Chapter: Sensation and Perception

Sensation and Perception

WHAT'S THE ANSWER?

Instructors in Driver Education advise their students to look twice in both directions before driving across an intersection. *Why?*

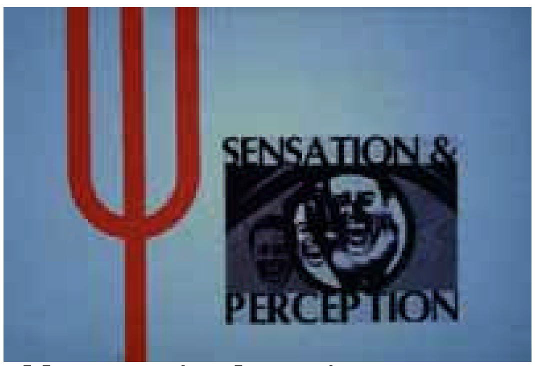
"Watch it, Klausman! Watch where you're going!. . . Well, would you look at that. He ran into the goal post!"

Moments later, "Klausman, how many times have I told you? You've got to look where you're going! What if that had been a defensive player from the opposing team? How do you feel?"

"I feel OK, coach, but I've got a bad ringing in my ears." *What causes the ringing in your ears that you may hear after bumping your head?*

How can ice skaters in a dancing routine make high-speed spinning turns without getting so dizzy that they lose their balance?

Some experimenters have reported frequent successes in transmitting images and thoughts between widely separated individuals. *Does extrasensory perception exist?*



Sensation and perception identify processes that differ primarily in their complexity. We have a greater number of senses than is widely believed. Psychophysics is the study of the relationship between physical events and our experience of those events. The absolute threshold is the smallest stimulus that arouses a sensation. The difference threshold is the smallest change in any stimulation that can be detected.

The stimulus for vision is light, which has three physical characteristics: wavelength, intensity, and pureness. The psychological attributes are hue, brightness, and saturation. Complementary colors, as well as other colors, may be mixed in an additive or subtractive process. The receptor for vision is the eye, which contains rods for black-white vision and cones for color vision. Vision is poorest at the blind spot and best at the fovea. Dark adaptation and the Purkinje Shift both result from the shift from cone- to rod-vision. Color blindness affects mainly males, but it is a relatively slight vision problem compared to blindness.

The physical stimulus for hearing is pressure waves, which have three physical characteristics: frequency, amplitude, and complexity. We hear sounds in terms of pitch, loudness, and timbre. The receptor for sound is the ear, within which hair cells in the cochlea stimulate the auditory nerve. Two major types of deafness include conduction deafness and nerve deafness.

The physical stimuli for the chemical senses are, for smell, gas and for taste, liquid. Several systems of "basic" smells have been proposed with varying degrees of success. The four basic tastes are sweet, sour, bitter, and salty. The receptor for smell is the nose, and the lock-and-key theory is the most successful attempt to explain how gases activate our sense of smell. The receptor for taste is the taste buds in the mouth. Specific patterns of taste-bud activity seem to be associated with specific tastes. The common cold shows the extent to which smell is the more important of the two chemical senses.

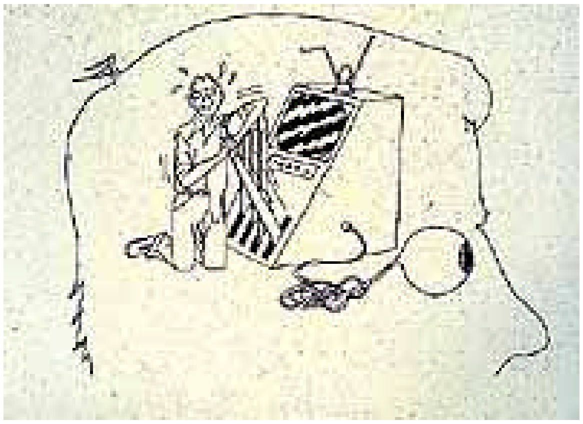
The physical stimuli for the skin senses are contact and temperature. They give us our sense of touch (or pressure), pain, hot, and cold. The physical stimuli for the vestibular sense are rotation and the position of the head. These give us our "sense of balance." Three semicircular canals and two otolith organs act as receptors. We sense our body position from receptors located in our muscles, tendons, and joints.

Perception is based on certain factors of organization, including the figure-ground relationship. Another factor is the wholeness of figures (determined by symmetry, closure, and familiarity). A third is the grouping of elements (based on proximity, similarity, continuation, and common fate). Three other factors importantly involved in perception include attention, variations in stimulus input, and the constancies (shape, size, brightness, and color).

There are two important jobs in visual perception. One is judging distance or depth, which is based on stimuli and cues within the organism. The other is detecting motion, which is based on the order in which sensing cells fire and/or movement relative to the environment or another object. In perceiving sound, our ability to locate a sound source is based on onset time, relative loudness, and phase differences of the sound waves reaching each ear.

"Errors" in perception occur when the constancies fail. The resulting illusions are of four types -- straight-line, bisecting or orientation, compound straight-line, and figure. Such information can be applied in designing clothing to create specific impressions. Subliminal perception is feared more than is warranted. Extra-sensory perception remains controversial and is still lacking in hard scientific proof.

The Review Questions will help with mastery of the materials covered in this chapter. After reading the chapter you may be interested in trying some of the suggested ACTIVITIES. Further information about selected topics within this chapter is available in follow-up readings suggested in the INTERESTED IN MORE? section.



Sensation versus Perception

In the study of sensation and perception, one of the basic questions concerns how these two concepts relate to each other. Several years ago a nationally broadcast television show tried to clarify how humans respond to stimuli. The inside of the head was depicted as having a large television screen. On the screen were displayed all of the stimuli viewed by this human. Within the big head lived a much smaller person, who simply pulled levers to make the larger human respond. While this presentation explains nothing (who or what makes the little person respond?), it does point out three basic elements involved when humans react to their environment. The first is the stimulus -- both its physical characteristics (what it is) and its psychological attributes (how we react to it). The second is the receptor, which receives the stimulus and sets the reaction in motion. Finally, there is the human organism itself -- both its prior experiences and its current physiological state. These three elements -- stimulus, receptor, and organism -- combine to determine the ways in which we respond, as we see in the Figure.

A sensation occurs any time a stimulus activates one of your receptors. Perception occurs when you apply your experience to interpret sensations. In this chapter we discuss both our environmental stimuli and receptors as well as the more complex processes of perception.

The differences between sensation and perception are more a matter of convenience than importance. In fact, some deny such distinctions can be made. Perception is composed of sensations to which the brain reacts. But there is no clean separation of sensations and perceptions. In the eye there are cells which fire only if a stimulus is moving in a particular direction -- for instance, left to right. The same cell does not fire if an identical stimulus is moving right to left. In the very act of firing, this cell has already initiated the perception that the object is moving left to right. A single note from a guitar is a simple event. It can be called a sensation throughout the processes involved in receiving the note and communicating it into the brain. Within the brain, however, combining the notes of the theme and their rhythm so you can recognize a song you know is a much more complex process of perception. There is no clear line of separation as to when something is a sensation and when it is a perception. It's better to think of the two processes as occupying opposite ends of a continuum stretching from sensation to perception with a gray or fuzzy border separating the two processes.

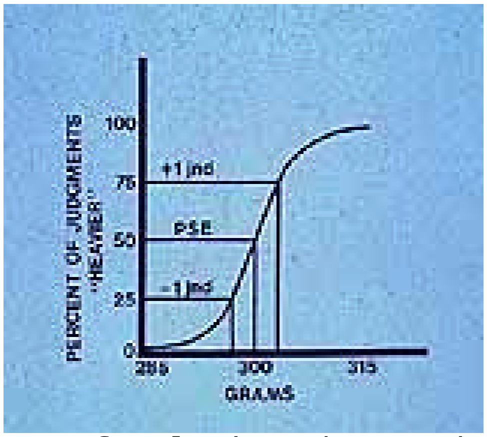
How many senses do we have? The answer depends on how you define a sense. If you do it in terms of different kinds of receptors, then we have about ten. These include vision, hearing, smell, taste, the skin senses (pressure, hot, cold, and pain), as well as balance and body sense, or kinesthesis. On the other hand, in terms of the stimuli to which we can react, there are about six senses, based on our sensitivity to light, sound, gas, liquids, solids, and body position and motion.

Psychophysics and Thresholds

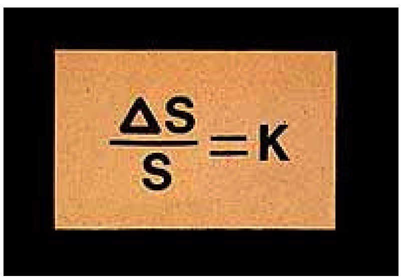
There is a fairly precise relation between what happens out in the physical world and the internal events to which we react -- the worlds of sensation and perception. But the relationship is not perfect. Psychophysics is the branch of psychology that studies the relations between physical events and the related psychological experiences. As we examine each of our senses, notice that we divide our discussion into two parts. We discuss the physical (real world) stimulus, such as light or gas or cold temperature. And we discuss the psychological experience, such as vision or smell or touch.

Look at the illustration for a moment. Now close your eyes and cross the index and middle fingers of your left hand like the hand shown. Rub a pencil or the index finger of your other hand back and forth through the notch formed by your two crossed fingers. What do you feel? Probably you feel as if two pencils or fingers are touching your left hand. You are not perceiving what is actually happening, so there is some "slippage" between real world events and your perception of them. This is one experience studied by psychophysicists.

The absolute threshold is the smallest amount of a stimulus that can be detected by an organism. Your "absolute" threshold may be different from mine. The partially deaf person's absolute threshold for sound is higher than either yours or mine. Thus, it's an absolute threshold in that it's the lowest amount of a stimulus that can be detected. However, it is neither an absolute threshold in the sense that it's the same for everyone, nor in the sense that it’s constant within any of us.



The just-noticeable-difference (or j.n.d.) is the amount by which any stimulus must be changed in order for that change to be detected. The difference threshold is the amount of the change necessary in order for the change to be detected half of the time. Weber's Law states that the greater the absolute amount of any stimulus, the larger the amount of relative change that will be required in that stimulus before an observer can detect it. The formula for Weber’s Law is (Delta S)/S = K, where Delta = change, S = stimulus magnitude and K = a constant. See Feature 1 for an example of how this works.



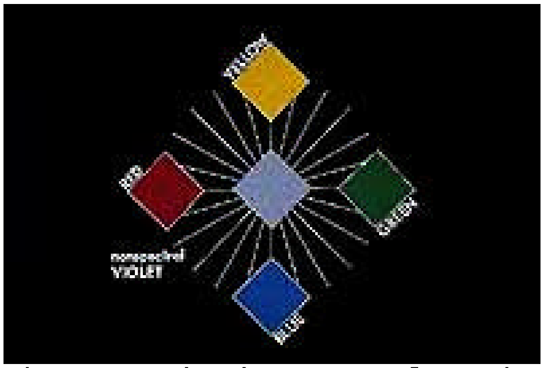
Feature 1

"I See the Light"

A psychologist named Weber was the first to observe that the size of the difference threshold depended on the level of stimulation at which that threshold was being measured. He found that as the level of stimulation increased, the size of the just-noticeable-difference also increased. In other words, the higher (or larger or louder) the stimulation, the more that stimulation must change before you can detect that change.

