CHAPTER 5

Perception

In this chapter, you will learn about:

- perception of physical properties that don't change
- how the brain organizes perception
- perception of movement
- visual illusions

About three hundred years ago, the French philosopher René Descartes proposed a theory to explain human visual perception. He suggested that images of the outside world received by the eyes were transferred to a small screen inside the brain, where the soul could observe them. In the centuries since Descartes's time, many scientists have investigated various aspects of perception. The more that is learned, the more aware scientists become of the complexity of the human brain and sensory systems.

Scientists have established that receptors in our sensory organs transform stimuli from the environment into electrical neural impulses—the brain's "language." The brain processes all of the incoming neural impulses and constructs a picture of what's "out there," with sounds, smells, and tastes accompanying full-color images. Different scientists have proposed various theories to describe how this occurs. The mysteries of human perception continue to intrigue scientists.

What Is Perception?

In the previous chapter, we discussed how the brain receives sensory information in the form of electrical neural stimuli. Perception occurs when the brain organizes the sensory information to make it meaningful. Some researchers have referred to sensation and perception as two different phenomena, and in this book a separate chapter is devoted to each. However, in reality, the difference between the two is not always clear. Some people think of a perception as a complex type of sensation requiring a greater degree of awareness and an interpretation of the stimulus. According to this definition, awareness of a single flash of light would be an example of a sensation, while a series of light flashes might result in a perception of movement. At any rate, a **perception** is an experience caused by stimulation of the senses.

While the process of perception is still not fully understood, scientists have gained a great deal of knowledge about its various aspects. Because a thorough discussion of perception—perception of sight, sound (including perception of speech), smell, taste, and touch—could easily fill an entire book, this chapter will focus mainly on important aspects of visual perception.

Psychological Factors Influencing Perception

There is no absolute way to perceive the world. Each person is unique, with different experiences, memories, personal tastes, and expectations. These differences are the psychological factors that affect and influence a person's perceptions. For example, some people consider opera music to be nothing but loud, screeching noise, while others find it to be exciting and delightful music. In another example, a person who admires nature would probably enjoy driving through a forest, noticing many different shades of green, as well as other colors and textures. Someone else might drive down that same forest road thinking, "If you've seen one tree, you've seen 'em all." That person would possibly perceive the forest as a continuous dull greenish blur.

The Psychophysical Approach

Because perception involves psychological factors as well as a physical process, many researchers have explored the behavioral aspects of a response to stimuli, an approach known as **psychophysics.** Such scientists compare a person's response to different stimuli and different people's responses to the same stimuli. One result of the psychophysical approach was the establishment of absolute thresholds for the various sensory organs—the minimum stimulus that can be detected.

Researchers have also studied another kind of threshold known as the **difference threshold**, the degree of change in a stimulus necessary for a person to detect the difference. For example, the difference threshold for taste has been determined to be 1/5, or 20 percent. Suppose a cup of coffee has five teaspoons of sugar in it. To create a noticeable change in the sweetness of the coffee, you would have to add 20 percent more sugar, or one more teaspoon of sugar.

Studies of thresholds are useful in determining an individual's sensitivity to various sensory stimuli. The lower the threshold, the greater the sensitivity. Researchers noticed that people in an experiment may each have different reasons for their responses. Each person may be influenced by different aspects in their surroundings. Personal motivation also affects the response. For example, you might be reading this book right now while music is playing in your room and a younger sibling is playing in the next room. Do these sounds interfere with your ability to concentrate on your reading? Or can you block out these distractions? Do you have a test on this section in the near future? Or are you simply interested in the content of this book? The **signal-detection theory** takes into account your sensitivity to stimuli in your environment, your physical condition, and your motivation, mood, and attitude. According to this theory, someone's detection of a stimulus depends both on that person's sensitivity to the stimulus and on his or her response criteria.

Perceptual Constancies

Perception allows us to make sense out of our environment. As we go through life, we learn more and more about the world around us. We are constantly responding to stimuli and accumulating memories of our experience of the world. The brain becomes an immense storehouse of knowledge about details of our physical environment, such as the size, shape, and color of objects. Our memories play an important role in helping us interpret all new incoming stimuli and allowing us to perceive certain aspects of our world as constant, or unchanging. If this were not the case, the world around us would be an incredibly confusing place, because we are continually exposed to new stimuli. The following **four** constancies help us make sense of it.

