. The other senses have received less attention and are more mysterious in their functioning.

VISION

Vision is the most studied of all the senses, reflecting the high importance we place on our sense of sight. Vision provides us with a great deal of information about our environment and the objects in it—the sizes, shapes, and locations of things, and their textures, colors, and distances.

How does vision occur? Light enters the eye through the **pupil** (see Figure 8.5) and reaches the **lens,** a flexible structure that focuses light on the **retina.** The retina contains two types of light-sensitive receptor cells, or photoreceptors: *rods* and *cones.* These cells are responsible for changing light energy into neuronal impulses, which then travel along the **optic nerve** to the brain, where they are routed to the occipital lobe.

Cones require more light than rods before they begin to respond, and cones work best in daylight. Since rods are sensitive to much lower levels of light than cones, they are the basis for night vision. There are many more rods (75 to 150 million) than there are cones (6 to 7 million), but only cones are sensitive to color. Rods and cones can be compared to black-and-white and color film. Color film takes more light and thus works best in daylight, like our cones. Sensitive black-and-white film works not only in bright light but also in shadows, dim light, and other poor lighting conditions, just like our rods.

pupil: the opening in the iris that regulates the amount of light entering the eye

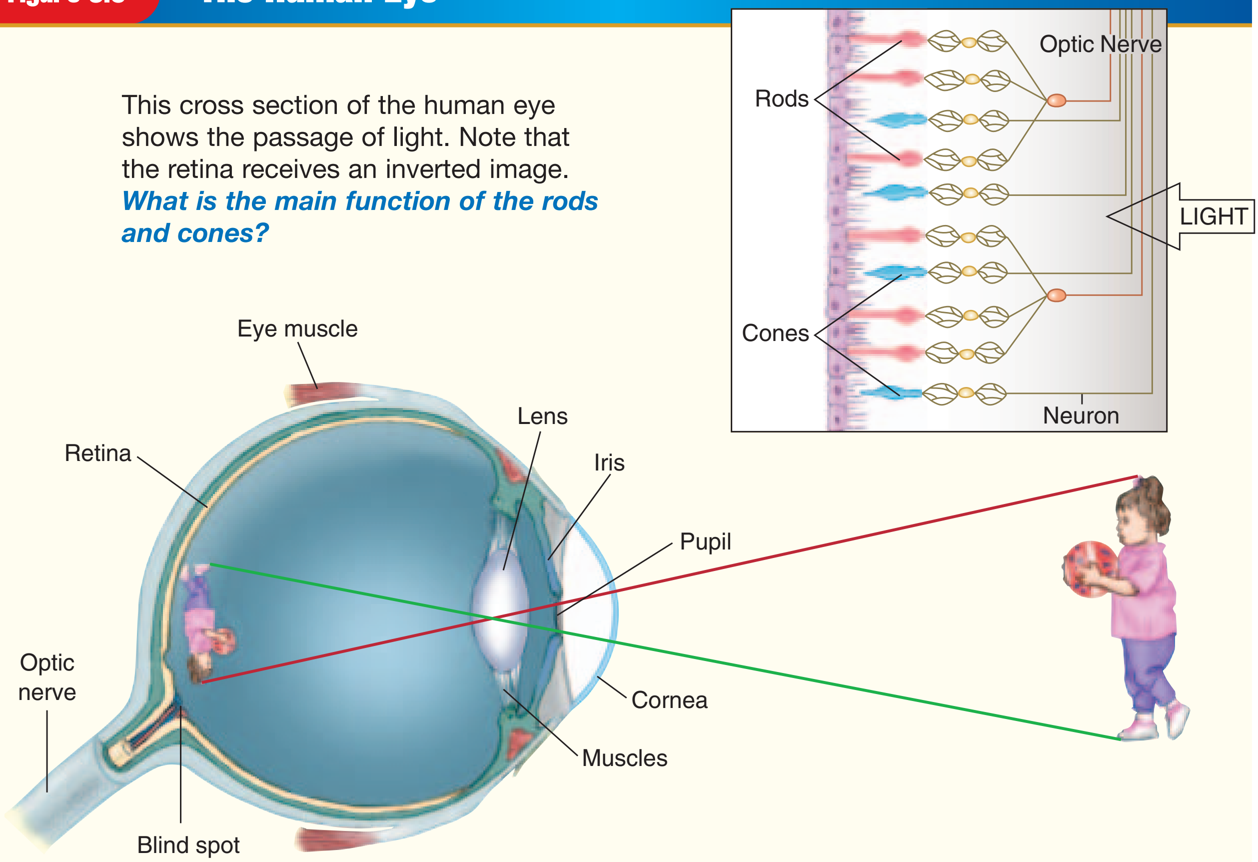
lens: a flexible, elastic, transparent structure in the eye that changes its shape to focus light on the retina

retina: the innermost coating of the back of the eye, containing the light-sensitive receptor cells

optic nerve: the nerve that carries impulses from the retina to the brain

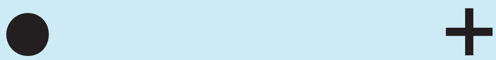
Figure 8.5 The Human Eye

This cross section of the human eye shows the passage of light. Note that the retina receives an inverted image. ***What is the main function of the rods and cones?***



Psychology and You: Your Blind Spot

The point where the optic nerve exits the eye is the blind spot (see Figure 8.5). When light hits that point, the eye registers nothing because this area lacks photoreceptors—neurons that are sensitive to light. Find your blind spot by holding the diagram below about 3–4 inches (8–10 cm) away from your eyes.



Make sure the cross is on the right. Close your right eye and look directly at the cross with your left eye. Notice that you can also see the dot. Focus on the cross, but be aware of the dot as you slowly bring the diagram toward your face. The dot will disappear and then reappear as you bring the diagram toward your face. Now close your left eye and look directly at the dot with your right eye. This time the cross will disappear and reappear as you bring the diagram slowly toward your face. What has happened? When you hold the diagram so that the light from the dot falls on the blind spot, you cannot see the dot. This is your blind spot.

Light

Light is a form of electromagnetic radiation. Other forms of electromagnetic radiation include radio waves, microwaves, infrared radiation, ultraviolet rays, X rays, and gamma rays. All of these are known collectively as the electromagnetic spectrum (see Figure 8.6).

Visible light represents a small portion of the electromagnetic spectrum, which is composed of waves of different length and frequency. You can observe the wavelengths of visible light with a prism. Passing sunlight through a prism breaks the light into a rainbow of colors. Each of these colors is comprised of light of different wavelengths. While prisms transmit light, other objects absorb and reflect light. The object's color depends, in part, on the light that reaches our eyes. For example, a pea looks green because it reflects green light and absorbs other colors.

Color Deficiency

When some or all of a person's cones do not function properly, he or she is said to be color-deficient. There are several kinds of color deficiency, and most color-deficient people do see *some* colors (see Figure 8.7). For example, some people have trouble distinguishing between red and green. Fewer people have no trouble with red and green but cannot distinguish between yellow and blue. A very few people are totally color-deficient. They depend on their rods, so to them the world looks something like black-and-white television programs—nothing but blacks, whites, and shades of gray.

Color deficiency affects about 8 percent of American men and less than 1 percent of American women. It is a hereditary condition. This gene is carried in the genes of women whose vision is usually normal. These women pass the genes on to their sons, who are born color-deficient.

binocular fusion: the process of combining the images received from the two eyes into a single, fused image

Binocular Fusion

Because we have two eyes, located about 2.5 inches (6.4 cm) apart, the visual system receives two images. Instead of seeing double, however, we see a single image—a composite of the views of two eyes. The combination of the two images into one is called **binocular fusion.**

retinal disparity: the differences between the images stimulating each eye

Not only does the visual system receive two images but there is also a difference between the images on the retinas. This difference is called **retinal disparity.** You can easily observe retinal disparity by bringing an