Using a 50-100-150 watt light bulb, it is very easy to demonstrate this concept. When you turn the bulb on to its lowest setting—50 watts—the increase from no light in even a semi-dark room is quite noticeable. As you switch from 50 to 100 watts, the light grows noticeably brighter. Now switch it once more from 100 to 150 watts. This third change involves the same increase in wattage (the physical stimulus) as the previous two changes, but it causes a much less obvious change in the apparent brightness of the light. Although the level of stimulation became equally greater with each increase, the same physical change (an increase of 50 watts) was perceived to be smaller as the base level of the bulb was brighter. There is not a 1:1

relationship between increases in physical stimulation and apparent or perceived increase in the accompanying psychological experience.



Vision

In studying the many processes of sensation and perception, the most widely studied and understood is vision. The physical stimulus for vision is light which stimulates the eye. Light from any source has three physical characteristics: wavelength, intensity (or amplitude), and pureness. These characteristics are seen by us as hue, brightness, and saturation (see Table 1).

Table 1

Light stimuli and how we experience them

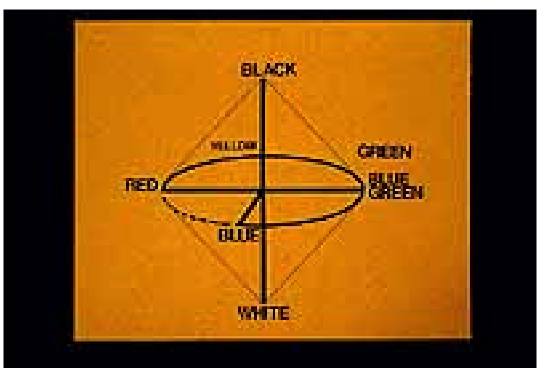
Physical Characteristic of Light Wave	**What We Perceive**
Wavelength	Hue (or color)
Intensity	Brightness
Pureness	Saturation

Changing any of the physical characteristics of light waves makes a difference in our experience of the light, and it alters the operation of the eye.

The source of most of our light -- the sun -- emits white light, which is a mixture of all light wavelengths. This can be demonstrated by passing sunlight through a prism, as seen in the Figure. A prism spreads light out into the colors of the visible spectrum, as illustrated. Hue identifies the perceived color of a particular wave. As wavelength changes, hue also changes.

As the intensity, amplitude, amount, or magnitude of a light wave increases, the result is an increase in perceived brightness. Thus, brightness is related to the amount of light present. The light meter, or photometer, in a camera measures the intensity of physical light waves entering the lens.

A totally saturated color is a pure light wave, but we don't see these very often. About as close to pure color as you see in the everyday world is the colors of a rainbow produced on a day of clear air. A pure red would have light waves of only one particular wavelength. An unsaturated light must be black, gray, or white. As you add white light to a pure color, the color becomes less saturated. If you mix all colors together, you recreate white light again. Saturation is also sometimes called purity. This refers to the extent to which a particular hue is mixed with white or other light. Hue, brightness, and saturation must all be mentioned to describe fully any light source. All three dimensions represented in the color solid can be seen in the illustration. Difficulties in perceiving color can lead to various problems with vision, ranging from relative mild color insensitivities to total color blindness and -- at the worst -- blindness.



The color solid, illustrated in the Figure, is used to determine what happens when colors are mixed. Two colors that are directly opposite one another on the color circle part of the solid are complementary colors. If they are mixed together, the result is gray.

We use the color solid only for predicting additive mixing of spectral colors. The hue depends on the light waves which are added together. (An additive mixture of several colors yields white.) If we were mixing paints -- which is a subtractive process, the results of our mixtures would be quite different. The pigment of paint absorbs almost all but one color of the spectrum -- as does colored glass. The subtractive mixture of several colors yields black.

USING PSYCHOLOGY: Color

An interesting application of the principles of sensation and perception involves their application to how we dress ourselves or decorate our environment. Colors as well as shapes and lines can play a vital role in projecting an image and creating a mood. Think of the many common expressions that recognize this fact: "seeing red," "green with envy," "feeling blue," "in a brown funk," "purple passion." Some colors are cool, such as blue. Yellow, orange, and red are warm colors. Green is the only color that looks cool in summer, warm in winter. Do you tend to wear brighter colors on a gloomy day? Of course, some colors are simply more becoming to you than others. Your own coloring will make a difference. Wearing blue can emphasize blue eyes. Wearing yellow can make a yellowish skin look sick. You can contrast clothing colors with your own colorations, or choose them to harmonize.

If you're going to wear two colors, it is best to wear two complementary colors, meaning colors directly across from each other on the color circle. If using three colors, use colors that are about 1200 apart from one another on the color circle. So as not to appear too "loud" or flamboyant as a dresser, use less saturated colors.

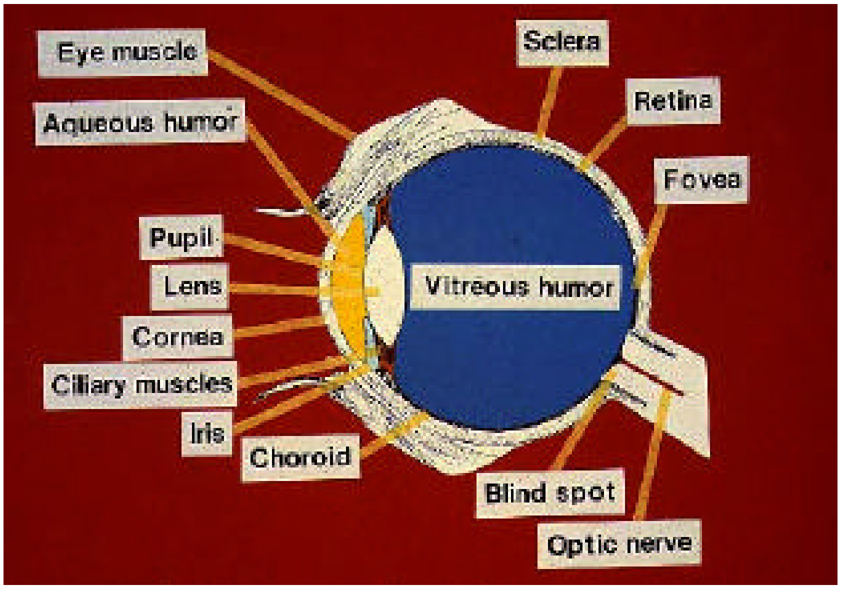
Blending in with the scenery can pose a safety hazard to humans: pea green slickers are best for visibility on rainy days. Snow skiers are safer not wearing white. Bicycle riders are advised to wear something white at night. (Of course, day-glo and fluorescent colors are helpful too.) You can extend the safety principle to your car as well. What colors would make it more visible in a fog, at night, or on a rainy day? The most visible? White!

Analogous color harmony uses colors that are next to one another on the color circle. If you choose these, you should stick to one primary color. Now that you have thought about the effects of color, you can experiment with them to see what works best for you.

Of course the lessons of dressing also apply to the choice of colors in fixing up your room or decorating in general. Again, apply the principles of perception to gain control over how your environment (and you) will be perceived.

Visual receptor: The eye

The receptor for visible light is the eye, diagrammed in the Figure below. The eye is in many ways similar to a camera, but it is much more complex. Light enters the eye through the pupil and is focused by the lens. The light falls on the retina, which is similar to the film in a camera. The retina is made up of two receptor elements, called rods and cones. Rods are more light-sensitive than cones, so they are used to see in poor light, especially at night. Cones are sensitive to color, but they demand more light to function. Rod vision is comparable to black-and-white television; cone vision is similar to color television.



The rods and cones connect with neurons that form the optic nerve, which relays visual information to the brain. The point at which these neurons exit from the eye is called the blind spot. It is a very small portion of the retina that has no receptor cells. Stimulation on the blind spot will not be received by the brain. Read the Think About It for an example of the effect of the blind spot in each of your eyes.

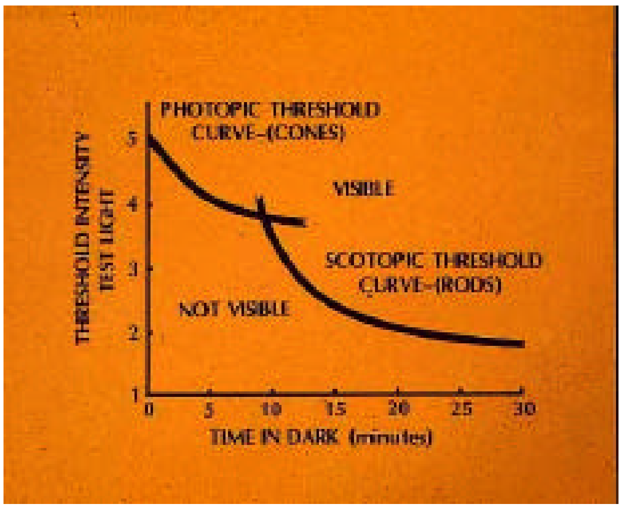
Think About It

The question: Instructors in driver education classes often advise their students to look twice in both directions before driving across an intersection. Why?

The answer: If you look to the right and to the left only once, it is possible that the image of a car coming from the right might fall on the blind spot of one eye. It might then be obscured from vision in the other eye by the right front roof support of your car. If the approaching car is moving fast enough to hit you, then looking again at the same spot will prevent an accident. This should allow enough time so that the image of that car would not fall on your blind spot both times. The figure shows the location of the blind spot that exists in each of your eyes.

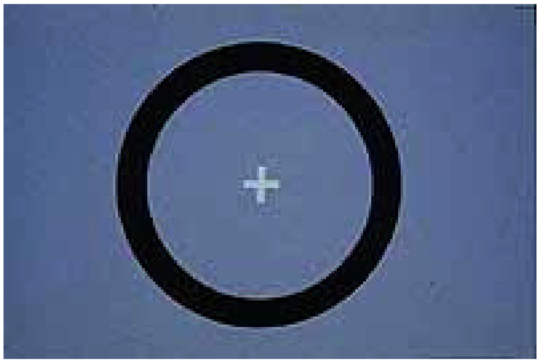
If you look at something, you cause the light rays from that object to fall on your fovea -- the focal point of your eyes. The fovea is the point of greatest concentration of cones on the retinal surface. At the edge of your visual field, images are sensed only by rods. Thus, color vision is best at your point of focus and absent at the edge.