1 Size Constancy

Imagine you are traveling in a car on a long, straight stretch of divided highway. Way off in the distance ahead of you, you see a big truck heading toward you. It appears tiny, about the size of a little plastic toy truck. Because you have seen such trucks up close many times in the past, however, you have a fairly good idea of the true size of the truck. So even though the image of the truck appears tiny, you accurately perceive the truck as a huge rig, which will soon be hurtling by you on the other side of the divided highway. This phenomenon is known as *size constancy.*

You Experiment

Size

Step One. Hold an object, such as a pencil, a sheet of paper, or a book, with your hand extended at arm's length.

Step Two. Notice the size of the object.

Step Three. Slowly move the object toward you. What happens to the object's size? Does it appear to grow larger or smaller?

Step Four. Bring the object right in front of your eyes. How does its size appear now?

Analysis. Did the object actually change in size as it moved toward you? Of course not! Even though it appeared to grow larger, you know the true size of the object remained constant. So your perception of the object remained constant. This is what is meant by the term *size constancy*. When your brain knows the true size of an object, it knows that an object only appears to change size when its distance changes.

Shape

Step One. Look at a sheet of paper or book on your desk.

Step Two. Move your head to the side and look at the object again. How has its shape changed?

Step Three. Pick up the object and tilt it at various angles. Observe how its shape changes.

Analysis. Although its shape seems to keep changing, you know that it is rectangular and that its shape isn't really changing. So your perception of the object's shape does not change.

2 Shape Constancy

Another perceptual constancy is *shape constancy*, an individual's ability to perceive an object as having a constant shape regardless of how it appears to change shape with a change in the observer's angle of view.

3 Brightness Constancy

When you are familiar with the bright quality of a particular item—for example, a yellow raincoat—you will perceive its brightness to be at a constant level even though its surroundings may change. You will perceive it as bright even on a dark rainy day or when it is hanging in a closet. This phenomenon is known as *brightness constancy*.

4 Color Constancy

Let's stay with the yellow raincoat a while longer. Since you know it is yellow, you will perceive it to be yellow whether you are seeing it outside on a bright sunny day or in the moonlight late at night—or even on a moonless night! The energy patterns—wavelengths of light—from the raincoat reaching your retina are very different at night than they are during the daytime. But *color constancy* allows you to perceive the yellow color of the raincoat no matter how the environment changes.

Perceptual Organization

Scientists have come up with different theories to explain how we organize perceptions. While the theories may vary a bit, one thing researchers seem to agree upon is that the perceptual process is extremely complex. The big question seems to revolve around the issue of how our brains continually process so many bits of information so quickly.

The Constructionist View

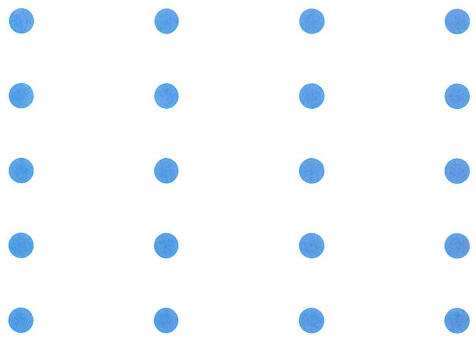
For a long time, the **constructionist view** prevailed among researchers. According to this theory, the brain constructs a perception out of a great many individual sensations. For example, when you meet someone and look at the person's face, your brain takes in countless sensations from each part of the face. A perception is then formed out of the sum of the sensations, and you "see" the face.