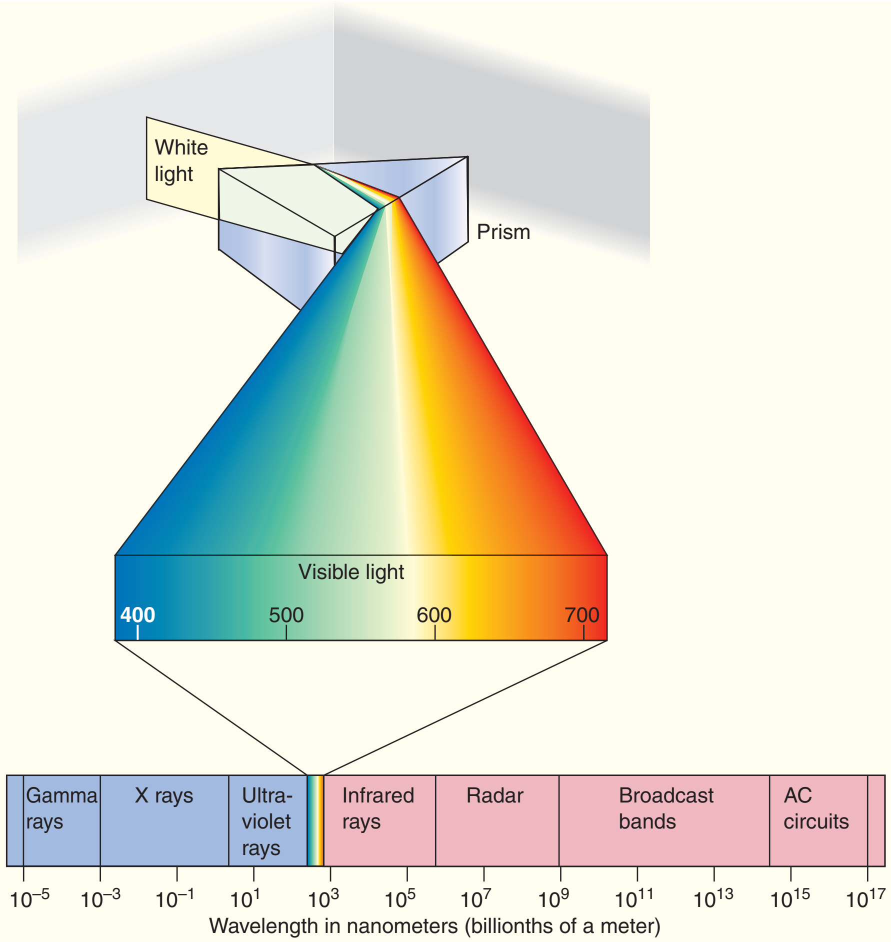


Figure 8.6 The Electromagnetic Spectrum

Light is the visible portion of the electromagnetic spectrum. When the wavelengths in white light are separated, the visual effect is an array of colors because different wavelengths are seen as different colors. ***Why are we able to see the wavelengths of the visible spectrum?***

object, such as an eraser, close to your eyes. Without moving it, look at the eraser first with one eye, then with the other. You will see a difference in the two images because of the different viewpoint each eye has. When you open both eyes, you will no longer see the difference but will instead see the object as solid and three-dimensional, if you have good binocular vision.

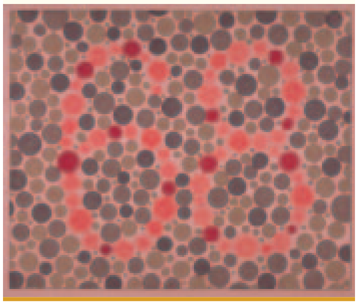
Retinal disparity is essential to your sense of depth perception. The brain interprets a large retinal disparity (a large difference between what the right eye and what the left eye are seeing) to mean that an object is nearby. The brain interprets a small retinal disparity (not much difference between the images the left and right eyes receive) to mean a distant object.

PSYCHOLOGY Online

Student Web Activity
Visit the *Understanding Psychology* Web site at glencoe.com and click on **Chapter 8—Student Web Activities** for an activity on sensation and perception.

Figure 8.7 Testing for Color Deficiency

Can you see numerals in the dot patterns that make up this figure? Those with normal vision will see a number, while those with red-green deficiency will see only random patches of color. ***What is the cause of color deficiency?***



auditory nerve: the nerve that carries impulses from the inner ear to the brain, resulting in the perception of sound

Nearsightedness and Farsightedness Some of us are born with perfectly shaped eyeballs. These people have almost perfect vision. If your eyeball is a little too long, however, you are nearsighted. Objects are focused at a point slightly in front of the retina, so you can see objects that are near but distant objects seem blurry. If your eyeball is too short, you are farsighted. Objects are focused at a point slightly behind the retina, so you can see distant objects clearly but near objects appear blurry. Eyeglasses and contact lenses alter the focus of objects.

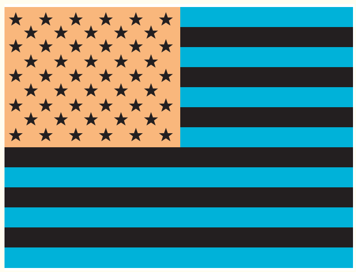
HEARING

Hearing depends on vibrations of the air, called sound waves. Sound waves from the air pass through various bones (see Figure 8.10) until they reach the inner ear, which contains tiny hairlike cells that move back and forth (much like a field of wheat waving in the wind). These hair cells change sound vibrations into neuronal signals that travel through the **auditory nerve** to the brain.

Loudness of sound is determined by the amplitude, or height, of sound waves. The higher the amplitude, the louder the sound. This strength, or sound-pressure energy, is measured in *decibels*. The sounds humans hear range upward from 0 decibels, just below the softest sound the human ear can detect, to about 140 decibels, which is roughly as loud as a jet plane taking off. Any sound over 110 decibels can damage hearing as can persistent sounds as low as 80 decibels. Any sound that is painful when you first hear it *will* damage your hearing if you hear it often enough. Figure 8.9 lists the decibel levels of some common sounds.

Pitch depends on sound-wave frequency, or the rate of the vibration of the medium through which the sound wave is transmitted. Low frequencies produce deep bass sounds, and high frequencies produce shrill squeaks. If you hear a sound composed of a combination of different frequencies, you can hear the separate pitches even though they occur simultaneously. For example, if you strike two keys of a piano at the same time, your ear can detect two distinct pitches.

Figure 8.8 A Changing Flag



Stare steadily at the lowest right-hand star for about 45 seconds. Then stare at the blank space to the left. You should see a negative afterimage of this figure. This occurs because the receptors for green, black, and yellow become fatigued or neuronal firing rates shift, allowing the complementary colors of each to predominate when you stare at the white paper. ***What happens when you shift your glance to a blank wall some distance away? Why?***

Sources of sounds can be located when your ears work together. When a noise occurs on your right, for example, the sound wave comes to both ears, but it reaches your right ear a fraction of a second before it reaches the left. It is also slightly louder in the right ear. These differences tell you from which direction it is coming.

The Pathway of Sound

The ear is designed to capture sound waves (see Figure 8.10). The outer ear receives sound waves, and the earflap directs the sounds down a short tube called the auditory canal. The vibration of air (the sound wave) causes air in the auditory canal to vibrate, which in turn causes the eardrum to vibrate.

The middle ear is an air-filled cavity. Its main structures are three tiny bones—the hammer, anvil, and stirrup. These bones are linked to the eardrum at one end and to the cochlea at the other end. When sound waves cause the eardrum to vibrate, these bones vibrate and push against the cochlea.

The cochlea makes up the inner ear. The cochlea is a bony tube that contains fluids and neurons. The pressure against the cochlea makes the liquid inside the cochlea move. Tiny hairs inside the cochlea pick up the motion. These hairs are attached to sensory cells. The sensory cells turn the sound vibrations into neuronal impulses. The auditory nerve carries these impulses to the brain. This neuronal input goes to the hearing areas of the cerebral cortex of the brain.