Operation of the Eye



The difference between rod and cone vision can be shown by testing your absolute threshold for light after you walk from sunlight into a darkened room. We become more and more sensitive to dim flashes of light during the first 30 minutes after coming out of the daylight. This process is called dark-adaptation. It explains the kind of awkward experience we've all had in going into a movie theater during the daytime and trying to find a seat. Thirty minutes later, when we want some popcorn, it is no problem to see our way clearly from our seat to the aisle. During that time our eyes have adapted to the darkness, and the rods are now playing a much larger role.

The physical stimuli that are present at sunset are the same as those occurring at sunrise. Yet, if you were asked to paint a picture of a sunset, you would tend to use more purples and darker colors. To paint a sunrise you would be more likely to use reds and oranges and yellows. Why? Because each day as you shift (at sunset, as depicted in the Figure) from cone to rod vision, you switch to receptors (your rods) that are more reactive to dim light and the darker colors. This is called the Purkinje Shift. Having lived for many hours with light being interpreted by your cones, you suddenly must rely more on your rods. Rods are relatively more sensitive to colors at the purple and blue end of the color spectrum. As a result, you perceive a sunset as more bluish and purple.



There is yet another visual process you have also probably experienced. Look at the illustration on the left for 30 seconds, then shift your focus to the illustration on the right. This is a demonstration of negative afterimage.

Positive afterimages don't occur as frequently as negative afterimages. The best example can be achieved if you'll get up at 4 a.m. tomorrow morning. Stumble over to the bedroom light switch. Flash the room lights on and off again instantly. What will remain in your visual field is a positive afterimage. If you turn your head or eyes, the view of your room also turns. It results from overstimulating the rods and cones which are fully dark-adapted. It causes no harm, although you may have winced a bit when the lights went on!

Eye Problem: (Color) Blindness

As you know, there are many physical disabilities to which humans may be subjected. An interesting visual effect is that of color blindness, which can be assessed using a test such as depicted in the Figure. It afflicts about eight percent of the men in North America, but less than one percent of the women. A totally color-blind person sees the world only in blacks, grays, and whites, with no trace of color. However, such a person is very rare. Most people who are called "color-blind" are actually just deficient in their ability to see one or more colors.

Red-green color blindness is the most common type. Such people experience the world in terms of black, gray, white, blue, yellow, and any other hues that can be achieved by mixing two or more of these colors. (See the illustration.) Yellow-blue color blindness is a less common form. These people perceive the world in terms of black, gray, white, red, green, and mixtures of these colors. Typically, color-blind people otherwise see quite well.

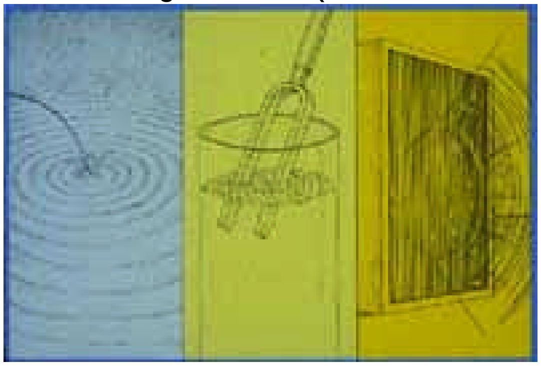
One disability -- the impact of which is only now beginning to be understood -- is that of total blindness. The problems created by blindness are basically two-fold.

First, it is now thought that perhaps 80 percent of all the information we learn is first taken in by means of our eyes. Although education and communication are not totally eliminated by blindness, they are made much more difficult. Learning to read Braille, the system of raised dots that serve as letters and numbers, is one way the blind can use touch to partially overcome their disability.

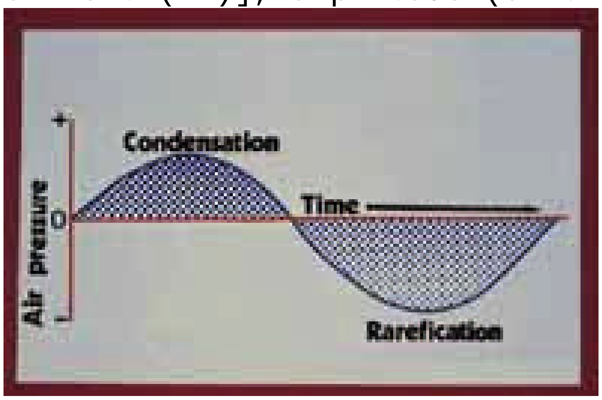
There are also the problems of navigation and locomotion. For ease in getting around and solving the problems of education and locomotion, a good and well-trained sense of hearing can also help compensate for deficits in vision.

Hearing

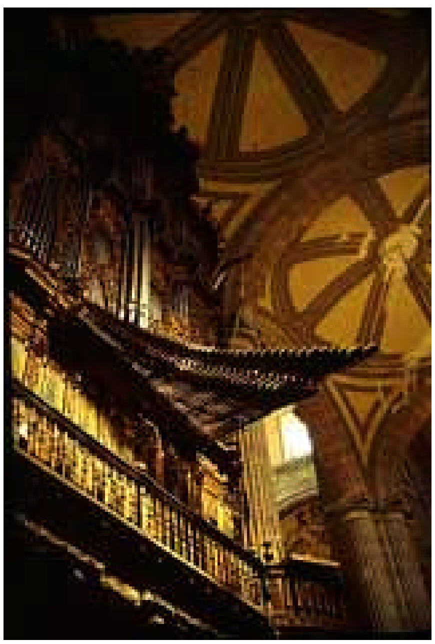
Assuming normal operation of the ear, sound will be detected any time three factors are present: First, there must be a vibrating source, or stimulus. Second, there must be a medium -- gaseous (as it usually is, like air), liquid, or solid -- for transmitting pressure waves from that source. (Remember the old cowboys-and-native-Americans trick of placing an ear on the rail to find out from many miles away whether or not a train is approaching?) Finally, third, there must be a receptor present.



The physical stimulus for sound, then, is usually airborne pressure waves. These vibrating waves of pressure are known as sound waves. Such changes in pressure are caused by the vibrations back and forth of the sound source itself. As is true of light waves, there are three ways in which sound waves may differ. They may differ in frequency [or cycles per second or hertz(Hz)], amplitude (or the amount of energy pushing the waves), and complexity (or the number of simple frequencies that are represented in a complex wave). To describe a sound source you would need to specify all three factors.



These physical qualities of sound are perceived by us as pitch, loudness, and timbre, as shown in Table 2



As sound waves increase in frequency, the pitch that you hear also increases. As the amplitude of a sound wave increases, so does the perceived loudness of that sound. Many older radios have a "volume" control instead of a loudness control, but the control is incorrectly labeled. A low note on a church organ has a certain room-filling ability unmatched by any note from a piccolo. What differs between the organ and the piccolo is volume, not necessarily loudness.

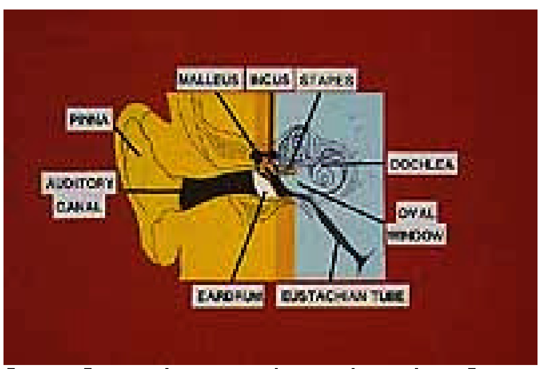
Timbre is essentially the complexity of a sound. Were you to pluck middle C on a guitar, the basic note would be the same as one played on a piano. But the various overtones (caused by vibrations of other parts of the instrument) would allow you quite easily to distinguish a piano from a guitar. Too many tones and overtones all heard at once may sound like noise, as described in Feature 6.4 when we discuss Hearing Perception. At the other extreme, deafness represents an inability to detect sound at all.

Table 2

Sound stimuli and how we experience them

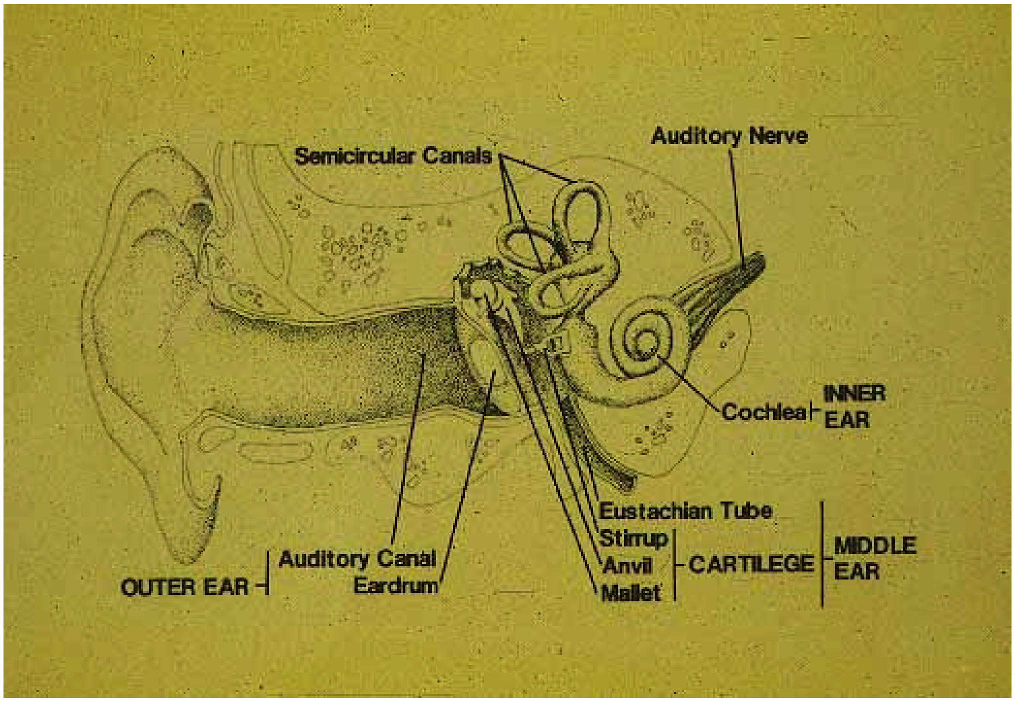
Physical Characteristic of Sound Wave	What We Perceive
Wavelength (frequency of vibration)	Pitch (bass sounds to squeaks)
Intensity (amplitude)	Loudness (not the same as volume)
Pureness	Timbre (complexity, due to overtones)