The Gestalt Psychologists

In 1912, Max Wertheimer, a German psychologist, formed a group known as the **Gestalt** psychologists. The Gestalt psychologists believed that the whole is more important than the sum of the parts and that each part affects every other. In other words, the brain immediately perceives a stimulus as a whole, rather than focusing on the individual sensations. The Gestalt psychologists focused on the interaction of the parts, observing how the brain uses certain perceptual cues to make sense of things. Based on their research, they developed what they called *laws of perception.*

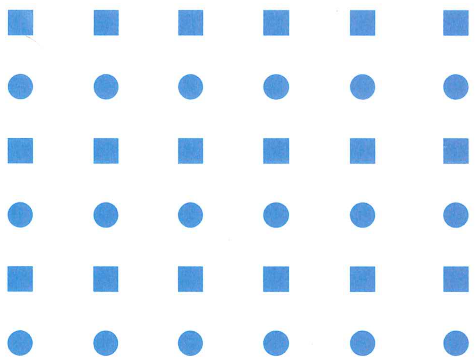
The following **four** are the most important of these Gestalt laws:

1. **Law of Proximity.** We tend to group together things that are close to one another.



▲
Do you see the dots in vertical rows or horizontal ones? Your brain groups the dots that are closest together. Measure the distance between the dots in both directions.

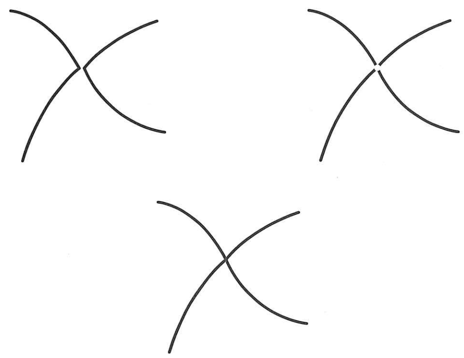
2. **Law of Similarity.** We group together things that have some visual element in common, such as size, shape, or color.



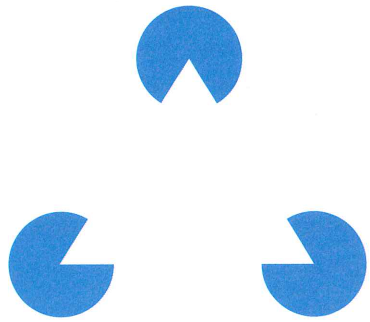
▲
Vertically, these objects are different from each other. Horizontally they are similar. Without conscious effort, your brain organizes these into horizontal rows.

3. Law of Continuation. We tend to see interrupted lines as continuous lines with something hiding part of them.

4. Law of Closure. We tend to fill in missing details to complete a figure so that it has a consistent overall form.



▲ Do the top two figures seem to be made of lines that cross?

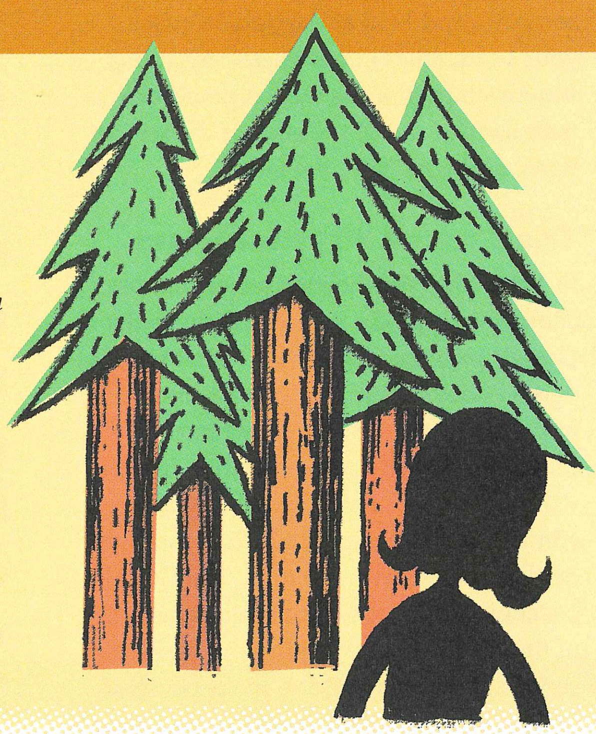


▲ What geometric figure is suggested by the broken circles?

Sidebar

Bottom-Up and Top-Down Processing

Bottom-up processing refers to a type of pattern recognition that begins with an analysis of small units or features and eventually results in a perception. *Top-down processing* involves a person's knowledge of the world. It starts with an analysis of higher-level information, such as the context in which a stimulus is seen. When you encounter something new, do you start by studying the details? Or do you look at the big picture?



