**Chapter 5**

**Objective 1**| **Contrast sensation and perception, and explain the difference between bottom-up and top-down processing.**

*Sensation*is the process by which our sensory receptors and, nervous system receive and represent stimulus energies from our environment. *Perception*is the process by which we organize and interpret this information. Although we view sensation and perception separately to analyze and discuss them, they are actually parts of one continuous process. *Bottom-up processing*is sensory analysis that begins at the entry level, with information flowing from the sensory receptors to the brain. *Top-down processing*is analysis that begins with the brain and flows down, filtering information through our experience and expectations to produce perceptions.

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**Objective 2**| **Distinguish between absolute and difference thresholds, and discuss whether we can sense stimuli below our absolute thresholds and be influenced by them.**

Each species comes equipped with sensitivities that enable it to survive and thrive. *Psychophysics*is the study of the relationships between the physical characteristics of stimuli and our psychological experience of them. Our *absolute threshold*for any stimulus is the minimum stimulation necessary for us to be consciously aware of it 50percent of the time. Signal detection theory demonstrates that individual absolute thresholds vary, depending on the strength of the signal and also on our experience, expectations, motivation, and alertness. Our *difference threshold*(also called *just noticeable difference*or *jnd*) is the barely noticeable difference we discern between two stimuli 50 percent of the time. As Weber’s law states, to be perceptibly different, two stimuli must differ by a constant proportion (such as a 2 percent difference in weight), not a constant amount, of the original stimulus. The priming effect and other experiments reveal that we*can*process some information from stimuli below our absolute threshold for conscious awareness. But the restricted conditions under which it occurs would not enable unscrupulous opportunists to exploit us with subliminal messages

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**Objective 3**| **Describe sensory adaptation, and explain how we benefit from being unaware of unchanging stimuli.***Sensory adaptation*is our diminished sensitivity to constant or routine odors, sounds, and touches. We benefit from this phenomenon because it focuses our attention on informative changes in stimulation, rather than on unchanging elements in our environment.

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**Objective 4**| **Define *transduction,*and specify the form of energy our visual system converts into the neural messages our brain can interpret.***Transduction*is the process by which our sensory systems encode stimulus energy as neural messages the brain can interpret. In vision, we convert light energy into these neural impulses. The energies we experience as visible light are a thin slice from the broad spectrum of electromagnetic radiation. The hue and brightness we perceive in a light depend on the wavelength and intensity. Pages: 204-205

**Objective 5**| **Describe the major structures of the eye, and explain how they guide an incoming ray of light toward the eye’s receptor cells.**Light enters the eye through the cornea, a protective covering that bends the light ray. The iris, a ring of muscle, controls the size of the pupil, through which light enters. The lens changes shape to focus light rays on the retina, the inner surface of the eye, where receptor cells convert the light energy into neural impulses. After coding in the retina, the impulses travel along the optic nerve to the brain. Although the retina receives an upside-down image, the brain constructs the impulses it receives into an upright-seeming image. Distortions in the eye’s shape can affect the sharpness of vision.

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**Objective 6**| **Contrast the two types of receptor cells in the retina, and describe the retina’s reaction to light.** The two types of receptors in the retina are the rods and the cones, and they differ in their shape, number, function, location, and links to the brain. When light enters the eye, it triggers a photochemical reaction in the rods and cones, which in turn activates bipolar cells. The bipolar cells activate ganglion cells, and their axons (combined to form the optic nerve) transmit information (via the thalamus) to the visual cortex in the brain’s occipital region. The more numerous rods, located mainly around the periphery of the retina, are more sensitive to light. Multiple rods send combined messages to a bipolar cell, and this pool of information lets us see rough images in dim light. Cones, concentrated in the fovea (at the center of the retina), are sensitive to color and detail. A cone may link directly to a single bipolar cell, and this direct line to the brain preserves fine details in the cone’s message.

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**Objective 7**| **Discuss the different levels of processing of visual information traveling from the eye’s retina to the brain’s cortex.** Perceptions arise from the interaction of many neuron systems, each performing a simple task. Processing begins in the retina’s multiple neural layers, and then the retina’s 6 million cones and 120 million rods relay their information via bipolar cells to ganglion cells. Impulses travel along the ganglion cells’ axons, which form the optic nerve, to the thalamus, and on to the visual cortex. In the visual cortex, feature detectors respond to specific features of the visual stimulus. Higher-levels upper cells integrate this pool of data for processing in other cortical areas. As sensory input passes through multiple levels of processing, it is influenced by our assumptions, interests, and expectations.

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**Objective 8**| **Define *parallel processing,*and discuss its role in visual information processing.***Parallel processing*is the brain’s natural mode of information processing, in which it handles many aspects of a problem simultaneously. This multitasking ability lets the brain distribute sub dimensions of vision (color, movement, depth, and form) to separate neural teams that work separately and simultaneously. Other neural teams collaborate in integrating the results, comparing them with stored information, and enabling perceptions.

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 **Objective 9**| **Explain how the Young-Helmholtz and opponent process theories help us understand color vision.** The *Young-Helmholtz trichromatic (three-color) theory*proposed that the retina contains three types of color receptors. Contemporary research has found three types of cones, each most sensitive to the wavelengths of one of the three primary colors of light (red, green, or blue). Hering’s *opponent-process theory*proposed two additional color processes (red-versus-green and blue-versus-yellow) plus a third black-versus-white process. Contemporary research has confirmed that, en route to the brain, neurons in the retina and the thalamus code the color-related information from the cones into pairs of opponent colors, as demonstrated by afterimages. These two theories, and the research supporting them, show that color processing occurs in two stages.