Operation of the Ear

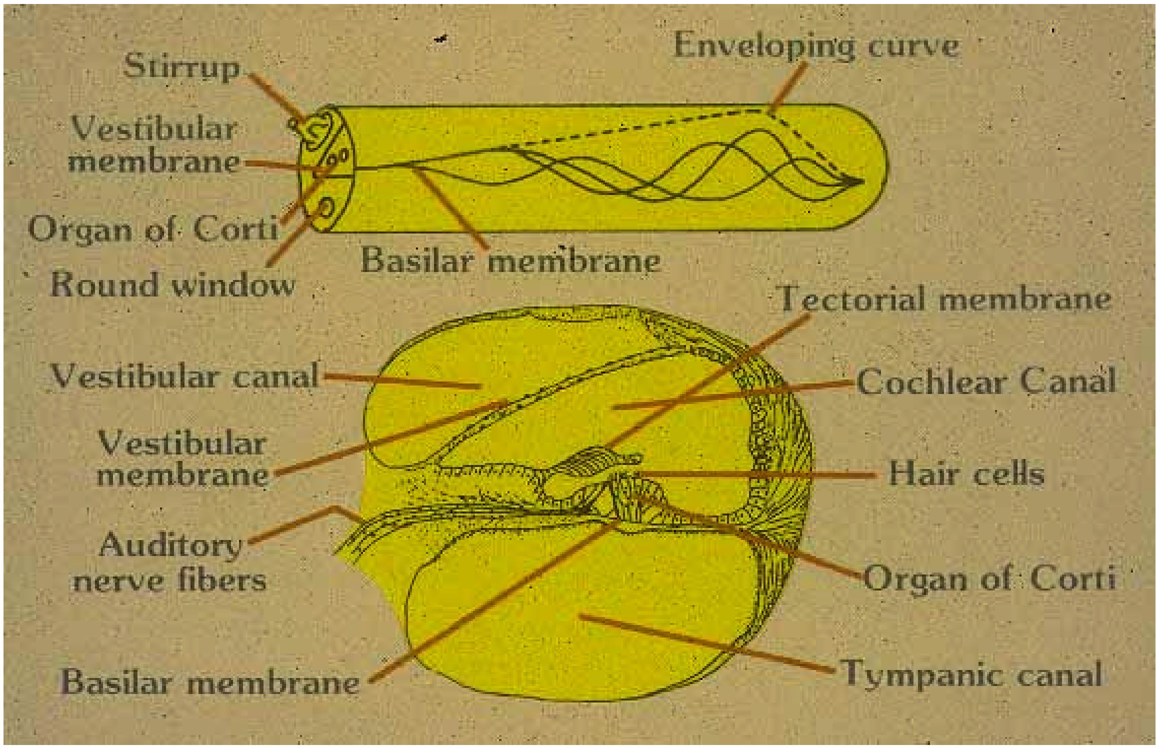


The stimulus for hearing changes its form several times before stimulating the auditory nerve. Examine the diagram of the human ear. Sound waves enter the auditory canal and cause movement of the eardrum. These two structures are called the outer ear. The eardrum changes vibrations of the air molecules into the physical movement of a solid, and the eardrum relays these vibrations to three bones that connect to it -- the malleus (or mallet), the incus (anvil) and the stapes (stirrup). The bones of the middle ear are arranged to reduce the power of the signal relayed by the eardrum and to increase the physical distance of the motion being relayed. A good analogy is to think of the mallet, anvil, and stirrup as being arranged like the seesaw you rode in elementary school. If you were riding with an 800-pound gorilla, your end of the seesaw would be very long; the gorilla's quite short. The gorilla (serving as our eardrum) would move very little; you au contraire would be flying great distances up and down representing the change achieved by the bones of the middle ear.

The middle ear is filled with air, but it's air tight, and that presents a problem. When you leave sea level and drive up into the mountains, you take sea level air with you. At some point your eardrums will “pop" as they invert from concave to convex. The pressure is released through the Eustachian tube which connects from your middle ear to the back of your throat. Each time you swallow, tubes open momentarily to reestablish equal pressure on both sides of your eardrum -- and it returns to normal.



The bones of the middle ear are connected to the cochlea which constitutes the inner ear, where the auditory nerve is stimulated. As can be seen in the drawing, the cochlea is a tightly coiled portion of the ear. It is liquid-filled, but projecting up into it are very tiny hair cells that may be stimulated by activity of the liquid within which they are set and the basilar membrane on which they are mounted. The movement of the basilar membrane causes the hair cells to be jammed against the tectorial membrane positioned just above the hair cells causing a shearing action on the hair cells. Bending these hair cells fires the auditory nerve. Physical movement is changed into an electro-chemical impulse. The implications of this are summarized in the Think About It. As you might expect, loudness is conveyed in the auditory nerve by the number and rate of neurons firing. As the number and rate of auditory nerve cells firing increase, perceived loudness increases. Different cells fire to reflect difference in frequency; the combination of cells firing determines to perceived timbre.



Think About It

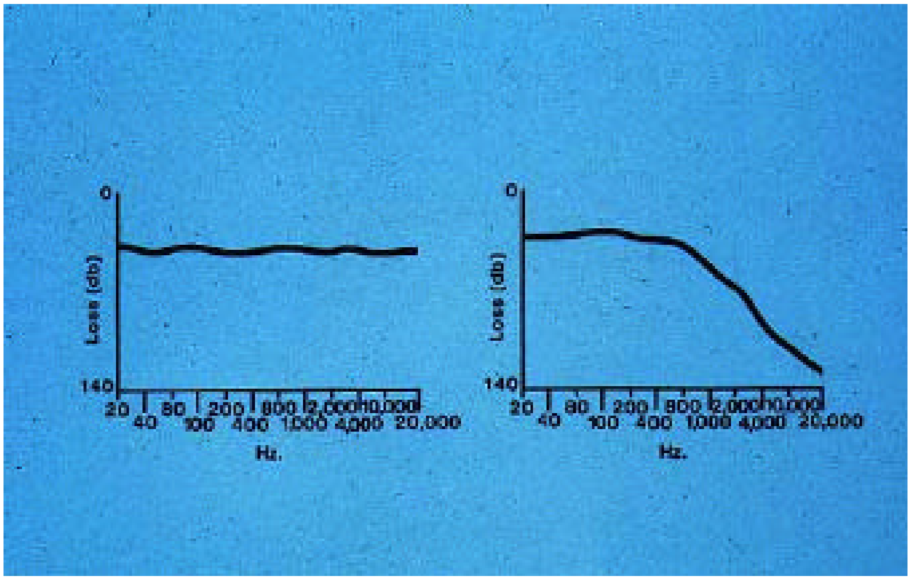
The question: What causes the ringing that you may hear just after bumping your head?

The answer: The process that changes physical sound waves into the psychological experience of sound is the movement or bending of the hair cells in your cochlea. A blow to your head will sometimes bend these hair cells. You will experience this as a sound or ringing sensation. As long as the hair cells are bent this way, you will continue to hear the "ringing" in your ears.

Ear Problem: Deafness

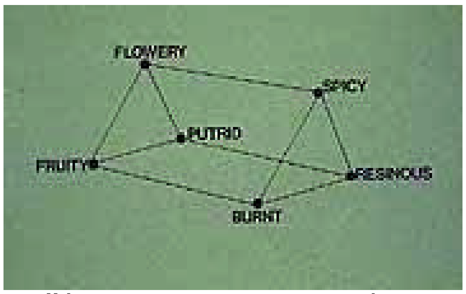
Deafness is second perhaps only to blindness in the difficulties which it may cause in sensing and perceiving our world. Obviously, much of the communication between people is verbal, not written (as we discuss in the Language and Communication Chapter). Until the invention of small, transistorized hearing aids, people with hearing problems were less well-off than those with visual problems.

Examination of the ear drawing suggests two means by which deafness may be caused. Sound impulses are transmitted mechanically from the auditory canal until they stimulate the hair cells. Interfering with any portion of this mechanical process causes conduction deafness. Such deafness decreases your sensitivity to tones of all frequencies.



The second means of conduction involves the hair cells and auditory nerve as well as parts of the central nervous system. Interference with, or deterioration of, the nerves causes nerve deafness. Nerve deafness usually hinders your perception of high-frequency sounds most, but it also somewhat reduces your sensitivity to low-frequency sounds.

Chemical Senses - Smell and Taste



Think for a moment what your nose may have to go through each morning. First you get up (and that is hard!), and if you're a male, there's pre-shave lotion to put on. Then, male or female, you soap your face (say, with a "hint of spring"). Next comes the mouth. There's toothpaste with a mint flavor, and, for good measure, mouthwash to keep your breath fresh. But, you're not finished yet. To that may be added hair spray or tonic and, perhaps, deodorant or cologne. By the time you're ready for breakfast, your nose can be exhausted!

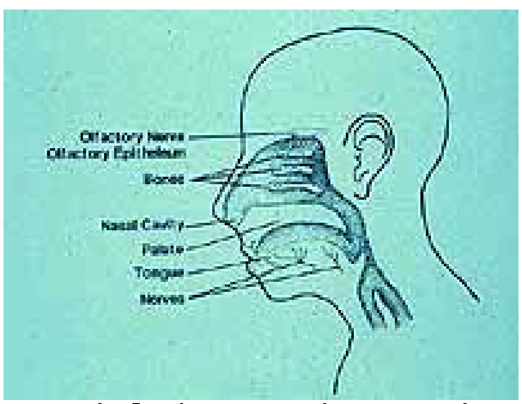
The physical stimulus for our sense of smell is gas. However, to be detected the gas must be soluble in liquid. Even the smell of a solid (such as your desk or your hand or any other nearby "solid" object) results from minute gaseous emissions from the object.

Efforts to identify a small number of basic smells from which others might be composed haven't been successful. Three different theories of "basic" psychological smells agree only on putrid, burnt, and fruity (or musky). There is no universally accepted list of basic psychological smells.

Whereas the receptors for smell react to substances in gaseous form, the receptors for taste react to substances in liquid form.

It is easier to identify tastes than smells. For taste there are four basic qualities: sweet, salty, sour, and bitter. The flavor of most of our food results from a combination of only three basic qualities -- bitter is not a significant contributor to most taste experiences. But, our sense of taste is nowhere near as varied and interesting as our sense of smell.

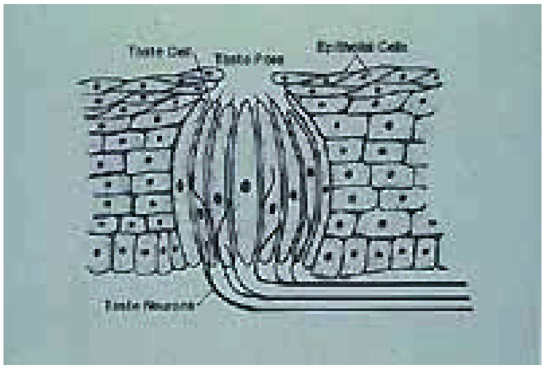
Chemical Senses Receptors: The Nose and Taste Buds



The diagram shows that the receptor site for the sense of smell is located on the roof of the nasal cavity. If you detect a new smell in your environment, your normal response is to "sniff." The differences in "sniffs" from one person to another make it very difficult to state definitely how much air has been swirled past the sensing surface. This, and the remote location of the olfactory epithelium, cause problems in studying the sense of smell.