Some bottom-up processors "can't see the forest for the trees." ▶

Figure and Ground

The Gestalt psychologists were also interested in an aspect of visual perception known as **figure-ground**. They realized that for us to perceive an object, we have to separate it from its background.

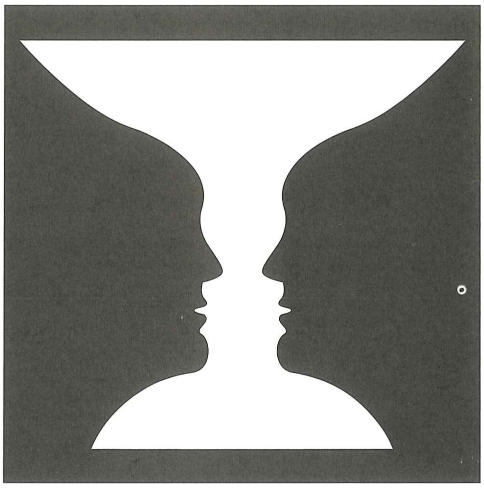
Here are the **three** Gestalt principles of figure-ground perception:

1. The figure is more "thinglike" and more memorable than the ground.
2. The figure is seen as being in front of the ground.
3. The ground is seen as unformed material and seems to extend behind the figure.

In one test of figure-ground perception, subjects are shown a Dalmatian dog against a background of black and white shapes. If they see a Dalmatian dog, they have perceptually organized the black and white shapes into a figure-ground pattern.

Look at the figure on the right. Do you see a white vase? Are you sure that is what you see? Look again. Perhaps you now see two profiles facing each other.

Notice that when you see the white vase against the black background, you cannot see the profiles. And when you see the profiles, you cannot see the vase. It is very difficult to see both profiles and vase at the same time. This is called a *reversible figure-ground pattern.* It was introduced by Danish psychologist Edgar Rubin in 1915.



Limitations of the Gestalt Approach

Many researchers today believe that the Gestalt approach, while useful as a way to describe certain aspects of perception, does not really explain how we perceive the world around us.

* Gestalt laws work best when applied to simple line drawings consisting of dots and lines on a page.
* Gestalt laws do not take into account the importance of recognition or prior familiarity with an object in forming our perceptions.
* Gestalt laws do not take into account our perception of depth in the three-dimensional real world.

Bodily Depth Cues

Several characteristics of our visual system work together to enable us to perceive depth. **Monocular cues** work if we look through only one eye. Other cues, known as **binocular cues**, require the use of two eyes. The following list describes **three** types of bodily depth cues.

1. **Accommodation** is the change in the shape of the lens that varies with distance. In this monocular cue, the lens in each eye bends or bulges to focus on objects as they come closer to the eye. The brain detects the sensation of this muscle movement and perceives the distance of objects closer than four feet.
2. **Convergence** is the way your eyes rotate inward and outward with changes in distance. In this binocular cue, the eyes have to converge to focus on an object closer than 50 feet away. To see how this works, hold a finger out at arm's length and focus your eyes on it as you slowly move it toward your eyes. When it gets close up, you will feel the sensation of muscles that control your eye movement.
3. **Binocular disparity** describes the difference between the images provided by each eye. Because our eyes are two and a half to three inches apart, each eye gets a slightly different view of the same scene. When our brain combines the sensations coming from both eyes, a convincing perception of depth results. Three-dimensional movies are based on this binocular cue. Such movies are filmed by two cameras several inches apart. Both images are simultaneously projected onto a screen. When the viewer wears glasses that filter out one of the images to each eye, each eye gets a separate image. And the brain is tricked into perceiving a two-dimensional scene as having a third dimension.

RESEARCH

The Visual Cliff Experiment

Depth perception is necessary to survival. Without it, everything would appear flat, and it would be extremely difficult to judge distances. Driving on a highway in traffic would be suicidal since you wouldn't be able to tell how near or far the other cars were. Activities, such as baseball or basketball, would be impossible, though not life threatening. Imagine how difficult walking would be!

Because depth perception is such a vital skill, we acquire it when we are very young. Research has shown that infants begin to perceive depth at around three months of age, as their eye muscles develop and their eyes focus effectively. Depth perception is fully developed by six months.

