- SENSATION AND PERCEPTION

YOU KNOW YOU HAVE MASTERED THE MAIN TOPICS IN THIS CHAPTER IF YOU ARE ABLE TO. . .

- ∞ Define sensation and introduce some of the key concepts developed by researchers in the study of sensation.
- ∞ Explain in detail how our sense of sight and our sense of hearing work and discuss some causes for impairments in these senses.
- ∞ Discuss the chemical senses of taste and smell and the lesser known somesthetic senses of touch, body position, and balance.
- ∞ Describe our experience of perception, especially in relation to visual stimuli.

RAPID REVIEW

Sensation allows us to receive information from the world around us. **Synesthesia** is the rare condition in which a person experiences more than one sensation from a single stimulus, for example the person who can hear and see a sound. Outside stimuli (such as the sound of your mother's voice) activate **sensory receptors** which convert the outside stimulus into a message that our nervous system can understand – electrical and chemical signals. The process of converting the outside stimulus into the electrical-chemical signal of the nervous system is called sensory **transduction**. The sensory receptors are specialized forms of neurons and make up part of our somatic nervous system. Ernst Weber and Gustav Fechner were two pioneers in the study of sensory thresholds. Weber studied the smallest difference between two stimuli that a person could detect 50 percent of the time. He called this difference a **just noticeable difference (jnd)** and he discovered that the jnd is always a constant. For instance, if a person needs to add 5 percent more weight to notice the difference in the heaviness of a package, then this person's jnd is 5 percent. If the initial weight of the package is 10 lbs, then 0.5 lbs would need to be added to detect a difference (5 percent of 10 lb = 0.5lb). If the initial weight is 100 lbs than 5 lbs would need to be added in order for the person to detect a difference in weight (5 percent of 100 lb = 5 lb). The fact that the jnd is always a constant is known as Weber's law. Fechner investigated the lowest level of a stimulus that a person could detect 50 percent of the time. He called this level the **absolute threshold**. **Habituation** and **sensory adaptation** are two methods our body uses to ignore unchanging information. Habituation takes place when the lower centers of the brain prevent conscious attention to a constant stimulus, such as the humming of a desktop computer. Sensory adaptation occurs in the sensory receptors themselves when the receptors stop responding to a constant stimulus, such as the feeling of your shirt on your skin.

The visual sensory system is activated by light waves. There are three psychological aspects to our experience of light. **Brightness** is determined by the height, or amplitude, of the wave. **Color**, or hue, is determined by the length of the light wave, and **saturation**, or purity, is determined by the mixture of wavelengths of varying heights and lengths. Light enters your eye through the cornea which protects your eye and helps to focus the light, and then travels through a hole in your iris, called your pupil. The iris is a group of muscles that control the size of the pupil. The light then passes through the lens which focuses the light and allows you to focus on objects that are close or far away. This process is known as **visual accommodation**. The light then travels through the vitreous humor in the middle of your eyeball to reach the **retina** at the very back of your eye. The retina is the size of a postage stamp and contains the sensory receptor neurons that convert the incoming light waves in to an electrical-chemical signal that the nervous system can understand. Your eye contains two types of sensory receptors, **rods** and **cones**. About 70 percent of the sensory receptors in your eyes are rods. Rods detect the brightness of light and send information about the levels of black, white, and shades of gray. The rods are located over the entire retina except at the very center. Rods are extremely sensitive to light but produce images with low acuity, or sharpness. Our eyes' ability to adapt to a dark room and eventually see objects is mediated by the rods in our eyes and is called **dark adaptation**. Cones make up the remaining 30 percent of the sensory receptors in your eyes and are located mainly in the center of the retina. Cones transmit information about color and produce images with very high acuity. Our ability to quickly adapt when we enter a bright room is called **light adaptation** and is accomplished by the cones. The place where the information from the rods and cones leaves the eye is called the **blind spot** because there are no visual receptors there to receive information.

The exact method the cones use to transmit information about color is still unknown. Two theories are currently proposed. The **trichromatic theory** was originally proposed by Thomas Young and later modified by Hermann Helmholtz. The theory suggests that there are three types of cones, red, green, and blue, that combine to produce sensation of color much like three spotlights would combine to produce the full spectrum of colors. The trichromatic theory most likely is an accurate description of the cones but cannot explain certain visual phenomena such as the **afterimage**. The afterimage is the image you see after staring at something and then looking away. For example, stare at something red, then look away and you see a green afterimage. A different theory of color perception known as the **opponent-process theory** was developed to explain phenomena such as the afterimage. The theory states that cones are arranged in pairs with a red-green pair and a blue-yellow pair. In one member of the pair is firing, then the other member cannot. When you stare at something red, the red member sends information and the green member is inhibited. When you look away, the green member is no longer inhibited and sends information even though you are not looking at anything green. Both the trichromatic theory and the opponent-process theory are probably correct. The trichromatic theory most likely explains the actions of cones in the retina, while the opponent-process theory explains the actions higher up in the visual system in the thalamus of the brain.

After light is converted to an electrical-chemical signal by the rods and cones, the message travels out of the eye through the optic nerve, crosses over at the optic chiasm, enters the medulla and then the thalamus. From the thalamus the signal is sent to the occipital lobes, when if you recall from the previous chapter, are responsible for processing visual information. Color blindness is caused by defective cones in the retina and can be one of three types.