If you hold your nose and breathe in gently through your mouth, even in a room where there is a pronounced odor, you will not detect it unless air spills into your nasal cavity from the rear. In addition, if you breathe normally and quietly through your nose, you will very quickly adapt to the smells in your environment.

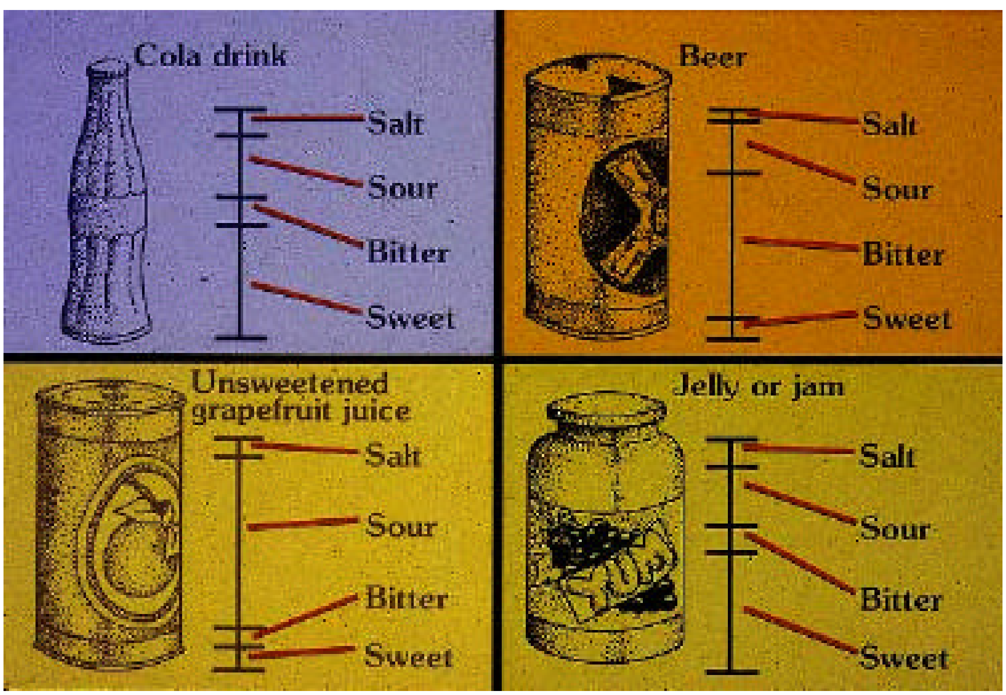
The receptors for your sense of taste are located on your tongue which is covered with a large number of bumps (called papillae). They are not the taste buds. The taste buds -- which, in cross-section, have a structure similar to an onion cut top to bottom -- are clusters of gustatory (or taste) cells.



The taste buds are located all over the inside of your mouth, concentrated on the papillae and located mostly on the surface and sides of your tongue, as illustrated in the Figure.

Operation of the Chemical Senses

There are two aspects of the sense of smell that are remarkable. One is the extreme sensitivity of the sense. You can detect as little as 7 parts per 10 billion of some musky aromas. Second, the sense of smell is also remarkable for its ability to detect specific but very small differences in chemical structure. Any theory of smell must be able to account for both of these abilities.



One of the most successful explanations of smell has come to be known as the lock-and-key-theory. It proposes that the shape, not the chemical structure, of gaseous molecules is important in detecting different odors. Much work remains to

Both your senses of balance and body position react to internal stimulation. They need no stimulation (other than gravity, acceleration, or deceleration) from the outside environment. The physical stimuli for your vestibular sense are changes in the rotary movement of your head, as well as its tilt or angle. Any change in the rate of movement produces the experience of rotation. For instance, swinging on a playground swing provides a constantly changing rate of movement. Rotation and the tilt of your head together provide the sense of balance you must have for correct posture, walking, and running.

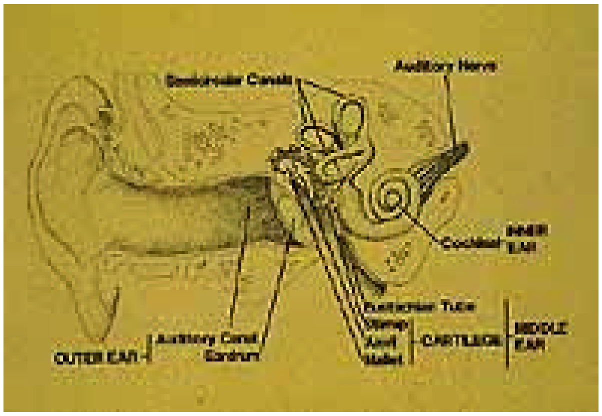
There are two receptors involved in the sense of balance. The first is a series of three semicircular canals filled with liquid and connected with the inner ear. (Refer back to the drawing.) They are positioned at right angles to one another and filled with a thick liquid. Projecting into the liquid are a large number of hair cells similar to those in the ear. Moving your head in any direction bends the hair cells because of the inertia of the liquid. Any change in rotation thus stimulates the hair cells and causes the feeling of acceleration, as discussed further in the Think About It.

Think About It

The question: How do ice skaters make high speed spinning turns in their dance routine without getting so dizzy they lose their balance?

The answer: The three semicircular canals are what give us our perception of movement. One of those canals is approximately horizontal to the surface of the earth. This canal, then, is most sensitive to left-right (turning) motions of the head. In a high speed spin, a professional tries to keep a fixed point in sight as long as possible. Then the skater spins his or her head around and fixates on that spot again while the body catches up and twists past the head again. Since the head is still most of the time, inertia keeps the fluid in the semicircular canal from spinning. When the skater stops, so does his/her perception of the world around him or her since the fluid is not moving.

In addition to the semicircular canals, there are two otolith organs. These react regardless of the position of your



head. Thus, the semicircular canals respond to changes in movement or rotation of the head, while the otoliths respond to static position. Together they allow you to maintain your balance.

There is one more sense -- body sense, or kinesthesia ("feeling of motion") -- which is described in Feature 6.2.

Feature 6.2

The Sixth Chapter Stretch

It is very easy to demonstrate your "body sense." Extend one arm out to its full length at shoulder height. With your index finger point out to your side. Look straight ahead and close your eyes. Now, without opening your eyes, touch the tip of your nose with the tip of the index finger by bending your now out-stretched arm. You should be fully able to do this even with your eyes shut. What you've just illustrated (if you didn't poke yourself in the eye) is your own kinesthetic sense. You can demonstrate that you know where your body is positioned even without looking.

We have at least four kinds of body-position sensors. Some are located in the muscles themselves. Others are on the tendons that anchor the various muscles, and in the joints where bone meets bone. They react to muscle movements and to changes in the angle of the bones in a joint. Because they are hard to reach, these sensors are not often studied.

Body sense is unusual because it operates "automatically." Without our knowing exactly how, it keeps us informed as to where our body is. In physical skills such as driver-training we benefit from our kinesthetic sense.

Perception

At this point we've examined briefly some of the many pieces of sensory equipment that keep us "in touch" with our environment. But these senses are really only equipment. Much more interesting are the processes -- the perceiving and misperceiving -- by which we interpret the incoming messages.

In our study of stimuli and receptors we touch upon some of the resulting experiences. When we focus directly on those experiences, you should keep two points in mind. First, we never perceive things exactly as they exist in the real world. For example, war veterans with amputated limbs sometimes report "feelings" in the part of an arm or leg that has been amputated -- an experience called the “phantom limb phenomenon." The messages to which they are reacting are coming from nerve endings -- perhaps at the site of the amputation, or from the sensory nerve connecting the site to the brain, or even from within the brain itself. These signals are perceived as if they were coming from the missing limb. This is an extreme example of how the real and the perceived are not the same.

Second, we will now be dealing with internal processes. They are much more complex than the mere act of reacting to (that is, "sensing") an incoming stimulus. If you cut your finger, your finger aches, not your brain. You don't experience a series of sounds, pressures, and colors, you interpret them -- automatically -- to give them meaning. A mass of confusing stimuli becomes, say, a game-winning home run.

Perception, then, involves your reaction to incoming stimuli. It also involves your awareness of your reactions. Most simply, perception is your ongoing experience, based on how you interpret incoming messages from your various senses. We examine mainly effects in visual perception, because these are the most fully studied. But, in all perception, past experience usually operates, as well as certain principles of organization.

Figure-ground Perception

Look at the illustration. What do you see? You may perceive two faces looking at one another, or it may look like a single vase. But you can't see both at once. This illustrates perhaps the most basic perceptual effect: one thing must be "figure," the other must be background, or "ground." The figure (either one) seems to have a shape. It seems more substantial, more like an object. It tends to seem nearer and more dominant. By contrast, the ground seems more formless. It seems to extend behind the figure, and is sensed as somewhat further away. The ground is sometimes less easy to remember. Its border is difficult to describe.

The principle operating here is related most directly to visual experiences, but it applies to other senses as well. A parent can hear the sound of his or her baby's cry over the chatter of guests. The cry becomes the figure, the party sounds become the ground. When someone you love touches your arm -- especially if it’s a new love, or the other half of a very intense relationship -- the touch becomes figure and (seemingly) everything else becomes background.

And what must become figure can occupy varying proportions of your total processing capacity. When you’re driving in easy situations and talking with a friend in the car, the conversation is the figure, your general environment is the ground. Yet, if the lane narrows or someone starts to step out in front of your car, that event becomes the figure and -- in complex situations -- the conversation ceases. Talking while driving can easily be achieved, but negotiating through tight or dangerous situations requires more active processing which leaves less capacity for simultaneously maintaining a conversation.

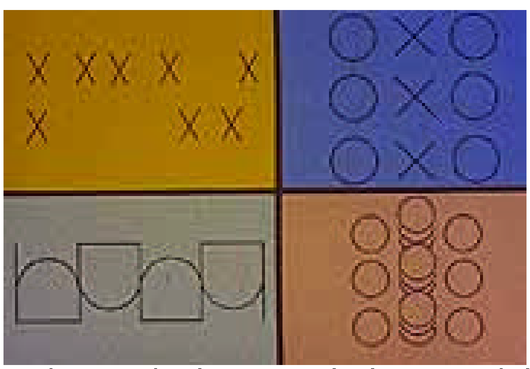
The Wholeness of Figures

How do we perceive our world? A number of factors combine to determine how we decide what is a "good" figure, or an acceptable whole. Among these is the figure's symmetry. In Chapter on Remembering we learn that the symmetry of a figure influences both how and how well we may remember it.

A second factor which impacts our perception is closure. The illustration shows you a variety of figures. Can you see the circle? The square? The triangle? If you'll look again, you'll see that by the traditional definitions no circle, square, or triangle is shown. None of the forms is a completely enclosed figure. Your own brain has closed in the figures to "neaten them up.

Finally, we tend to see as a figure those forms with which we are most familiar. You can pick out the alphabetical letters in the drawing even though the other lines are more dominant. All of these factors -- symmetry, closure, and familiarity -- operate to determine how we will perceive a figure.