In 1960 Elinor Gibson and Richard Walk devised an experiment known as a "visual cliff" to demonstrate that infants can perceive depth. Using a glass-topped table, they placed a sheet of patterned material directly beneath half of the glass and several feet below the other half. An infant on the table would crawl toward its mother when she stood near the "shallow" side. But when she stood near the "deep" side, the infant would refuse to crawl toward her, apparently afraid of "falling off a cliff," and thus demonstrating the ability to perceive depth.

Pictorial Depth Cues

Pictorial depth cues can give a two-dimensional painting, photograph, or movie the illusion of depth where none exists. All pictorial depth cues are monocular cues, since all of these can work even if one eye is closed. These **seven** cues exist in the real world as well as in pictures.

1. **Linear Perspective.** Parallel lines in the environment appear to converge as they move away from you. Perhaps you have stood near train tracks and noticed how they appear to come together in the distance, conveying a sensation of depth.
2. **Relative Size.** Objects that are known to be the same size will convey depth if one is smaller than the other.
3. **Relative Height.** Objects that are higher in a scene are usually perceived as being more distant, as long as they are below the horizon. Objects above the horizon appear to be closer if they are higher in your field of view.
4. **Overlap.** A sensation of depth is created when one object partially blocks another, because this means that one object is a certain distance behind the other.

5. **Texture.** Changes in texture can convey depth when the texture in the foreground contains vivid details that become less and less apparent as the texture recedes into the background.
6. **Atmospheric (or Aerial) Perspective.** Distant objects tend to look less sharp than close objects because the atmosphere often contains smog, fog, dust, or haze. A sensation of depth is conveyed because objects that are hazy and lacking in detail appear to be far away.
7. **Relative Motion.** This phenomenon can be seen by looking out the side window of a car as you are riding. Objects that are close to the car seem to be moving by very quickly, while objects in the distance, such as hills, appear to move slowly. This effect can convey the sensation of depth in a movie.

Perception of Motion

Our visual sensory system detects and perceives many different kinds of movement. A few examples are: a figure moving against a stationary background, objects at rest against a moving background, objects moving at different speeds in relation to each other, the observer's own movements in relation to his or her surroundings, and many different kinds of apparent movement where there is none. We can only marvel at the eye's amazing ability to sift through all the movement it encounters and the brain's ability to make sense of it all.

Induced movement, or the perception of movement of an object that is not moving, can be caused by the motion of nearby objects. For example, the moon often seems to be racing through clouds, when it is the clouds that are moving.

Our perception of movement in film is influenced not only by the physical movement on the screen but also by our past experience with moving objects and with watching films.

In the Eye

The eyes sense motion in **two** ways: detecting movement and tracking movement.

1. When the eye is still, the image of a moving object sweeps across the retina, firing a row of receptors in sequence. Neurons in the visual cortex, linked to the receptors, act as motion detectors.
2. When the retina locks onto a moving object and follows it in a tracking process, there is no movement on the retina, but the brain nevertheless perceives motion.

In the Brain

The brain perceives motion by **two** main processes, usually occurring simultaneously.

1. The short-range system detects movements without knowing what is moving, reacting only to changes in the patterns of light sensed by the retina. It operates automatically and is not influenced by attention.
2. The long-range system registers what is moving from one place to another. It can be influenced by attention.

Sidebar

Movement in Film

One of the most amazing illusions is something we have all experienced many times—the "motion" in motion pictures. In reality, movies consist of a sequence of thousands of still photographs projected onto the screen at a rate so fast that the gaps in motion between each frame are imperceptible. We perceive movement in the smooth flow of images on the screen.

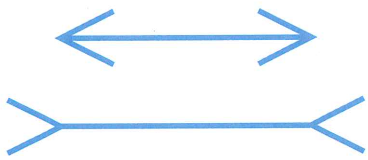
Illusions

Most of us have heard the expression "Seeing is believing," and we accept it as an accurate statement. In other words, if you see something, you can believe that it is really there. But the fact is that when you see something, it is not simply the result of your eyes passively recording something. Rather, it is the result of your brain's interpretation of the stimuli reaching your eyes. What you see may not be what is really there; it may be what your brain believes is there. These inaccurate perceptions are called **illusions**. So instead of "Seeing is believing," perhaps a more accurate expression would be "Believing is seeing." It is our beliefs, based on prior experience of the world "out there," that sometimes causes us to perceive something inaccurately.