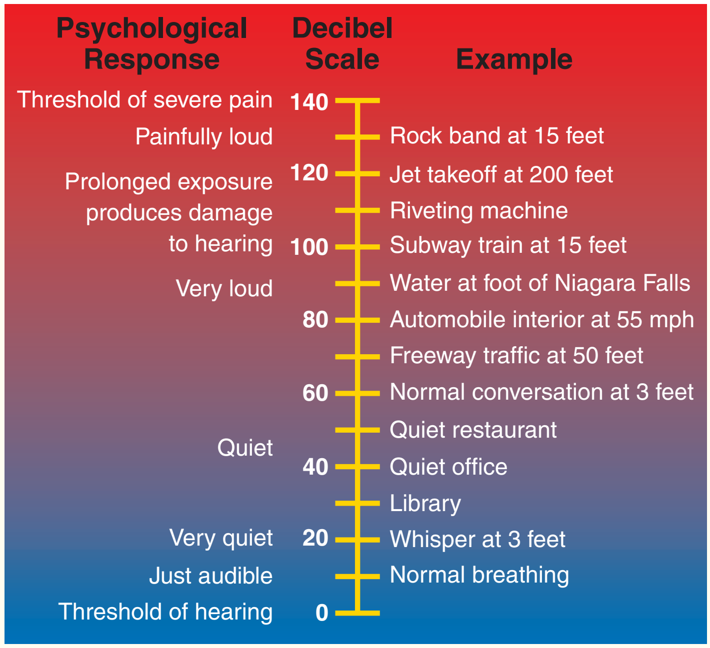


Figure 8.9 Decibel Levels

The loudness of a sound (its amplitude) is measured in decibels. Each increase of 10 decibels makes a sound 10 times louder. A normal conversation at 3 feet measures about 60 decibels, which is 10,000 times louder than a whisper of 20 decibels. Sound becomes painful at 130 decibels. ***What is the measurement in decibels of a subway train?***

Deafness

There are two types of deafness. Conduction deafness occurs when anything hinders physical motion through the outer or middle ear or when the bones of the middle ear become rigid and cannot carry sounds inward. People with conduction deafness can usually be helped with a conventional hearing aid. A hearing aid picks up sound waves, changes them into magnified vibrations, and sends them to the inner ear. Sensorineural deafness occurs from damage to the cochlea, the hair cells, or the auditory neurons. People with complete sensorineural deafness cannot be helped with a conventional hearing aid, but may be helped with a special hearing aid called a cochlear implant. A cochlear implant is a miniature electronic device that is surgically implanted into the cochlea. The device changes sound waves into electrical signals. These signals are fed into the auditory nerve, which carries them to the brain. The brain then processes the sensory input.

Reading Check
How does sound occur?

BALANCE

vestibular system: three semicircular canals that provide the sense of balance, located in the inner ear and connected to the brain by a nerve

The body's sense of balance is regulated by the **vestibular system** inside the inner ear. Its prominent feature is the three *semicircular canals*. Hair cells project into the fluid within each of the canals. When you turn your head, these canals also move. Inertia causes the fluid in the canals to resist changes in motion, which bends receptor hair cells projecting into the fluid.

The stimuli for vestibular responses include movements such as spinning, falling, and tilting the body or head. Overstimulation of the vestibular sense by such movements can result in dizziness and motion sickness, as you probably have experienced by going on amusement-park rides. Although you are seldom directly aware of your sense of balance, in its absence you would be unable to stand or walk without stumbling or falling.

SMELL AND TASTE

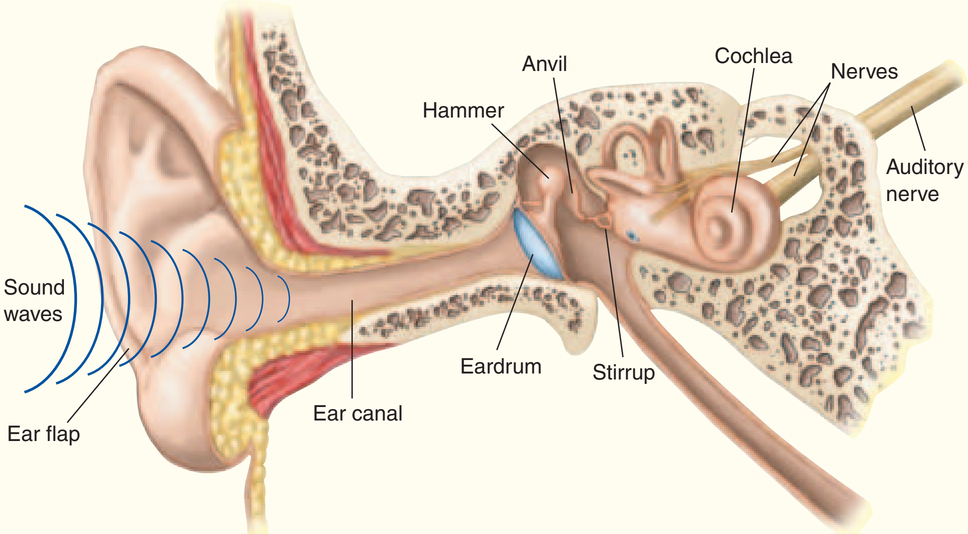
olfactory nerve: the nerve that carries smell impulses from the nose to the brain

Smell and taste are known as the chemical senses because their receptors are sensitive to chemical molecules rather than to light energy or sound waves. For you to smell something, the appropriate gaseous molecules must come into contact with the smell receptors in your nose. These molecules enter your nose in vapors that reach a special membrane in the upper part of the nasal passages on which the smell receptors are located. These receptors send messages about smells through the **olfactory nerve** to the brain. For you to taste something, appropriate liquid chemicals must stimulate receptors in the taste buds on your tongue. Taste information is relayed to the brain along with data about the texture and temperature of the substance in your mouth (see Figure 8.11).

Studies show that four primary sensory experiences—sour, salty, bitter, and sweet—make up taste (Beebe-Center, 1949). The combining of taste, smell, and tactile sensations is known as *flavor*. Research suggests that a person can detect flavors anywhere on the tongue, using the taste buds pictured in Figure 8.11. There are people

Figure 8.10 **The Human Ear**

The earflap funnels sound waves down the ear canal to the eardrum. The bones of the middle ear pick up the vibrations and transmit them to the inner ear. ***What is the function of the cochlea?***



who have greater taste sensitivities than others. So-called supertasters have two or more times the taste buds than nontasters, resulting in increased sensitivity to sweet, bitter, sour, and salty.

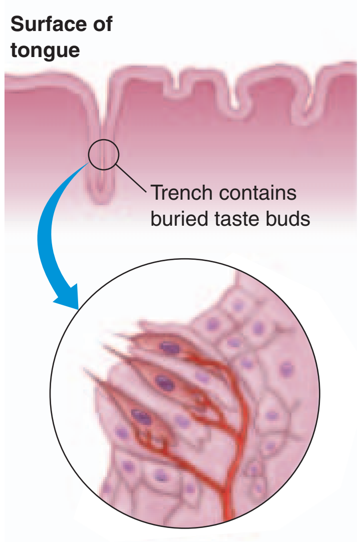
Much of what is referred to as taste is actually produced by the sense of smell. As people age, their sense of taste does not seem to decline. When older people complain that food does not taste as good as it once did, the reason usually is a loss of smell rather than a failing sense of taste (Bartoshuk, 1989). You have undoubtedly noticed that when your nose is blocked by a cold, foods usually taste bland.

Sensations of warmth, cold, and pressure also affect taste. Try to imagine eating cold chicken soup or drinking a hot soda. Now imagine the textural differences between a spoonful of pudding and a crunchy chocolate bar, and you will see how the texture and temperature of food influence taste.

The chemical senses seem to play a relatively unimportant role in human life when compared to their functions in lower animals. Insects, for example, often depend on smell to communicate with one another, especially in mating. In humans, smell and taste have become more a matter of pleasure rather than of survival.

Figure 8.11 The Human Tongue

When you chew, chemicals of the food mix with saliva and run down into trenches in your tongue. Once there, taste buds react to chemicals dissolved in saliva. ***How do the senses of taste and smell work together?***



THE SKIN SENSES

Receptors in the skin are responsible for providing the brain with at least four kinds of information about the environment: pressure, warmth, cold, and pain. Sensitivity to pressure varies from place to place in the skin. Some spots, such as your fingertips, are densely populated with receptors and are, therefore, highly sensitive. Other spots, such as the middle of your back or the back of your calf, contain relatively few receptors. Pressure sensations can serve as protection. For example, feeling the light pressure of an insect landing on your arm warns you of the danger of being stung.

Some skin receptors are particularly sensitive to hot or cold stimuli. To create a hot or cold sensation, a stimulus must have a temperature greater or less than the temperature of the skin in the sensing area. If you plunge your arm into a sink of warm water on a hot day, you will experience little or no sensation of its heat. If you put your arm in the same water on a cold day, however, the water will feel quite warm.

Many kinds of stimuli—scratches, punctures, pressure, heat, and cold—can produce pain. What they have in common is real or potential injury to bodily tissues. Pain makes it possible for you to prevent damage to your body; it is an emergency system that through your prior experience with pain demands immediate action.

Perceptions of Pain

Whereas other senses rely primarily on a single stimulus, pain results from many different stimuli. For example, pain can be caused by intense pressure, bright lights, loud noises, intense heat, and so on. There are two types of pain sensations—the sharp, localized pain you may feel immediately after an injury and the dull, generalized pain you may feel later.