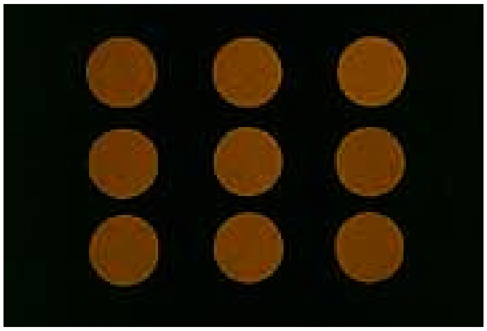
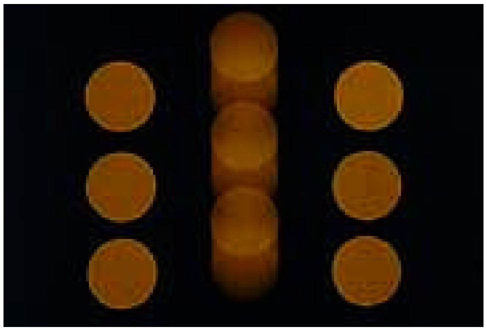
Perceptual Grouping



In many of our senses, how we will combine individual stimuli to achieve a perception can be predicted in terms of the laws of grouping, illustrated in the Figure.

Objects that are close together tend to be grouped together. We tend to arrange them into familiar patterns based on their proximity. Objects that look or feel alike will also be grouped together. As long as there is an obvious basis of similarity, we see them as part of the same pattern.

There is a another cue we use which you might have predicted, based on the other laws of grouping. In breaking down any complex form into its parts, you tend to group together those parts or lines or elements that seem to make the best "whole." The art of camouflage is simply applying this principle to allow an alien object to blend into its surroundings as much as possible; the likelihood this occurs is based on increasing the object's logical continuity with the other elements in its neighborhood. Good continuation increases the likelihood that a camouflaged object will not be detected.

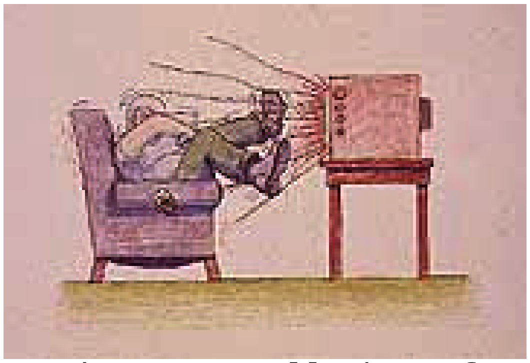
In any scene, all parts that have similar or common motion will tend to be grouped together. A frequent defense of animals is to "freeze" in the presence of predators. What happens when a camouflaged animal moves? It becomes easy to detect where it is located because all of the parts of its body are experiencing a common fate.

These principles of grouping operate in situations where your attention is drawn to an event or object. Similarly, stimulus variation increases our ability to perceive events in our environment, and we base those perceptions on a variety of constancies in terms of which we perceive our world.

Perception and Attention

Attention is our ability to focus on certain aspects of our immediate, ongoing experience while we ignore other aspects of it. Attention is crucial if we are to isolate what we want to perceive from the vast array of stimuli to which we might attend. At a party, what happens if someone mentions your name? You will manage to hear that conversation even though it may be occurring in a group other than the one in which you are standing. If you look out through a screen door, you ignore the screen to attend to the objects and events beyond.

Advertising provides some good examples of the principles of attention-getting. So do the activities you go through in trying to find a date for Friday night. Three groups of factors influence your attention: aspects of the stimulus itself, aspects of you as a perceiver, and interactions between specific stimuli and your unique experiences and interests. Let's review each factor.



First, altering the stimulus offers an obvious means to attract attention. The intensity or size of an advertisement influences whether you will notice it. Likewise, movement and repetition also attract attention. Finally, contrast will catch your interest. Advertisers use all these factors in calling attention to their products, and they have specific control of all these features of the stimulus itself.

Second, you have personal attitudes and ideas that will help determine what aspects of the environment you will notice. Set is an adjustment that you make, often without being aware of it. Your past experience prepares you to respond in a particular way. Look at the Figure. How long did it take you to find out what was wrong there? You didn't see anything wrong? Look again. Within the triangle it says "Now is the time"! Another example of set or expectancy combined with camouflage is illustrated in the other Figure.

Your prior experience leads you to expect to see certian things. For instance, did you notice that "certain" in the last sentence was misspeled? Further, did you notice that "misspelled" was misspelled in the last sentence? You don't expect such things in a text, so you're not on guard to find such errors. Your internal state can also bias your perceptions. If you're hungry, you are much more likely to perceive food objects in an ambiguous picture. Remember the last time you were a baby-sitter at night? Every strange sound was a burglar, right? Again, it's your own internal state.

Moreover, the social situation of which you are a part may influence what you perceive. Experiments have shown that when making perceptual observations, most people will even change their minds to agree with the majority. Social pressure can influence your perception.

Finally, third, there are aspects of the stimulus that combine with your own prior experience to determine what will attract your attention. Such mixed factors also influence your decisions as to what to attend to in the environment. There are two examples: One is novelty, illustrated by an advertising

campaign of the former Braniff International Airlines. To attract attention to their airline, Braniff hired a South American artist to turn one their planes into an artistic statement. It gained attention only because our prior experience suggests that airplanes are usually aluminum-colored or some sky-related, solid color.

Another mixed factor, familiarity, influences your attention. If you see at a gathering the local newscaster of the evening news program that you usually watch, you will pay attention. You're familiar with him or her, and you usually associate that person with news events -- disasters, wrecks, and various other crises. Familiarity breeds comfort and interest in this case! When someone hands you a photo of those who attended a party, the first things that attract your attention are the people whom you know. Only later, if at all, do you pay attention to those you don't know in the photo.

Stimulus Variation and Perception

Attention and set -- in fact, all normal operations of the perceptual processes -- depend on some variety in the incoming stimulation. The ultimate threat for prisoners, short of torture, is to be put in solitary confinement.

Stimulus variation forms a background of experience that allows us to interpret incoming stimuli. It allows us to "anchor" that to which we are attending. Removing most incoming stimulation is very distressing; isolating ourselves from stimulus variation is ultimately intolerable for most of us

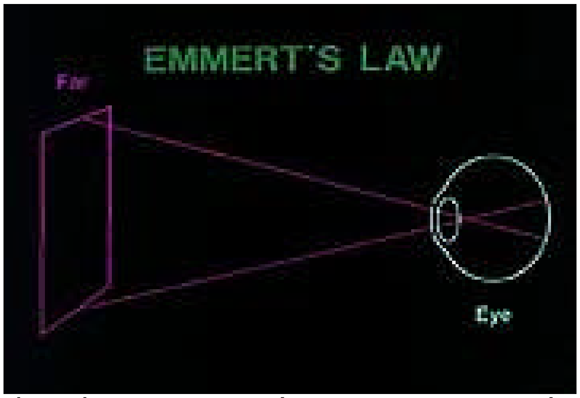
Imagine this: You are invited to spend quiet time in an isolation chamber, and you will be paid (the equivalent in today's dollars) roughly $75/day of as long as you can stay in the chamber. Half Ping-Pong balls are taped over your eyes, so your eyes function, but see nothing but white. An air conditioner provides an audio mask of "white" noise. You must wear cardboard sleeves on your arms to minimize tactile stimulation of your skin, and you must agree to lie as quietly as possible so that excessive movement doesn't become a source of stimulation. You will be fed and removed from the chamber when you need to go to the rest room. Aside from that, you must lie quietly. How long could you last?

The average participating college student lasted into his or her third day. Requests by participants for rest room trips increased throughout the study -- one way in which creative undergraduates with nothing else to do discovered they could increase the variability of their very boring chamber experience! The arrival of hallucinations forced the experimenters to stop the experiment for a number of subjects. Ultimately, our brain seems to start generating its own stimuli if those offered by the environment are not interesting enough. That's the reason you twiddle your thumbs or your foot starts bouncing if you're bored in class. Yet, although we may seek heightened stimulation, such as a ride on a roller coaster, we also tend to limit our exposure to that.

Perceptual Constancies

Look at the nearest window or door in the room where you are right now. What shape is it? You're probably thinking to yourself that it's rectangular, yet if you held up a piece of glass in front of you and traced the exact outline of the door or window, the shape on the glass you are holding would probably not be rectangular. This illustrates one of several constancies that operate within us. Although physical stimuli may vary tremendously, the objects from which they come are interpreted as constant. These constancies aid us in perceiving our world, and at least four constancies can be identified.

The fact that familiar objects can be identified as square or round or rectangular in spite of the angle from which they are viewed is called shape constancy. Perception is a "bet" you are constantly wagering with yourself -- balancing off your past experience against the specific incoming stimuli of the moment. Illusions are cases where you bet wrong and misperceive things.



Someone gives you a meter stick to hold at arm's length. Then he or she asks you to pick the matching stick from among a dozen or so sticks, ranging from 0.7 meter to 1.3 meters, that are 10 meters away from you. You can do so quite easily. You based your decision on size and shape constancy and the incoming depth cues. Size constancy is the result of a perceptual process summarized as Emmert's Law -- that there is a precise inverse relationship between the distance of an object whose image falls on the retina and the size of that object.

Look at the shirt or blouse you're wearing right now. Turn off the room lights and look at it again. In comparison with other objects in the room it keeps its relative brightness. Brightness is related to the relative amplitude of the light waves reaching your eyes from each object in the room. Stress that word relative, however, since the effects may differ. For instance, the black squares on the victor's flag waved at a noontime road race may reflect more light than the white squares of that same flag being waved at sundown. The relative brightness is crucial in determining the perceived brightness of every object we view, and brightness constancy is among the most stable cues we use in perception.

What color is the shirt or blouse or sweater you're wearing right now? If you went outside now, would that color change? Of course you know that wouldn't happen. Likewise, if you cast a shadow on part of your clothing, the color in the shadow doesn't really change though it may appear to be different. Your experience and the environmental cues combine to maintain a color constancy and your ability to perceive color quite accurately.

Visual Perception of Distance

Four factors play a major role in our ability to sense and perceive our world -- identifying figure-ground relationships, attention, our need for stimulus variation, and the constancies -- as well as the various principles for organizing the wholeness of figures and grouping stimuli. These factors are always operating, especially in visual perception. Now let's have a look at how we judge our environment. In our visual world there are two jobs that are most important -- judging distance and judging movement.

We use a tremendous variety of cues to judge distance. Some stimulus cues come from the environment. Other organism cues come from our own body as we adjust to our environment. Let us first review the various external stimulus cues we can use. (1) One cue for judging distance is based on size. (See above illustration.) The bigger something is, the closer we judge it

to be. (2) We also rely on overlap, or interposition. A whole object is closer than any object of which we can only see a part. (3) Shadows may give us help, if we know where the light is coming from. (4) We also rely on the texture-density gradient. Look at the floor right where you are. Now look at the farthest piece of floor you can see in the same room. See how much less detail you can see far away? That's the texture-density gradient.