Psychologists are interested in studying how people respond to illusions. These inaccurate perceptions, caused by our attempt to make sense of the world outside, can reveal useful clues about the functioning of our system of visual perception. Because there are so many kinds of visual illusions, researchers have not yet been able to come up with one theory that can explain them all. In addition to Rubin's reversible figure illusion (page 71), the following **five** illusions are those most often used by psychologists.

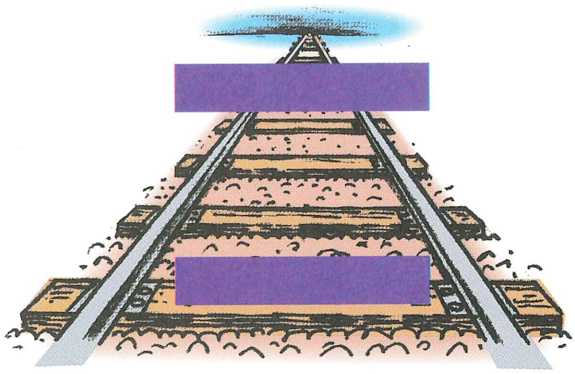
1 The Muller-Lyer Illusion

Which line appears longer? Measure them. Psychologists theorize that we misperceive the lengths of the lines because of our years of experience with straight lines, sharp edges, and corners.



2 The Ponzo Railroad Track Illusion

Which of the two horizontal bars on the railroad track is longer? Measure them. Why does the one on top appear larger?



CRITICAL THINKING

Do Some People Have ESP?

Researchers have conducted experiments designed to demonstrate whether or not extrasensory perception (ESP) exists in human beings. What do you think such experiments prove?

THE EXPERIMENT

Psychologist J. B. Rhine was interested in studying extrasensory perception. In 1933 he devised a special deck of cards. It consisted of 25 cards, each having one of five symbols on it—a star, three wavy lines, a circle, a square, or a cross. In one of his early experiments, he chose a subject, Pierce, who claimed to have ESP. He had Pierce attempt to identify the symbols on cards that were manipulated by an assistant in a building over 100 yards away. The assistant shuffled the cards and laid them facedown, one by one, so that the assistant himself did not see the symbol on the card. In 1,850 trials, Pierce scored 558 correct hits. Chance would have yielded 370 hits. The probability that Pierce would have identified by guesswork so many cards above the chance expectation was less than one in a million times a million times a million times a million. Rhine believed he had demonstrated the existence of ESP, but many people remained skeptical. Over the years he carried out many ESP experiments. His critics pointed out that some of Rhine's experiments used badly printed cards on which a faint outline of the symbol showed through the back. At other times the experimenter knew the correct cards and may have unconsciously given subjects cues with his eyes, facial gestures, or lip movements. The performance of subjects on repeated tests has been inconsistent. So we are left with both believers in ESP and skeptics.

THE PROCESS

1. **Restate the argument.** In your own words, explain what Rhine was attempting to demonstrate.
2. **Provide evidence.** List the evidence from the experiments that *supports* Rhine's theory.
3. **Give opposing arguments.** From the experiments and from your own experience, list the evidence that Rhine's theory was *not proven.*
4. **Look for more information.** What else would you want to know before you decide whether ESP exists? Make a list of questions. Then research *J. B. Rhine* and *ESP* in an encyclopedia, on the Internet, in the psychology section of a library, or in the index of a psychology reference book.
5. **Evaluate the information.** Make a chart with two columns:

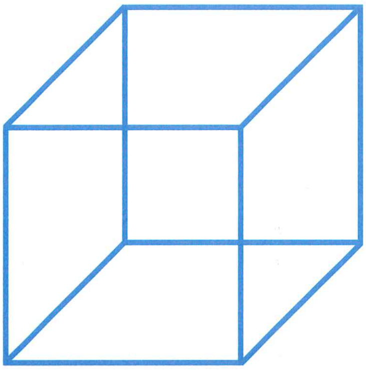
Rhine's Experiments	
Conclusive	Not Conclusive

   Record the evidence and give each item a number from 1 to 5 to show its importance. Number 1 is most important.