Have you ever stubbed your toe and then rubbed it to reduce the pain? According to the *gate control theory of pain,* we can lessen some pains by shifting our attention away from the pain impulses or by sending other signals to compete with the pain signals. This creates a sort of competition between nonpain and pain impulses. This bottleneck, or gate, limits the number of impulses that can be transmitted. Thus, by increasing nonpainful impulses (rubbing your toe), you decrease the pain impulses, and the sensation of pain is dulled.

The gate control theory of pain could explain how athletes are able to complete a game even though they have injured themselves. Although a soccer player may know that she has bruised her side, she may not feel the pain fully until the game is over and she has calmed down.

Psychology and You

Orange Juice and Toothpaste

Have you ever brushed your teeth and then had orange juice for breakfast? How did the orange juice taste? Usually the orange juice will taste bitter. Our taste buds have membranes that contain fatlike phospholipids, while toothpastes contain a detergent that breaks down fat and grease. So the toothpaste first assaults the membranes with its detergents, leaving them raw. Then chemicals in the toothpaste, such as formaldehyde, chalk, and saccharin, cause a sour taste when they mix with the citric and ascorbic acids of orange juice. Try eating artichokes, then drinking water. What does the water taste like?

THE BODY SENSES

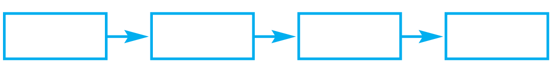
kinesthesis: the sense of movement and body position

The sense of movement and body position is **kinesthesis.** It cooperates with the vestibular and visual senses to maintain posture and balance. The sensation of kinesthesis comes from receptors in and near the muscles, tendons, and joints. When any movement occurs, these receptors immediately send messages to the brain. Without kinesthetic sensations, your movements would be jerky and uncoordinated. You could not walk without looking at your feet and complex physical activities, such as conducting surgery, piano playing, and acrobatics, would be impossible.

Assessment

1. **Review the Vocabulary** What are the five basic senses? Describe two additional senses that humans have.
2. **Visualize the Main Idea** Use a flowchart similar to the one below to describe the pathway of sound.

The Pathway of Sound



3. **Recall Information** What is the electromagnetic spectrum and why do we see only a portion of it?
4. **Think Critically** Why can we see steadily and read street signs even though we may be walking or running?
5. **Application Activity** Take a friend to a brightly lit area and then to a dimly lit area and notice how the size of his or her pupils change. How can you explain this?

SECTION 3 Perception

Reader's Guide

Main Idea

The way we interpret sensations and organize them into meaningful experiences is called perception.

Vocabulary

- Gestalt
- subliminal messages
- motion parallax
- constancy
- illusions
- extrasensory perception (ESP)

Objectives

- Outline the principles involved in perception.
- Describe how we learn to perceive and what illusions are.

EXPLORING PSYCHOLOGY

Trying to Catch a Fly

The frog's bug detector shows the rigidity of reflexive behavior. If you sever the frog's optic nerve, it will grow back together, and the bug detector will still work fine. If you sever the optic nerve and then rotate the frog's eye 180 degrees, the nerve will still heal and reestablish all the old connections; however, this time the results will not be so good. The bug detector does not know that everything has been rotated, so it miscomputes a bug's location. If the bug is high, the frog shoots its tongue low. If the bug is to the right, the tongue goes to the left. The frog never learns to compensate for the changed situation.

—from *A Second Way of Knowing: The Riddle of Human Perception* by Edmund Blair Bolles, 1991

The purpose of the excerpt above is to demonstrate to you how useful your powers of perception are. Perception goes beyond reflexive behavior and allows us to confront changes in our environment. Perceptual thinking is essential for us to adapt to change.

People do not usually experience a mass of colors, noises, temperatures, and pressures. Rather, we see cars and buildings, hear voices and music, and feel pencils, desks, and physical contact. We do not merely have sensory experiences; we perceive objects. The brain receives information from the senses and organizes and interprets it into meaningful experiences—unconsciously. This process is called perception.

PRINCIPLES OF PERCEPTUAL ORGANIZATION

Gestalt: the experience that comes from organizing bits and pieces of information into meaningful wholes

Through the process of perception, the brain is always trying to comprehend the confusion of stimuli that bombard the senses. The brain makes sense of the world by creating whole structures out of bits and pieces of information in the environment. Each whole that is organized by the brain is called a **Gestalt.** Here, the whole is more than the sum of the parts. (*Gestalt* is a German word meaning "pattern" or "configuration.")

Gestalt psychologists have tried to identify the principles the brain uses in constructing perceptions (Koffka, 1963). Some of the principles they have discovered are demonstrated in Figure 8.12. For example, people tend to see dots in patterns and groups. Principles that people use in organizing such patterns are *proximity, continuity, similarity, simplicity,* and *closure.* If the elements of the pattern are close to one another or are similar in appearance, they tend to be perceived as belonging to one another.

The Gestalt principles of organization help explain how we group our sensations and fill in gaps to make sense of our world. In music, for instance, you tend to group notes on the basis of their closeness, or proximity, to one another in time—you hear melodies, not single notes. Similarity and continuity are also important. They allow you to follow the

Figure 8.12 **Gestalt Principles**

Humans see patterns and groupings in their environment rather than disorganized arrays of bits and pieces. ***Why do we use the principles of organization illustrated here?***

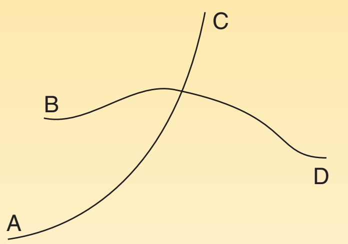
Proximity
When we see a number of similar objects, we tend to perceive them as groups or sets of those that are close to each other.

Similarity
When similar and dissimilar objects are mingled, we see the similar objects as groups.

Closure
When we see a familiar pattern or shape with some missing parts, we fill in the gaps.

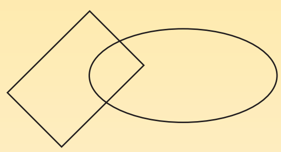
We see a star instead of five Vs.

Continuity
We tend to see continuous patterns, not disrupted ones.



Two curves or two pointed shapes?

Simplicity
We see the simplest shapes possible.



sound of a particular voice or instrument even when many other sounds are occurring. Closure aids us in perceiving an object even though there may be gaps in what our senses pick up. The rule of simplicity states that we tend to perceive complex figures as divided into several simpler figures.

FIGURE-GROUND PERCEPTION

One form of perceptual organization is the division of experience into figure and ground (see Figure 8.13). Figure-ground perception is the ability to discriminate properly between a figure and its background. When you look at a three-dimensional object against the sky, you have no trouble distinguishing between the object and its background. Objects become the figure and stand out from the background. It is when something is two-dimensional, as in Figure 8.13, that you may have trouble telling the figure from the ground. Nevertheless, such figure-ground perceptions give clues as to the nature of perception. That we can perceive a single pattern in more than one way demonstrates that we are not passive receivers of stimuli.

Figure and ground are important in hearing as well as in vision. When you follow one person's voice at a noisy meeting, that voice is a figure and all other sounds become ground. Similarly, when you listen to a piece of music, a familiar theme may leap out at you: the melody becomes the figure, and the rest of the music merely background.

Did You Know?

Hearing Colors All of her life, a woman, finally diagnosed with synesthesia, had seen colors when she heard words or letters. She always saw yellow with hints of green when she heard the word *king,* for instance. *Synesthesia* is the mingling or swapping of sensory information in which stimulating one sense triggers conscious experience in another sense. People with synesthesia may experience spoken words as tastes or shapes, colors as smells, and touches as sounds. The condition occurs in about 1 in 25,000 people and may result from "crossed wires" in the sensory areas of the brain.

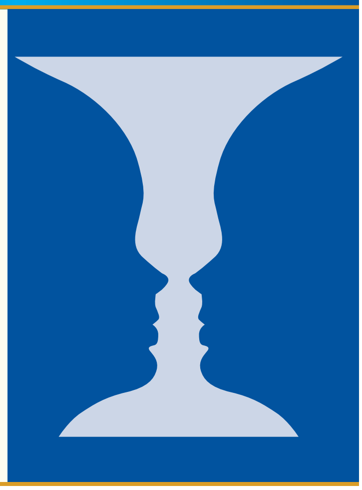
PERCEPTUAL INFERENCE

Often we have perceptions that are not based entirely on current sensory information. When you hear barking as you approach your house, you assume it is your dog—not a cat or a rhinoceros or even another dog. When you take a seat in a dark theater, you assume it is solid and will hold your weight even though you cannot see what supports the seat. When you are driving in a car and see in the distance that the road climbs up a steep hill then disappears over the top, you assume the road will continue over and down the hill, not come to an abrupt end just out of sight.