And there are some other more subtle cues we use. (5) One is called aerial perspective or bluing. Over long distances, the further away something is, the bluer it looks as in the Figure. (6) Linear perspective is illustrated by what you see looking down the railroad track; parallel lines seem to come together as seen in the Figure. Finally, (7) if an object is too close to us, it will

blur (See the Figure). And if we're looking at an object far away, things between us and that object may also seem blurred. All of these stimulus cues are used in judging distance.

Regarding organism cues, look at the tip of your nose (without using a mirror!). The pain you feel is caused by the ciliary muscles, which are causing your eyes to converge. (1) Convergence is a major cue to distance at close range.

Close one eye. Hold your index finger up and focus on it. Now focus on a point on the far wall that is just above your finger tip. Now focus on your finger again. (2) The change in focus is called accommodation. It is achieved by the lens in each eye every time you look at anything.

While you've still got that index finger waving around in the air, bring it in to about 10 centimeters in front of your face and look at it with the same one eye you used for the accommodation demonstration. Now close that eye and open the other one. Notice how the view of your finger changes slightly? (3) That's called retinal disparity. The different views of your eyes help you judge distance, and also combine to give you the three-dimensional view that you have of the world. This is discussed more in Feature 6.3

Feature 6.3

Double or Nothing

The illustration shows two slightly different views of the same scene with a line separating them. In bright light, place your head directly over the line and hold a sheet of paper along the line between your face and the book. Hold the paper so that each of your eyes can see only one of the views.

Now we're ready to demonstrate binocular discoupling. It's not a disease; it's a process. Holding your head, the book, and the helpful sheet of paper as we just described, pretend you are looking at something about half a mile beyond the two pictures. In other words, make your eyes converge on a make-believe distant subject while you are actually looking at the view very close to your face. Make the two images you can see fuse into one image. That image is a three-dimensional picture. Now, if you carefully slide the sheet out of the way without altering the position of your eyes, you should now see three images—one to the left of the center image on which you are focusing and another to the right. It's the two that are overlapping in the middle that you want to work on. See if you can adjust your eyes so as to focus the fused images.

What happens when they do? You see a stereoscopic, three-dimensional picture! In this case we've made the two separate views of the same scene slightly different. Then, by causing your eyes to adjust themselves as if they were converging on a distant target, we've fooled your brain into interpreting the retinal disparity as a full-blown, normal view of the world. All three cues—convergence of both eyes, accommodation of your lenses, and retinal disparity-combine to allow you to perceive three dimensions where only two actually exist.

All three of these internal cues can be detected as you adjust to your environment. There are some other cues that we also rely on, but this should give you enough of an idea about how complex the perception of distance really is.

Visual Perception of Motion

We perceive movement very differently from how we perceive distance. At least two processes are involved. First, individual cells (rods and cones) in the eye either fire or don't fire. Higher up -- both in the eye and in the brain -- there are cells which are sensitive to the order in which lower cells fire. Such a higher-order cell fires, for instance, if an object is moving left to right in front of you, but the same cell does not fire if the same object is moving right to left in front of you. Direction and speed can thus be perceived.

More importantly, second, we don't see movement in an absolute sense. We only see movement relative to the background or another object. Have you ever been in a car on an Interstate highway? When you're going at the same speed as someone you're passing (or trying to pass anyway!), you don't seem to be moving at all, even though both of you may be doing 60 m.p.h. So both the context and internal processing are involved when you perceive movement.

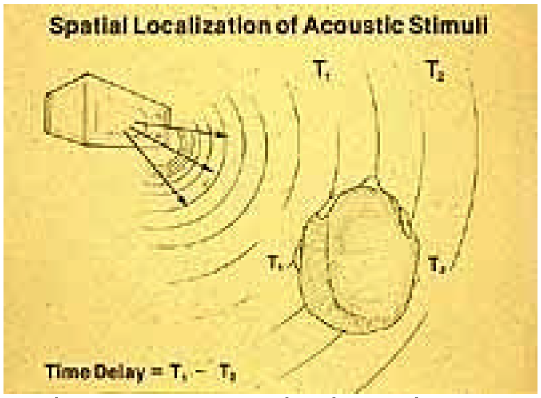
There is a different situation in which we will perceive movement where none exists. Two lights are placed side by side. First one flashes and then the other. As the rate of alternate flashing increases, what happens? Although you know you're looking at two separate lights, you experience this as only one light moving back and forth. By controlling the intensity of the lights, the distance between them, and the delay from one flash to the next, we create what is called the phi phenomenon.

A similar example is provided by movies. "Motion" pictures actually are just a series of individual still pictures projected rapidly enough so that your brain fills in the missing information, ignores the flicking, and perceives movement where none exists.

Yet another form of motion involves induced movement. Have you ever seen the moon on a night when clouds are blowing past it? The moon seems to be moving rapidly the other way. Your perception of motion here is based on the context, your prior experience, and internal processing. Since you can't see the edge of the moving pattern of clouds, your brain doesn't comprehend that the foreground is moving, not the object. You make an error. Illusions are another form of such errors.

Hearing Perception

Our sense of hearing permits us to perceive the location of a sound by analyzing three elements of the situation. First, sounds out to one side always reach the nearer ear first. Onset time is a cue. Second, your head casts what is called a sound shadow. The ear that is further away will hear a slightly softer sound. Difference in loudness is a cue. Finally, when the sound enters each ear, it starts being analyzed by the cochlea. But the ear that hears the sound first has a head start. The sound waves it is analyzing are farther through each phase of their cycle all the time. So, phase difference is a cue.

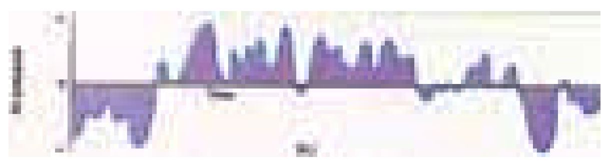


Can you tell where a sound is coming from when it originates directly in front of you? It's not easy to do so because the three cues are identical to both ears. The sound waves reach both ears with the same loudness simultaneously.

Feature 5.4 discusses the problem of noise. Any unwanted sound, or a sound that is not understood, or one inappropriate to the situation in which it is heard qualifies as noise. A whisper when you're alone with your love is fine, but a whisper at a symphony is noise to anyone other than the person to whom you whispered.

Feature 5.4

How Do We Perceive Noise?



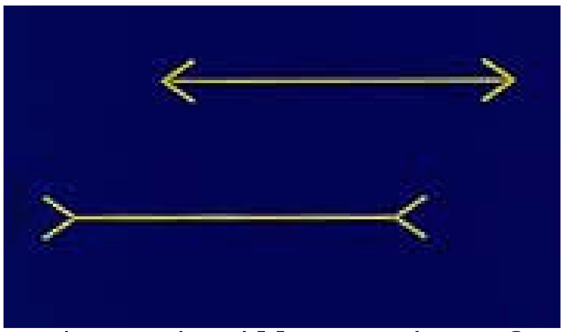
What, exactly, is noise? Noise occurs if the resulting sound waves don't have an identifiable pitch. The illustrations show the difference in sound wave patterns generated by a complex, but meaningful, sound as opposed to a complex and unmeaningful noise. When too many frequencies all occur at once, the result is noise. The static that is heard on the FM radio dial between stations contains a mix of many frequencies. It is called "white" noise in direct reference to white light, which is a mixture of many light waves.

Noise is also perceived if the person who is listening doesn't understand the sound. Thus, most of us from West European or North American countries might view Chinese music as noise. Such music uses rhythms and sources that are alien to the Western ear.

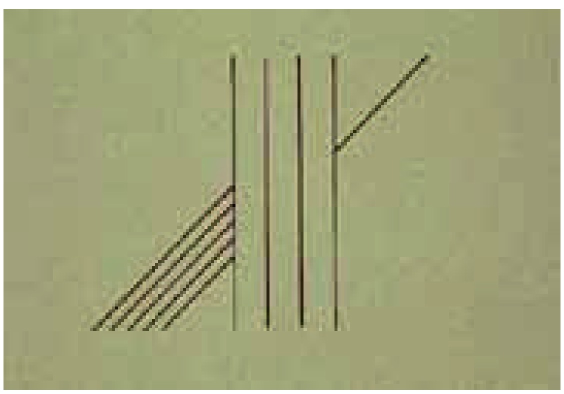
Thirdly, noise also identifies any sound occurring when/where it should not occur. Even a clearly identifiable sound (such as a voice) is "noise" if it occurs during a symphony concert or a speech.

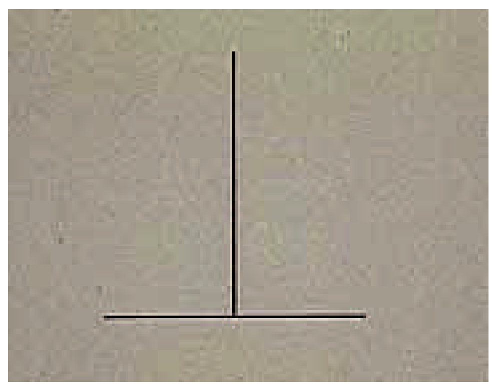
Illusions as "Errors" in Perception

Our various sensory experiences are the bases for the perceptions which they enable. Such perceptions are based on figure-ground relationships, our creation of whole figures, and the principles we use in grouping stimuli. Our attention, the variation of stimuli we experience, and the constancies we create for the sensations we experience all aid the accuracy of our perceptions. But what happens when the constancies fail?

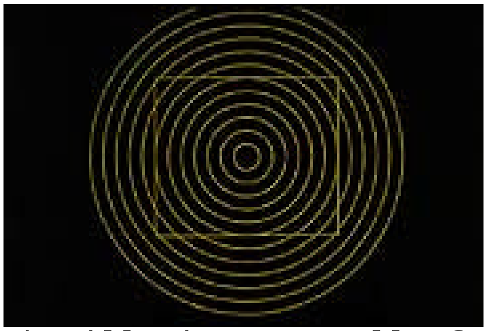


Illusions most often happen when the environmental stimulus shares some -- but not total -- similarity with environmental situations you've experienced before. Your brain will then use your past experience incorrectly to interpret the new stimulus. Look at the illustrations for some common illusions. Related to the illusions we've shown are two other interesting questions.





First, are hallucinations actually illusions? Here the answer is no. Hallucinations result from improper mental activities. They may be caused by drugs or by physical or emotional problems, as we discuss in more detail in the Personality: Mental and Behavioral Disorders Chapter.



Second, can you photograph illusions? The answer is yes. Illusions result from processing errors. Even mirages can be photographed. Presenting the same physical stimulus pattern -- whether in real life, or simply from a photograph -- still produces the illusion. In all of the compound and figure illusions, the background interferes with your ability to make the judgments required about part of the figure. Much work remains before we can fully explain why we make these perceptual "errors."