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**Objective 10**| **Explain the importance of color constancy.** Color constancy is our ability to perceive consistent color in objects, even though the lighting and wavelengths shift. This phenomenon demonstrates that our brains construct our experience of the color of an object through comparisons with other surrounding objects.

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**Objective 11**| **Describe the pressure waves we experience as sound.**Sound waves are bands of compressed and expanded air. Our ears detect these changes in air pressure and transform them into neural impulses, which the brain decodes as sound. Sound waves vary in frequency and amplitude, which we perceive as differences in pitch and loudness.

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**Objective 12**| **Describe the three regions of the ear, and outline the series of events that triggers the electrical impulses sent to the brain.**The outer ear is the visible portion of the ear. The middle ear is the chamber between the eardrum and cochlea. The inner ear consists of the cochlea, semicircular canals, and vestibular sacs. Through a mechanical chain of events, sound waves traveling through the auditory canal cause minuscule vibrations in the eardrum. The bones of the middle ear amplify the vibrations and relay them to the fluid-filled cochlea. Rippling of the basilar membrane, caused by pressure changes in the cochlear fluid, causes movement of the tiny hair cells, triggering neural messages to be sent (via the thalamus) to the auditory cortex in the brain.

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**Objective 13**| **Contrast the place and frequency theories, and explain how they help us to understand pitch perception.***Place theory*proposes that our brain interprets a particular pitch by decoding the location (thus, “place”) where a sound wave has stimulated the cochlea’s basilar membrane. *Frequency theory*proposes that the brain deciphers the number and rate (thus “frequency”) of the pulses traveling up the auditory nerve to the brain. Research supports both theories, but for different ranges. Place theory cannot explain how we hear low-pitched sounds (which cannot be localized on the basilar membrane), but it can explain our sensation of high pitched sounds. Frequency theory cannot explain how we hear high-pitched sounds (individual neurons cannot fire fast enough to produce the necessary number of surges), but it can explain our sensation of low-pitched sounds. Some combination of the two explains how we hear sounds in the middle range.

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**Objective 14**| **Describe how we pinpoint sounds.** Sound waves strike one ear sooner and more intensely than the other. Using parallel processing, the brain analyzes the minute differences in the sounds received by the two ears and computes the source of the sound.

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**Objective 15**| **Contrast the two types of hearing loss, and describe some of their causes.***Conduction hearing loss results*from damage to the mechanical system that transmits sound waves to the cochlea. *Sensorineural hearing loss*(or nerve deafness) results from damage to the cochlea’s hair cells or their associated nerves. Diseases and accidents can cause these problems, but age-related disorders and prolonged exposure to loud noise are more common causes of hearing loss, especially of nerve deafness.

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**Objective 16**| **Describe how cochlear implants function, and explain why Deaf culture advocates object to these devices.** Cochlear implants are wired into various sites on the auditory nerve, allowing them to transmit electrical impulses to the brain. These devices can help deaf children to hear some sounds and to learn to use spoken language. But cochlear implants are most effective when children are very young, which means that parents must make this decision for their deaf children. Deaf culture advocates believe the operation is unnecessary since they do not see deafness as a disability—Deaf people already have a complete language, sign. Some further argue that sensory compensation, which enhances other senses, gives deaf people advantages that the hearing does not have.

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**Objective 17**| **Describe the sense of touch.** Our sense of touch is actually four senses—*pressure, warmth, cold,*and *pain*—that combine to produce other sensations, such as “hot.” Of these, only pressure has specialized receptors.

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**Objective 18**| **State the purpose of pain, and describe the biopsychosocial perspective on pain.** Pain is an alarm system that draws our attention to some physical problem. One theory of pain is that a “gate” in the spinal cord either opens to permit pain signals traveling up small nerve fibers to reach the brain, or closes to prevent their passage. The biopsychosocial perspective views a person’s experience of pain as the sum of three sets of forces: biological influences, such as nerve fibers sending messages to the brain; psychological influences, such as the situation and our past experiences; and social-cultural influences, such as cultural expectations and the presence of observers. Treatments to control pain often combine physiological and psychological elements.

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**Objective19**| **Describe the sense of taste, and explain the principle of sensory interaction.** Taste, a chemical sense, is a composite of five basic sensations—*sweet, sour, salty, bitter,*and *umami*—and of the aromas that interact with information from the taste buds. Taste buds on the top and sides of the tongue and in tieback and on the roof of the mouth contain taste receptor cells. These cells send information to an area of the temporal lobe near the area where olfactory information is received. The influence of smell on our sense of taste is an example of sensory interaction, the ability of one sense to influence another.

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**Objective 20**| **Describe the sense of smell, and explain why specific odors so easily trigger memories.** Smell is a chemical sense, but there are no basic sensations for smell, as there are for touch and taste. Unlike the retina’s receptor cells that sense color by breaking it into component parts, the 5 million olfactory receptor cells, with their approximately 350 different receptor proteins, recognize individual odor molecules. The receptor cells send messages to the brain’s olfactory bulb, then to the temporal lobe and to parts of the limbic system. Some odors trigger combination of receptors. An odor’s ability to spontaneously evoke memories and feelings is due in part to the close connections between brain areas that process smell and those involved in memory storage.

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**Objective 21**| **Distinguish between kinesthesis and the vestibular sense.**By means of millions of position and motion sensors all over our body, our *kinesthetic*sense monitors the position and movement of our individual body parts. Our vestibular sense relies on semicircular canals and vestibular sacs in the inner ear to sense our head’s—and thus our whole body’s—position and movement, letting us maintain our balance.

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