This phenomenon of filling in the gaps in what our senses tell us is known as *perceptual inference* (Gregory, 1970). Perceptual inference

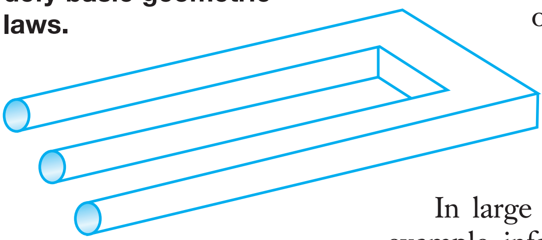
Figure 8.13 What Is It?

What did you see the first time you looked at this illustration—a vase or two profiles? People invariably organize their experience into figure and ground. ***What does the fact that we perceive a single pattern more than one way demonstrate?***



is largely automatic and unconscious. We need only a few cues to inform us that a noise is our dog barking or that a seat is solid. Why? Because we have encountered these stimuli and objects in the past and know what to expect from them in the present. Perceptual inference, thus, often depends on experience. On the other hand, we are probably born with some of our ability to make perceptual inferences.

This drawing seems to defy basic geometric laws.



LEARNING TO PERCEIVE

In large part, perceiving is something that people *learn* to do. For example, infants under one month will smile at a nodding object the size of a human face, whether or not it has eyes, a nose, or other human features. At about 20 weeks, however, a blank oval will not make most infants smile, but a drawing of a face or a mask will. The infant has learned to distinguish something that looks like a person from other objects. Infants 28 weeks and older are more likely to smile at a female than a male face. By 30 weeks, most infants smile more readily when they see a familiar face than when they see someone they do not know. It takes, however, 7 or 8 months for infants to learn to recognize different people (Ahrens, 1954).

Experiments with human beings have also shown that active involvement in one's environment is important for accurate perception. People who have been blind from birth and who have had their sight restored by an operation have visual sensations, but initially they cannot tell the difference between a square and a circle or see that a red cube is like a blue cube (Valvo, 1971). In fact, some had difficulty making such simple distinctions six months after their vision was restored.

Learning to perceive is influenced by our needs, beliefs, and expectations. When we want something, we are more likely to see it. Psychologists (Wispe & Drambarean, 1953) have demonstrated that hungry people are faster at identifying food-related words when words are flashed quickly in front of them. What we identify as truth may be twisted and reconstructed to fit our own belief systems. Previous experiences influence what we see (Lachman, 1996). For example, if you have always perceived all elderly women as honest, you might not even question the elderly woman at the next table when your wallet disappears in a restaurant, even if she is the most obvious suspect. This is called a perceptual set. This set prepares you to see what you want to see.

Figure 8.14 **Pop-Out Features**

Reality is a jumble of sensations and details. The letter *P* probably pops out to you. The *Q*s may also pop out, but not as much as the *P*. You may not have noticed the *O*, though. ***Why does the* P *pop out?***

QQQQQQQQ
QQQQQPQQ
QQOQQQQQ
QQQQQQQQ

Subliminal Perception

subliminal messages: brief auditory or visual messages that are presented below the absolute threshold

In his 1957 book *The Hidden Persuaders,* Vance Packard divulged that advertisers were using a revolutionary breakthrough in marketing techniques—subliminal advertising. The word *subliminal* comes from the Latin: *sub* ("below") and *limen* (threshold). This concept used **subliminal messages,** which are brief auditory or visual messages presented below the absolute threshold so that there is less than a 50 percent chance that they will be perceived.

One advertiser, James Vicary, falsely claimed that the words "Eat Popcorn" and "Drink Coke" had been flashed on a movie screen in a New Jersey theater on alternate nights for six weeks. Although the flashes were so brief (1/3000 of a second, once every five seconds) that none of the moviegoers even seemed to notice them, Vicary claimed that the sales of popcorn had risen 58 percent and Coke sales had risen 18 percent.

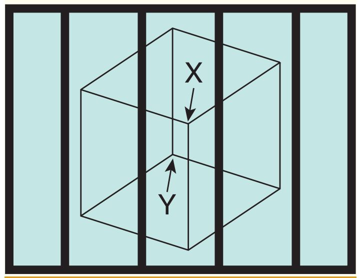
The public response to this announcement was long, loud, and hysterical. Congressional representatives called for FCC regulations, while several state legislatures passed laws banning subliminal ads. Eventually, Vicary admitted that the data from the movie theater experiment were false, and many people believe the experiment never really took place. However, public furor over the potential for abuse of subliminal advertising remained. In 1974, the FCC condemned subliminal advertising, regardless of its efficacy.

The idea for subliminal ads was a natural outgrowth of a long series of controversial studies on *subliminal perception*—the ability to notice stimuli that affect only the unconscious mind. Most of these earlier studies involved presenting verbal or visual material at intensities that were considered too low for people to perceive. A more critical look at the studies, however, revealed several flaws in the way they were designed and carried out. For example, no attempt was made to assess or control factors other than the subliminal message that might have influenced the purchase of Coke or popcorn. The temperature in the theater or the length of the movie might have contributed to the increase in sales. Unfortunately, the study was not presented in enough detail to be evaluated by scientists.

Even if it is possible for people to perceive information at very low levels of intensity, there is no clear evidence that these weak, often limited messages would be more powerful in influencing people than would conscious messages. Nevertheless, many people believe that subliminal advertising is powerful.

Figure 8.15 The Necker Cube

The Necker cube is an ambiguous figure. You can will yourself to see it as if you were looking down on it, with corner X closest to you, or as if you were looking up at it, with corner Y closest to you. ***How might you make this cube less ambiguous by adding details?***



DEPTH PERCEPTION

Depth perception—the ability to recognize distances and three-dimensionality—develops in infancy. Psychologists have placed infants on large tables and found that they most likely will not crawl over the edge. From this observation, it is possible to infer that infants do have depth perception.

Monocular Depth Cues

People use many monocular depth cues to perceive distance and depth. *Monocular depth cues* are cues that can be used with a single eye. There are at least a half-dozen monocular cues external to us that we use. In the absence of any other cues, the size of an object—bigger is nearer—will be used. We use *relative height*—objects that appear farther away

Figure 8.16 **Monocular Cues**

As you look down a long stretch of highway, the parallel sides of the road seem to converge. The expansive desert appears furrowed up close and smooth in the distance. ***How would you use the relative height cue to perceive the distance of the desert?***

from another object are higher on your plane of view. *Interposition,* or the overlapping of images, causes us to view the object we can see in its entirety to be closer than one whose outline is interrupted by another object. *Light and shadows* yield information about an object's shape and size. Brightly lit objects appear closer, while objects in shadows appear farther away. *Texture-density gradient* means that the farther removed an object is, the less detail we can identify (see Figure 8.16).

motion parallax: the apparent movement of stationary objects relative to one another that occurs when the observer changes position

Another cue is **motion parallax**—the apparent movement of objects that occurs when you move your head from side to side or when you walk around. You can demonstrate motion parallax by looking toward two objects in the same line of vision, one near you and the other some distance away. If you move your head back and forth, the near object will seem to move more than the far object. In this way, motion parallax gives you clues as to which objects are closer than others.

Another distance cue, *linear perspective,* is based on the fact that parallel lines converge when stretched into the distance (see Figure 8.16). For instance, when you look at a long stretch of road or railroad tracks, it appears that the sides of the road or the tracks converge on the horizon. A final related cue is *relative motion.* When you are riding in a car, for example, and look at distant mountains, the objects in a nearby field seem to be moving in the opposite direction to your movement. Yet, when you look at an animal in a nearby field, the mountains or land beyond the animal seem to be moving in the same direction you are.

Binocular Depth Cues

Binocular depth cues depend upon the existence or movement of both eyes. For example, *convergence* is the process by which your eyes turn inward to look at nearby objects. Another cue is the information provided by retinal disparity, as discussed earlier in the chapter. Because each of your eyes occupies a different position, each eye receives a slightly different image. That difference is *retinal disparity.* The brain interprets a large retinal disparity to mean a close object and a small retinal disparity to mean a distant object.

Reading Check How do monocular and binocular depth cues differ?