USING PSYCHOLOGY: Clothing

Perception involves a very complex variety of factors. Our previous experiences can influence the ways in which we respond to stimuli. And there is no doubt that our senses can and do deceive us. But how can you turn this fact to good account? What practical use can you make of your knowledge of perception?

Well, you might ask yourself if you are satisfied with the way people perceive you (assuming, of course, you can be objective enough to know). Suppose you want to "change your image" -- the image, that is, that meets the eye. There are some simple tips that can help.

Are you overweight? Do you want to appear taller and slimmer? Up-and-down lines will help create the illusion. One piece garments of vertical stripes or darker solid colors keep the eye from stopping at your waist where another color begins. Single-breasted jackets will direct the eye in a vertical line. Smooth fabrics are better than fuzzy or textured ones. Likewise, clothes that fit well will make you look less bulky, and more tall and slim.

Suppose your problem is being skinny or extremely tall. To look heavier and shorter, reverse the advice just given. Color contrasts that cut your height in half, and cross-wise lines and stripes will help. Light colors and fuzzy, bulky fabrics add width. Large, splashy prints, distinctive pendants, and belts with fancy buckles will distract the eye. Double-breasted jackets, with their two rows of buttons, also break height.

All of this advice is based on the implications of the vertical-horizontal illusion. See the Figure as a reminder. The advice comes straight from the psychological laboratory, based on factors known to increase/decrease that illusion!

Extrasensory perception (ESP)

Parapsychologists ("Para-" means resembling or similar to) who believe in ESP suggest that our response capabilities are not limited only to identifiable, physical, observable stimuli. They speak of communication directly from mind to mind, not using the normally accepted channels and systems of communication. ESP is most frequently studied using a deck of 25 cards with five symbols: circles, squares, triangles, waves, and crosses. There are five cards with each symbol. Table 6.3 lists four types of ESP, including an example of each type.

Table 6.3

Forms of Extrasensory Perception (ESP)

TITLE	DEFINITION	Example
Clairvoyance	Sensing a message without an identifiable physical stimulus.	Can you guess which of five symbols is on the symbol card held by a friend?
Telepathy	Communications of thoughts from one person to another.	Requires "sender" and "receiver": Can receiver guess or sense card symbol being viewed by sender?
Precognition	Predicting a future event before it happens.	Can you predict the order of the cards before they are exposed?
Psychokinesis	Mental control of physical things.	Uri Geller alleged* in the mid-70s that he could bend keys by exercising his mental powers.

* Evidence was later developed which suggested that Geller may have used skills as a magician, not supernormal powers of ESP, to achieve his effects.

The obvious question is, does it work? The evidence is mixed, but generally negative. The "you must believe in it to find it" attitude is contrary to the basic principles of science. Very few well-controlled studies have had positive results. In fact, the most interesting thing about the scientific pursuit of ESP is that the better controlled the studies are, the less likely it is the effect will show up. That is exactly the reverse of findings with respect to almost all other phenomena studied using the scientific method: Better control usually gives a more accurate picture of a phenomenon.

Does it exist? Well, how can we describe those who say they "have" ESP? We know "some have it more than others." We know "only certain people show it." We know "no one has it all the time." And, we know "we can't predict when a person having it will be 'on' or 'off'." When you sum it up this way, what we also know is that the same four statements could also be made of a chance or random event. Don't these same statements apply to your likelihood of finding someone who can toss pennies so that they land "heads up"? ESP is an interesting, challenging notion, but there's little hard evidence to support its existence so far for reasons analyzed in the Think About It.

Think About It

The question: Does extrasensory perception exist?

The answer: The evidence is mixed, but offers a compelling lesson as to what a statistician would expect. If there is no effect present—that is, if ESP does not exist -- we would expect 1 experiment in 20 in the long run to demonstrate positive effects by chance alone at a significance level of .05. Though the likelihood of finding ESP effects at the .05 level of significance has not been determined across the vast numbers of ESP studies completed, the rarity of finding a replicable effect has caused many psychologists to question the legitimacy of ESP as a demonstrable effect. The best attitude at present is to continue to study the phenomenon, basing a conclusion to support its existence on the ability of researchers to meet traditional .05 or .01 significance levels in their research. When such expectations are applied to the current literature, there's scant evidence of a demonstrable ESP effect.

REVIEW QUESTIONS

SENSATION VS. PERCEPTION

1. Explain some ways in which sensation and perception are similar.
2. Explain some ways in which sensation and perception are different.

PSYCHOPHYSICS AND THRESHOLDS

1. Define the two types of thresholds.
2. What is Weber's Law?

VISION

1. The stimulus for vision is light waves that are received by the eye. Name the three physical characteristics of light and the psychological attributes related to each.

VISUAL RECEPTOR: THE EYE

1. Describe the parts of the eye and the functions performed by each part.

HEARING

1. The stimulus for hearing is pressure, or sound waves received by the ear. Name the three physical characteristics of sound waves and the psychological attributes related to each.

CHEMICAL SENSES: SMELL AND TASTE

1. What are the two chemical senses and the elements to which they respond?

CHEMICAL SENSES RECEPTORS

1. What are considered to be our four basic tastes?

OPERATION OF THE CHEMICAL SENSES

1. Name and describe the theory that best explains the sense of smell.
2. What is the receptor for taste, and how does it work?

OTHER SENSES: SKIN SENSES

1. What are the physical stimuli for the skin senses? What are the psychological attributes involved?

OTHER SENSES: BALANCE AND BODY POSITION

1. What is the role of the physical organs upon which the vestibular sense is based?
2. Explain kinesthesia and the source of the stimuli that produce it.

PERCEPTION

1. What is perception?

FIGURE-GROUND, WHOLENESS OF FIGURES, GROUPING

1. Name the three organizing factors that help us perceive and the elements involved in each factor.

ATTENTION

1. What are three factors that influence our attention as it

is related to perception?

STIMULUS VARIATION

1. Describe the role played by stimulus variations.

CONSTANCIES

1. Name some constancies that influence our perceptual accuracy.

VISUAL PERCEPTION OF DISTANCE

1. What does visual perception involve?

VISUAL PERCEPTION OF MOTION

1. Describe the phi phenomenon.

HEARING PERCEPTION

1. Our ability to locate sound sources is based on what three factors?
2. What is noise?

ILLUSIONS AS "ERRORS" IN PERCEPTION

1. When do illusions occur?

EXTRASENSORY PERCEPTION (ESP)

1. Describe subliminal perception.
2. Describe extrasensory perception. How valid is it? Why?

ACTIVITIES

1. We have discussed how most of the sounds we hear result from the transmission of pressure waves through the air. To demonstrate this process, blow up a balloon to be full but not in danger of bursting. Hold that balloon in front of the bass speaker of a stereo set. (You might try this in a department store if you don't have a system where you live.) What happens to the balloon? Now hold the balloon in front of the treble speaker. What happens? What does this show you about the transmission of physical sound waves?

2. A British psychologist suggested an easy way to demonstrate the source of the negative afterimage. Is it in your brain? Is it on the receiving surface of your eye? Touch the outside corner of your eye socket and locate a notch in the bone surrounding your eye. If you apply a steady, moderate pressure to your eye at that spot, you will find your vision will disappear within 30 seconds or so. While continuing to

press, turn on a light bulb in front of you. Your eye won't be able to see it. Turn the bulb off and then release the pressure on your eye. As your vision restores itself, you will see a negative afterimage of the bulb you couldn't see before! This demonstration shows that afterimages occur on the sensing surface of the eye.

3. Take the time to visit the psychology laboratories at your school. Ask the one of the faculty in/near the lab to explain the nature of any experiments being conducted that relate to physiology. What objectives are being sought? Are animals being used? How can such animal research can be helpful to humans?

4. One measure of the number of skin sensors that occupy any part of the surface of your body is your ability to detect whether you are being touched by one or two objects at any given point. To measure this, get a friend who will help you. Ask your friend to close his or her eyes. Then, using two sharpened pencils, tell your friend that you are going to touch him or her with one or two pencils, either holding both points together, or separating the points by up to four inches. As you conduct your experiment, make sure that you (a) always touch both points to your friend's skin at the same time, and (b) ask your friend to tell you each time whether the contact was made with one or two points. Gradually increase the distance between the pencils by one half to one centimeter each time you make the contact. In this way you can measure what is called a two-point threshold. When your friend's reports shift from "one" to "two," do not increase the distance again, but re-contact several times. Does the report go back to "one"? Now try this on your friend's arm, cheek, center of the neck, lower part of the leg, and front side of the index finger. Which area is the best detector? Why do you think this is so?

5. Doing this demonstration requires some preparation. You'll need a friend with a cold. Prepare half-centimeter pieces of raw, peeled potato, turnip, beet, apple, and the seedless (edge) part of squash. Have the parts of food ready beforehand, and keep the food covered so your subject can't see it before being blindfolded for the demonstration. Ask your friend to taste the pieces of food. Allow your friend to rinse a swallow of water around in his or her mouth between tastes of each type of food. Ask your participant to identify each type of food as it is tasted. How rapidly can your subject make the judgment? How accurate is it?

Try the same test with a person who doesn't have a cold. Can someone without a cold make the identification more easily and accurately? What happens to this person's accuracy when you allow him or her to smell the smoke of a cigarette or a bit of ammonia or an onion just before making the taste judgment?

INTERESTED IN MORE about SENSATION/PERCEPTION?

GOLDSTEIN, E. B. (1980.) *Sensation and Perception.* Wadsworth. A well written, college-level text explaining the basic processes of sensation and perception. In addition to the traditional topics, it includes chapters on perception of music and speech.

HELD, R. & RICHARDS, W. (eds.) (1976.) *Recent Progress in Perception: Readings from Scientific American.* W. H. Freeman. A collection of articles from past issues of the magazine, featuring theories and mechanisms of perception. Richly illustrated.

HOCHBERG, J. E. (1978.) *Perception,* 2nd ed. Englewood Cliffs, NJ: Prentice-Hall. A good, tough book greatly expanding the coverage of topics in this chapter. Contains a wide variety of illustrations of sensory mechanisms, illusions, and other current concerns of psychologists interested in perception.

LINDSAY, P. H. & NORMAN, D. A. (1977.) *Human information Processing: An Introduction to Psychology* 2nd ed. Academic Press. Although intended as a general, college-level introductory text, this book is actually an excellent introduction to sensory processes and perception. Well illustrated.

McBURNEY, D. H. & Collings, V. B. (1977.) *Introduction to Sensation/Perception*. Englewood Cliffs, NJ: Prentice-Hall. A book with a little bit of everything: research, "how-to-do-it" advice on simple sensory and perceptual effects, and discussions of various factors that affect our perceptual skills.

WADE, N. (1982.) *The Art and Science of Visual Illusions.* Routledge & Kegan Paul. A lavishly illustrated volume containing the most recent theories and research about illusions. Contains hundreds of illusions.