Our sense of hearing, the auditory system, is activated by the vibrations of molecules in the air that surrounds us. These vibrations are called sound waves, and like light waves, we respond to three features of sound waves. **Pitch** corresponds to the frequency of the wave, **volume** is determined by the amplitude of the wave, and **timbre** relates to the purity of the wavelengths. Humans can only respond to wavelengths of a certain frequency. The average range for humans is between 20 and 20,000 **Hertz** (Hz) or waves per second. Sound waves enter our auditory system through the **pinna**, travel down the ear canal – also known as the **auditory canal**, and then vibrate the eardrum which causes the hammer, anvil, and stirrup to vibrate. The vibrations of the stirrup cause the oval window to move back and forth which causes the fluid in the **cochlea** to vibrate. The fluid causes the basilar membrane to vibrate which causes the organ of Corti to move up, and this causes the **hair cells** to bend. The hair cells are the sensory receptors of the auditory system, and the movement of the hair cells triggers an action potential in the axon. The axons travel to the brain in a bundle called the **auditory nerve**. A louder noise causes the hair cells to fire more action potentials.

There are three theories that explain how the brain receives information about pitch. **Place theory** states that pitch is determined by the place on the organ of Corti that is stimulated. The **frequency theory** suggests that the speed of vibrations of the basilar membrane determine the pitch heard by the person. The **volley principle** suggests that hair cells take turns firing in a process called volleying. All three theories are correct. Frequency theory holds true for wavelengths of 100 Hz or less, volley theory covers the wavelengths from 100 to 1000 Hz, and place theory seems to account for the wavelengths faster than 1000 Hz. Hearing impairment is the term used to describe difficulties in hearing. Conduction hearing impairment occurs from damage to the eardrum or the bones of the middle ear. Nerve hearing impairment is caused by problems in the inner ear or in the auditory pathways and cortical areas of the brain. Ordinary hearing aids are designed to assist with conduction hearing impairment, whereas **cochlear implants** can be used to restore some hearing for people with nerve hearing impairment.

The sense of taste, or **gustation**, is activated by chemicals that dissolve in the mouth. The sensory receptors are receptor cells found within the **taste buds** that are located on the little bumps on the tongue, cheek, and roof of your mouth The little bumps that you can actually see with your eye are called papillae. Five basic tastes have been proposed; they are sweet, sour, salty, bitter, and umami. Umami is the newest taste and corresponds to a "brothy" taste like the taste from chicken soup.

The sense of smell, or **olfaction**, is also a chemical sense. Humans have about 10 million olfactory receptor cells located in a 1 square inch area at the top of the nasal passage. Olfactory receptor cells send their axons directly to the **olfactory bulbs** which are located right under the frontal lobes.

The sense of touch is actually composed of several sensations and is more accurately referred to as **somesthetic senses**. The three somesthetic senses are **skin**, **kinesthetic**, and **vestibular**. The skin contains at least six different types of sensory receptors and transmits information about touch, pressure, temperature, and pain. The currently accepted theory about pain is called **gate-control theory** and suggests that pain information is regulated by a number of factors in the brain and spinal cord. Two chemicals involved with pain messages are substance P and endorphins. Substance P transmits information about pain to the brain and spinal cord, while endorphins inhibit the transmission of signals of pain. The kinesthetic sense relays information about your body's sense of position in space. The information comes from sensory receptors called **proprioceptive receptors** located in your skin, joints, muscles, and tendons. Our sense of balance, or **vestibular sense**, is regulated by receptor cells in the otolith organs and the **semicircular canals**. Both structures are located near the cochlea of the inner ear. The otolith organs contain small crystals suspended in fluid. Movement causes the crystals to move and activates the sensory receptors. The semicircular canals are three fluid-filled cavities located in three different planes.

Perception is the interpretation of sensation and seems to follow some basic principles, although individual and cultural differences in perception have been recorded. One principle is that of perceptual constancy. We tend to view objects as the same **size**, **shape**, and **brightness** even if the sensations we are receiving from our sensory systems are not constant in size, shape, or brightness. An example of perceptual constancy is our perception of the size and shape of a door as it is opened and closed. Gestalt psychologists believe that when people are presented with visual information, they interpret the information according to certain expected patterns or rules. The patterns are called the Gestalt principles of perception, and they include the following seven rules: **figure-ground relationships**, **closure**, **similarity**, **continuity**, **contiguity**, **proximity**, and common region. The principle of figure-ground relationships can be illustrated by looking at **reversible figures**, which are visual illusions in which the figure and ground seem to switch back and forth.

Visual perception of depth, called **depth perception**, appears to be present at a very early age. Visual cues for depth that require the use of one eye are referred to as **monocular cues** and include **linear perspective**, **relative size**, **overlap** or interposition, **aerial perspective**, **texture gradient**, **motion parallax**, and **accommodation**. Visual cues that use two eyes are called **binocular cues** and include **convergence** and **binocular disparity**. An **illusion** is a perception that does not correspond to reality. Some famous visual illusions include the **Müller-Lyer illusion**, the moon illusion, and illusions of motion. In addition to cultural and individual differences, perceptions can be influenced by **perceptual sets** or expectancies. One example of perceptual expectancy is **top-down processing** and occurs when a person uses pre-existing knowledge to fit individual features into an organized whole. If there is no expectancy to help organize information, a person might use **bottom-up processing** to build a complete perception by making sense of the smaller features piece by piece.

Parapsychology is the field of psychology that studies phenomenon that fall outside the normal realm of psychology such as extrasensory perception or ESP.