CONSTANCY

When we have learned to perceive certain objects in our environment, we tend to see them in the same way, regardless of changing conditions. You probably judge the whiteness of the various portions of these pages to be fairly constant, even though you may have read the book under a wide range of lighting conditions. The light, angle of vision, distance, and, therefore, the image on the retina all change, but your perception of the object does not. Thus, despite changing physical conditions, people are able to perceive objects as the same by the processes of size, shape, brightness and color **constancy** (see Figure 8.17).

constancy: the tendency to perceive certain objects in the same way regardless of changing angle, distance, or lighting

An example of size constancy will illustrate how we have an automatic system for perceiving an object as being the same size whether it is far or near. A friend walking toward you does not seem to change into a giant even though the images inside your eyes become larger and larger as she approaches. To you, her appearance stays the same size because even though the size of your visual image is increasing, you are perceiving an additional piece of information: distance is decreasing. The enlarging eye image and the distance information combine to produce a perception of an approaching object that stays the same size.

Distance information compensates for the enlarging eye image to produce size constancy. If information about distance is eliminated, your perception of the size of the object begins to correspond to the actual size of the eye image. For example, it is difficult for most people to estimate the size of an airplane in the sky because they have little experience judging such huge sizes and distances. Pilots, however, can determine whether a flying plane is large and far away or small and close because they are experienced in estimating the sizes and distances of planes.

Through the wide middle range of brightness, and in a mix of many colors, reds are perceived as red, greens as green–color constancy. Similarly, across a wide range of light, from dawn's early light to dusk's fading light, the brightest shirt in a crowd will always be perceived the brightest–brightness constancy. With brightest light, colors fade to white; at dusk, they fade to gray or black.

illusions: perceptions that misrepresent physical stimuli

ILLUSIONS

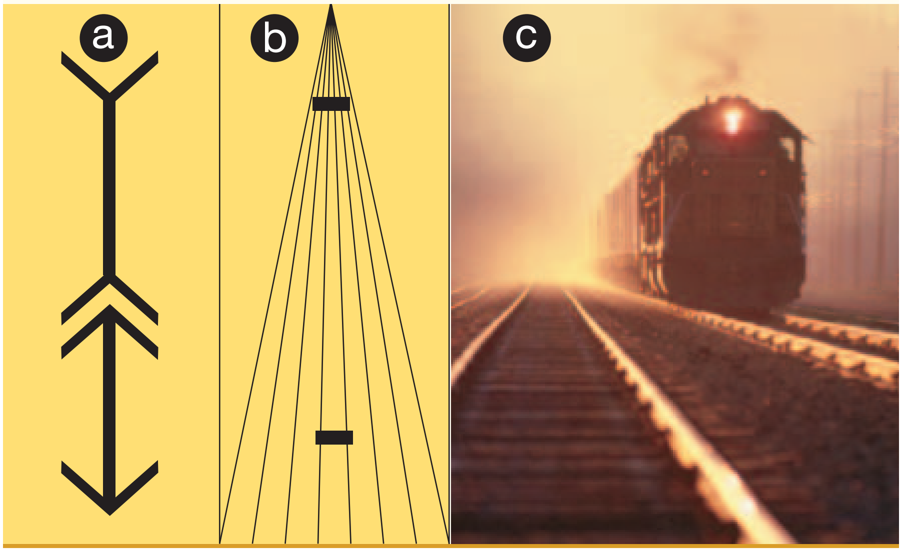
Illusions are incorrect perceptions. Illusions can be useful in teaching us about how our sensory and perceptual systems work. Illusions are created when perceptual cues are distorted so that our brains cannot correctly interpret space, size, and depth cues. For example, look at the lines in Figure 8.18. Which lines in

Figure 8.17 Shape Constancy

We perceive the opening door as being rectangular in shape, although our view of the shape of it changes as it opens. ***Why are perceptual constancies important to our understanding of the world?***

Figure 8.18 **Lines of Different Lengths?**

The Müller-Lyer illusion (a) and the Ponzo illusion (b) are depicted here. The lines between the arrowheads in (a) are exactly the same length, as are the heavy black lines in (b). Some psychologists believe that the reason the lines in (a) seem of different lengths is because they are interpreted as offering different cues to their distance from the viewer. The lines in (b) may appear to be different in length because the brain interprets this diagram as though it is from a scene such as that in (c). ***Why does the brain interpret scenes in certain ways?***



each set are longer? Measure the lengths of the pairs of lines with a ruler, then look again. Do the lines look as long now that you know they are the same? For most people, the answer is no.

A possible explanation of this type of illusion is that even though the patterns are two-dimensional, your brain treats them as three-dimensional. These illusions have features that usually indicate distance in three-dimensional space. The top line in Figure 8.18a, for example, can be thought of as the far corner of a room; the bottom line is like the near corner of the building. In Figure 8.18b and Figure 8.18c, the converging lines create the illusion of distance so that the lower bar looks nearer and shorter than the upper bar. This perceptual compensation seems to be unconscious and automatic.

Figure 8.19 shows two individuals in a room. Their sizes look dramatically different because you perceive the room as rectangular. In fact, the ceiling and walls are slanted so that the back wall is both shorter and closer on the right than on the left. Yet even when you know how this illusion was achieved, you still accept the peculiar difference in the sizes of the two people because the windows, walls, and ceiling appear rectangular. Your experience with rectangular rooms overrides your knowledge of how this trick is done.

EXTRASENSORY PERCEPTION

extrasensory perception (ESP): an ability to gain information by some means other than the ordinary senses

We are fascinated by things that cannot be seen, easily explained, or sometimes even verified, such as flying saucers, atoms, genes, and extrasensory perception. **Extrasensory perception (ESP)**—receiving information about the world through channels other than the normal senses—is a hotly debated topic. There are four types of ESP: (1) clairvoyance is perceiving objects or information without sensory input; (2) telepathy involves reading someone else's mind or transferring one's thoughts; 3) psychokinesis involves moving objects through purely mental effort;

and (4) precognition is the ability to foretell events. Since the 1960s, James Randi, known as "The Amazing Randi," has campaigned against people who claim they have ESP. He has exposed many of these people as frauds.

Many people are convinced that ESP exists because of an intense personal experience that can never be scientifically validated. For instance, we all have some fears before traveling, and we imagine the worst: our plane will crash, our train will be derailed, or we will have an automobile accident. These events almost never happen, and we easily forget about our frightening premonitions. If the improbable should actually take place, however, our premonitions turn into compelling evidence for the existence of precognition. Such coincidences sometimes become widely publicized evidence supporting paranormal phenomena, and we may quickly forget all the occasions when our premonitions were completely wrong. If we are truly interested in validating the existence of ESP, though, we must keep track of the frequency of its failures as well as its successes.

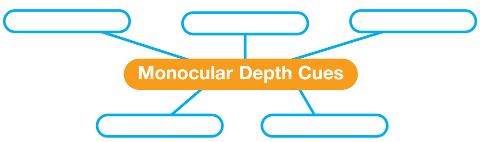
Figure 8.19 **A Strange Room**

The room, constructed by Adelbert Ames, changes depth cues to distort our perception. ***What makes this illusion work?***

Scientists have been investigating ESP since the 1900s. (Probably the most famous parapsychologist is J.B. Rhine.) Many scientists do not accept the results of experiments supporting ESP because the findings are highly unstable. One of the basic principles of scientific research is that one scientist should be able to replicate another scientist's results. Not only do different ESP experiments yield contradictory findings, but the same individual seems to show ESP on one day but not on the next. Perhaps the most telling argument against ESP is that when strict controls are used in an ESP experiment, there is little likelihood of demonstrating ESP. This is contrary to what one normally expects when trying to demonstrate a phenomenon using the scientific methods described in Chapter 2.

SECTION 3 Assessment

1. **Review the Vocabulary** Describe the Gestalt principles of organization. How do these principles help us organize reality?
2. **Visualize the Main Idea** Use a graphic organizer similar to the one below to list and briefly describe monocular depth cues.



3. **Recall Information** What are the binocular depth cues? How do they help us judge reality?
4. **Think Critically** How do illusions demonstrate the difference between sensations and perceptions?
5. **Application Activity** Consider the following question: You have suddenly lost all perceptual constancies—what specific problems do you encounter? Create a scene—in the form of a play, narrative, or newspaper article—that illustrates a problem you might encounter.

Case Studies

Seeing Is Believing

Period of Study: Late 1950s and early 1960s

Introduction: In the late 1950s and early 1960s, an anthropologist, C.M. Turnbull, traveled to the Ituri Forest in the present-day country of the Democratic Republic of the Congo (formerly Zaire) to study the life and culture of the BaMbuti Pygmies. Turnbull traveled from one village to another. A 22-year-old man named Kenge from a local Pygmy village accompanied and assisted him. Kenge had spent all of his life living in the dense forests surrounding his village. He was accustomed to seeing only the images contained within the forests.