6. **Draw conclusions.** Write one paragraph explaining your thinking about the experiment.

3 The Necker Cube

There are two ways of seeing this cube. As you look at it, the cube suddenly seems to shift and another side seems closer to you. Then it shifts back again. Your brain is trying to decide which is the proper viewing angle, but not enough information is given for a conclusive interpretation.

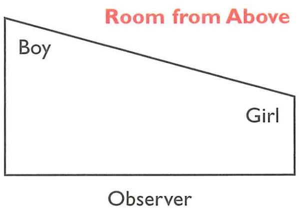


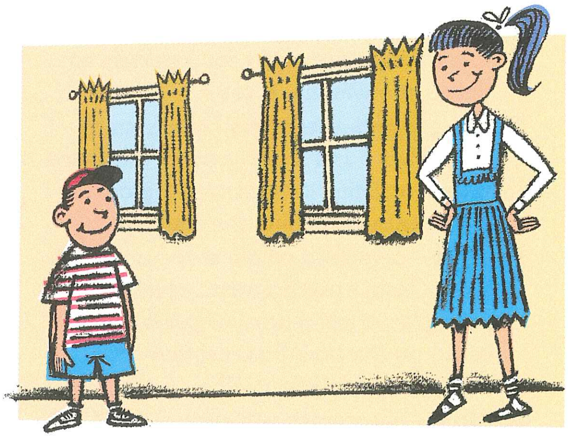
4 The Boring Figure

Designed by the American psychologist E. G. Boring, this ambiguous figure can alternately be seen as either a young girl or an old woman. Can you see them both?

5 The Ames Room

Designed by Albert Ames, this room appears to be a normal rectangular room when viewed from the front. But it is actually shaped so that the left corner is almost twice as far away from the viewer as the right corner. The viewer perceives the nearer person as being much larger than the other, although both are exactly the same height. The viewer has to decide if the room is an odd shape or if the people are odd sizes. Based on experience with the usual rectangular rooms, the viewer chooses the most probable interpretation—the people must be different sizes. This special room demonstrates that perception is an active process.





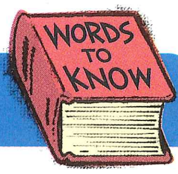
▲ This diagram above of the Ames Room reveals why the girl appears bigger than the boy.

Chapter 5 Wrap-up

PERCEPTION

Scientists do not fully understand how the brain processes incoming neural impulses to perceive the world. Perception, as opposed to mere sensation, is believed to involve a person's previous experience, memories, personal tastes, and expectations. Prior knowledge of perceptual constancies—such as size, shape, brightness, and color—helps us make sense of our environment. Scientists have proposed various theories to describe how perceptions are organized. Constructionists believe that the brain constructs a perception from a great many elementary sensations. The Gestalt psychologists believed that the brain perceives a stimulus as a whole, not as individual sensations. They proposed a series of Gestalt laws to describe the process. Our perception of depth involves certain bodily depth cues and pictorial depth cues. Our eyes sense motion in two ways—detecting movement and tracking movement. Illusions occur when we perceive something inaccurately.

Psychology



binocular cues—depth perception cues that require the use of two eyes. *p. 72*

constructionist view—theory that the brain constructs a perception out of a great many individual sensations. *p. 69*

difference threshold—degree of change in a stimulus necessary for a person to detect the difference. *p. 67*

figure-ground—separation of a pattern into a figure and a background; the figure is seen as being in front of the ground, which extends behind the figure. *p. 71*

Gestalt—organized whole shape or form. Gestalt psychologists developed principles of perceptual organization based on the brain's perception of a stimulus as a whole. *p. 69*

illusions—inaccurate perceptions. *p. 75*

induced movement—perception of movement of an object that is not moving; it can be caused by the movement of nearby objects. *p. 74*

monocular cues—depth perception cues that require only one eye to be processed. *p. 72*

perception—experience caused by stimulation of the senses. *p. 66*

psychophysics—study of behavioral aspects of a response to stimuli, such as absolute and difference thresholds. *p. 66*

signal-detection theory—theory for detecting sensory stimuli that takes into account not only the strength of the stimuli but also other elements such as one's mood and physical state. *p. 67*