Hypothesis: Because Kenge had been isolated by the forests all of his life, the sight of new images would appear complex and confusing. The thick forests blocked the local villagers' view of distant objects such as animals, mountains, and the sun and moon on the horizon. Because Kenge had never seen these things, his perceptual development (in this case, *size constancy*, or the ability to perceive a familiar object as being the same size regardless of its distance from you) was limited. He understood only what he could see directly in front of him. The information collected from Turnbull's experience with Kenge raised the question of whether perceptual understanding is a learned ability or biological mechanism: a question of nature versus nurture.

Method: The discovery of Kenge's perceptual limitations took place when Turnbull and Kenge came to a clearing on the eastern edge of the Ituri Forest. At that point Kenge and Turnbull enjoyed a clear view of the Ruwenzori Mountains. Confused by the sight of the mountains, Kenge asked Turnbull if the mountains were hills or clouds. Turnbull explained that they were hills but much larger than any Kenge had seen before. Kenge agreed to ride with Turnbull to the mountains for further inspection. A passing thunderstorm obstructed the travelers' view and did not clear until the two reached the mountains. When Kenge peered up at the enormous mountain range, he was amazed.

As Turnbull and Kenge turned to leave, Kenge noticed a wide open plain on which stood a herd of buffalo. Kenge wanted to know what type of "insects" the buffalo were. Turnbull explained that the animals were not insects but buffalo. When the two arrived close to the herd of buffalo, Kenge now knew that the "insects" were buffalo all along, but he still could not understand why they had appeared to be so small.

Results: Turnbull's accounts support the idea that human perception develops (at least in the case of size constancy) as we use the environment around us, or by nurture. However, some research with infants supports the nature side of perception. For example, individuals who were blind at birth and later gained their sight were able to perceive figure-ground relationships. Are we born with certain perceptual abilities and not others, or is perception something we learn? In Kenge's case, perceptual ability was a learned phenomenon. Certain perceptual skills may be necessary for our survival. In Kenge's case, he did not need a wide range of size constancy to survive in the dense jungle.

Analyzing the Case Study

1. Why did some images seem confusing to Kenge?
2. According to Turnbull, how do we learn size constancy?
3. **Critical Thinking** Do you think that Kenge could adjust to life in your city or town? Explain the difficulties he might encounter.

CHAPTER 8

Summary and Vocabulary

People take in information through their senses. Through their senses they perceive the world around them.

Section 1 Sensation

Main Idea: Sensations initiate humans' understanding of their reality. Sensations occur anytime a stimulus activates a receptor.

- The absolute threshold is the weakest amount of a stimulus required to produce a perception; the difference threshold is the minimum amount of distinction a person can detect between two stimuli.
- Senses are most responsive to increases and decreases, rather than unchanging stimulation.
- Sensory adaptation allows people to notice differences in sensations and react to the challenges of different or changing stimuli.

Section 2 The Senses

Main Idea: The sense organs—the eyes, ears, tongue, nose, skin, and others—are the receptors of sensations.

- Vision provides people with a great deal of information about the environment and the objects in it.
- Hearing depends on vibrations of the air, called sound waves.
- The body's sense of balance is regulated by the vestibular system, adjacent to the inner ear.
- Smell and taste are known as the chemical senses because their receptors are sensitive to gaseous and liquid molecules respectively.
- Receptors in the skin are responsible for providing the brain with information about pressure, warmth, cold, and pain.
- Kinesthesis cooperates with the vestibular and visual senses to maintain our sense of movement and body position.

Section 3 Perception

Main Idea: The way we interpret sensations and organize them into meaningful experiences is called perception.

- The Gestalt principles of organization help explain how we group our sensations and fill in gaps to make sense of our world.
- Figure-ground perception is the ability to discriminate properly between figure and ground.
- Perceptual inference is the phenomenon of filling in the gaps in what our senses tell us.
- Learning to perceive is influenced by our needs, beliefs, and expectations.
- People use monocular depth cues and binocular depth cues to perceive distance and depth.
- Incorrect perceptions, created when perceptual cues are distorted, are called illusions.

Chapter Vocabulary

sensation (p. 208)
perception (p. 208)
psychophysics (p. 208)
absolute threshold (p. 209)
difference threshold (p. 210)
Weber's law (p. 211)
signal-detection theory (p. 212)
pupil (p. 215)
lens (p. 215)
retina (p. 215)
optic nerve (p. 215)
binocular fusion (p. 216)
retinal disparity (p. 216)
auditory nerve (p. 218)
vestibular system (p. 220)
olfactory nerve (p. 220)
kinesthesis (p. 222)
Gestalt (p. 224)
subliminal messages (p. 226)
motion parallax (p. 228)
constancy (p. 229)
illusions (p. 229)
extrasensory perception (ESP) (p. 230)

CHAPTER 8 Assessment

PSYCHOLOGY Online

Self-Check Quiz
Visit the *Understanding Psychology* Web site at glencoe.com and click on **Chapter 8—Self-Check Quizzes** to prepare for the Chapter Test.

Reviewing Vocabulary

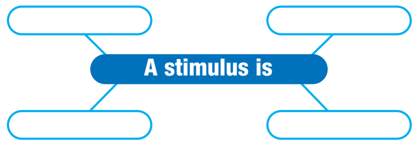
Choose the letter of the correct term or concept below to complete the sentence.

a. sensation
b. psychophysics
c. absolute threshold
d. difference threshold
e. binocular fusion
f. perception
g. vestibular system
h. kinesthesis
i. subliminal messages
j. illusions

1. The organization of sensory information into meaningful experiences is __________ .
2. The psychological study of questions such as the relationship between color and wavelength is called __________.
3. The minimum amount of difference a person can detect between two stimuli is the __________.
4. __________ are incorrect perceptions.
5. __________ is the sense of movement and body position.
6. The combination of two images into one is __________ .
7. A(n)__________ is created when a stimulus activates a receptor.
8. Advertisers sometimes use __________, which are brief auditory or visual stimuli presented below the absolute threshold so that there is less than a 50 percent chance that they will be perceived.
9. The weakest amount of stimuli required to produce a sensation is called the __________.
10. A body's sense of balance is regulated by the __________ connected to the inner ear.

Recalling Facts

1. Using a graphic organizer similar to the one below, define stimulus and give at least four examples of stimuli.



2. What is the psychological principle that explains why you are more likely to notice when a single lightbulb burns out in a room with three lamps than when a single lightbulb burns out in a sports arena?
3. What is our vestibular system? Why do we need it?
4. List four kinds of information we receive from our skin.
5. Define figure-ground perception and provide an example of it.

Critical Thinking

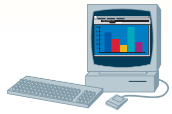
1. **Synthesizing Information** Which of the senses do you consider most important to you? Why do you think so?
2. **Making Inferences** How might being color-deficient affect your daily life? Your choice of career?
3. **Analyzing Concepts** What is the difference between vestibular sense and kinesthesis? In what situations are both senses needed?
4. **Analyzing Concepts** What sensation do you experience when you close your eyes and gently press on one of your eyeballs at the outer edge? How can you explain the visual experience in the absence of light rays?
5. **Evaluating Information** One of the objections to the use of subliminal advertising techniques is that they could be used to manipulate or influence large numbers of people without their knowing it. Do you think this is an important objection? Why or why not?

CHAPTER 8

Assessment

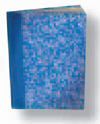
Psychology Projects

1. **The Senses** Peel a fresh potato and an apple. Have a friend close his eyes and smell a fresh onion while he takes a bite of each one. Can he tell which food is which without his sense of smell? Try this experiment with various people, using different foods that have similar textures. Report your findings in a chart. Explain the relationship between the senses of taste and smell.
2. **Perception** Watch a movie with your parents or grandparents. As soon as the film is over, ask each person to write a paragraph describing the last scene in the movie. Read each paragraph aloud. What was everyone's perception of the scene? How could you explain any differences?
3. **Sensation** Sensory adaptation refers to the ability of the senses to adjust themselves to a constant level of stimulation. Create a simple experiment to test for sensory adaptation. Ask a classmate to demonstrate the experiment.



Technology Activity

Search the Internet for information and examples of optical illusions. Present examples to your class and explain how the illusions were created.



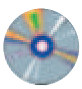
Psychology Journal

1. Reread your journal entry about hearing another conversation in a crowded setting. Is your explanation still valid? If necessary, how would you change it?
2. Think about what it would be like if our senses did not have the limits they do. What visual problems might we have? What would we hear if our sense of hearing had a different range? Write answers to these questions in your journal.

Building Skills

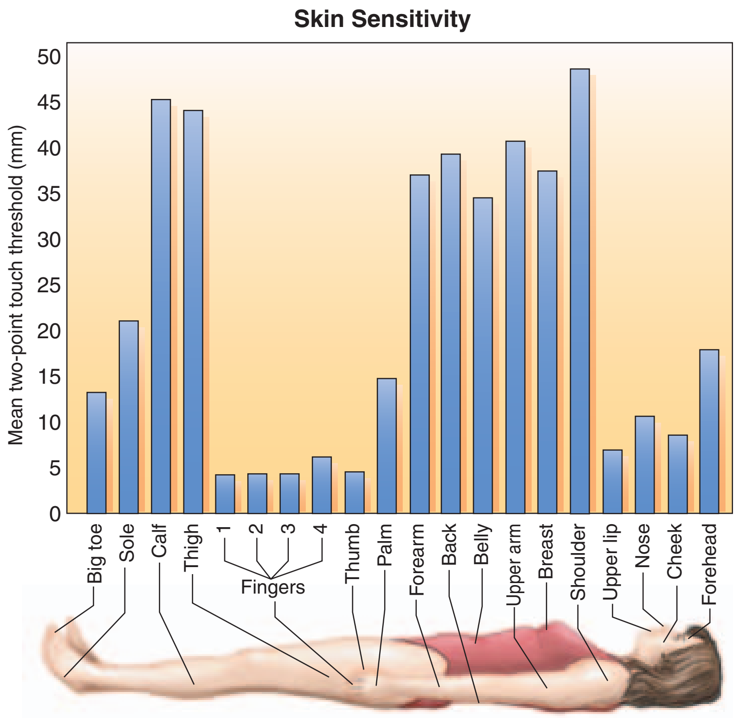
Interpreting a Graph Review the graph, and then answer the questions that follow.

1. What three body parts are the least sensitive to touch?
2. Why are certain parts of the body more sensitive to touch than others?
3. How does the information in the graph help explain why people reading in Braille use their fingertips?



Practice and **assess** key social studies skills with **Glencoe Skillbuilder Interactive Workbook CD-ROM, Level 2.**

See the Skills Handbook, page 628, for an explanation of interpreting graphs.



READINGS IN PSYCHOLOGY

How do we recognize an object we are seeing? The experience of Virgil, a 55-year-old man who regained his sight after being blind, raises questions about seeing and perception. Oliver Sacks, a physician, is known for writing case histories of neurological experiences. This account appeared in *The New Yorker* on May 10, 1993.

Reader's Dictionary

acute: severe

indolence: laziness or sloth

retina: the sensory membrane that lines the eye and functions as the instrument of vision

cataract: a clouding of the lens of the eye

incessant: continuing without interruption

coherence: being unified or understandable

agnostic: loss of ability to recognize familiar objects

To See and Not See

BY OLIVER SACKS

Virgil (nearly all the names in this account have been changed, and some identifying details have been disguised) was born on a small farm in Kentucky soon after the outbreak of the Second World War. He seemed normal enough as a baby, but (his mother thought) had poor eyesight even as a toddler, sometimes bumping into things, seemed not to see them. At the age of three, he became gravely ill with a triple illness—a meningitis or meningoencephalitis (inflammation of the brain and its membranes), polio, and cat-scratch fever. During this acute illness, he had convulsions, became virtually blind, paralyzed in the legs, partly paralyzed in his breathing, and, after ten days, fell into a coma. He remained in a coma for two weeks. When he emerged from it, he seemed, according to his mother, "a different person" and "sort of dull inside"; he showed a curious indolence, nonchalance, passivity, seemed nothing at all like the spunky, mischievous boy he had been.

The strength in his legs came back over the next year, and his chest grew stronger, though never, perhaps, entirely normal. His vision also recovered significantly—but his retinas were now gravely damaged. Whether the retinal damage was caused wholly by his acute illness or perhaps partly by a congenital retinal degeneration was never clear.

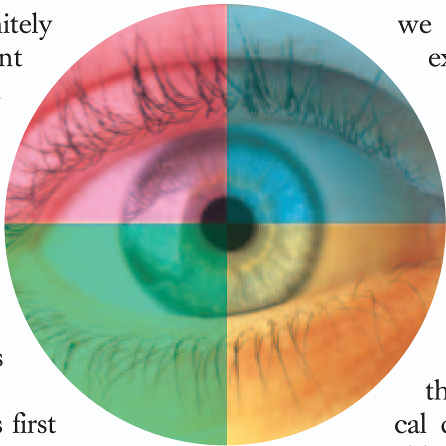
In Virgil's sixth year, cataracts began to develop in both eyes, and it was evident that he was becoming functionally blind. That same year, he was sent to a school for the blind, and there he eventually learned to read Braille and to become adept with the use of a cane. . . .

Virgil graduated from the school, and when he was twenty, decided to leave Kentucky, to seek training, work, and a life of his own in a city in Oklahoma. He trained as a massage therapist, and soon found employment at a Y.M.C.A. He was obviously good at his job, and highly esteemed, and the Y was happy to keep him on its permanent staff and to provide a small house for him across the road, where he lived with a friend, also employed at the Y. Virgil had many clients—it is fascinating to hear the tactile detail with which he can describe them—and seemed to take a real pleasure and pride in his job. . . . Life was limited, but stable in its way.

Then, in 1991, he met Amy. . . . [Amy] saw Virgil stuck (as she perceived it) in a vegetative, dull life. . . . Restoring his sight [through surgery], she must have felt, would, like marriage, stir him from his indolent bachelor existence and provide them both with a new life. . . . Virgil himself showed no preference in the matter; he seemed happy to go along with whatever they decided.

Finally, in mid-September, the day of the surgery came. Virgil's right eye had its cataract removed, and a new lens implant was inserted; then the eye was bandaged, as is customary, for twenty-four hours of recovery. The following day, the bandage was removed, and Virgil's eye was finally exposed, without cover, to the world. The moment of truth had come.

Or had it? The truth of the matter (as I pieced it together later), if less "miraculous" than Amy's journal suggested, was infinitely stranger. The dramatic moment stayed vacant, grew longer, sagged. No cry ("I can see!") burst from Virgil's lips. He seemed to be staring blankly, bewildered, without focusing, at the surgeon, who stood before him, still holding the bandages. Only when the surgeon spoke—saying "Well?"—did a look of recognition cross Virgil's face.



Virgil told me later that in this first moment he had no idea what he was seeing. There was light, there was movement, there was color, all mixed up, all meaningless, a blur. Then out of the blur came a voice that said, "Well?" Then, and only then, he said, did he finally realize that this chaos of light and shadow was a face—and, indeed, the face of his surgeon. . . .

The rest of us, born sighted, can scarcely imagine such confusion. For we, born with a full complement of senses, and correlating these, one with the other, create a sight world from the start, a world of visual objects and concepts and meanings. When we open our eyes each morning, it is upon a world we have spent a lifetime *learning* to see. We are not given the world: we make our world through incessant experience, categorization, memory, reconnection. But when Virgil opened his eye, after being blind for forty-five years—having had little more than an infant's visual experience, and this long forgotten—there were no visual memories to support a perception, there was no world of experience and meaning awaiting him. He saw, but what he saw had no coherence. His retina and optic nerve were active, transmitting impulses, but his brain could make no sense of them; he was, as neurologists say, agnostic.

Everyone, Virgil included, expected something simpler. A man opens his eyes, light enters, and falls on the retina: he sees. It is as simple as that, we imagine. And the surgeon's own experience, like that of most ophthalmologists, had been with the removal of cataracts from patients who had almost always lost their sight late in life—and such patients do indeed, if the surgery is successful, have a virtually immediate recovery of normal vision, for they have in no sense lost their ability to see. And so, though there had been a careful surgical discussion of the operation and of possible postsurgical complications, there was little discussion or preparation for the neurological and psychological difficulties that Virgil might encounter. . . .

On the day he returned home after the bandages were removed, his house and its contents were unintelligible to him, and he had to be led up the garden path, led through the house, led into each room, and introduced to each chair.

Analyzing the Reading

1. How did Virgil become blind?
2. Why didn't Virgil realize what he was seeing after his sight was regained?
3. **Critical Thinking** What psychological difficulties do you think Virgil encountered after regaining his sight?