Meriwether Lewis, leader of the nineteenth-century Lewis and Clark expedition, was exploring ahead of his group. Startled by an aggressive grizzly bear charging out of the bush, Lewis jumped into a river to escape, and the bear withdrew. While traveling the 12 miles back to his group, the shaken Lewis found himself perceiving other animals as threatening, and he preemptively shot several. "It now seemed to me that all the beasts of the neighborhood had made a league to destroy me" (Larsen, 2004). Primed by his frightening encounter, Lewis was perceiving the world differently.

Two centuries later, Amadou Diallo, an unarmed West African immigrant, was approached by four New York City police officers on the stoop of his Bronx apartment complex. As he pulled his wallet and identification out of his pocket, the officers—apparently feeling threatened by their own previous encounters—mistook his wallet for a gun. Diallo, a street vendor, died in a hail of 41 bullets.

Some 2400 years ago, Plato rightly discerned the principle that these cases illustrate—that we perceive objects through our senses, with our mind. To construct the outside world inside our heads we must detect physical energy from the environment (bottom-up) and then encode it as neural signals (a process traditionally called sensation). We must also select, organize, and interpret (top-down) our sensations (a process traditionally called perception). We not only sense raw sights and sounds, tastes and smells, we perceive. We hear not just a mix of pitches and rhythms but a child’s cry, the traffic’s hum, a symphony’s crescendo. Our perceptions are affected by the biology of our sensory systems, but also by our previous experiences (a bear attack) and cultural expectations (police officers are trained to expect and cope with “action”). In transforming sensations into perceptions, we create the meaning.

Selective Attention

**Objective 1 | Describe the interplay between attention and perception.**

Perceptions come to us moment by moment, one perception vanishing as the next appears. Note how the Necker cube in **Figure 6.1** evokes more than one perception. The circles can be organized into several coherent images, each equally plausible, and your mind switches back and forth from one to the next. You know that alternative interpretations of this figure are possible, but you can consciously experience only one at any moment. This illustrates an important principle: Our conscious attention is selective.

Selective attention means that at any moment our awareness focuses, like a flashlight beam, on only a limited aspect of all that we experience. Indeed, a very limited aspect: By one estimate, our five senses take in 11,000,000 bits...
selective attention  the focusing of conscious awareness on a particular stimulus, as in the cocktail party effect.

inattentional blindness  failing to see visible objects when our attention is directed elsewhere.

of information per second, of which we consciously process about 40 (Wilson, 2002). Yet we intuitively make great use of the other 10,999,960 bits. Until reading this sentence, you have been unaware that your shoes are pressing against your feet or that your nose is in your line of vision. Now, suddenly, your attentional spotlight shifts. Your feet feel encased, your nose stubbornly intrudes on the page before you. While attending to these words, you’ve also been blocking from awareness information coming from your peripheral vision. But you can change that. While staring at the X below, notice what surrounds the book (the edges of the page, your desktop, and so forth).

Another example of selective attention, the cocktail party effect, is your ability to attend to only one voice among many (though let another voice speak your name and your cognitive radar will instantly bring that voice into consciousness). This focused listening comes at a cost. Imagine hearing two conversations over a headset, one in each ear, and being asked to repeat the message in your left ear while it is spoken. When paying attention to what is being said in your left ear, you won’t perceive what is said in your right. Asked later what language your right ear heard, you may draw a blank (though you could report the speaker’s gender and loudness).

At the level of conscious awareness, our attention is divided. Talk while driving and your attention will shift back and forth from the road to the phone. That explains why drivers typically stop talking when demanding situations require their full attention. The process of switching attentional gears also costs a bit of time, especially when shifting to complex tasks (Rubenstein & others, 2001). But even shifting from cell-phone talking to a driving crisis can entail a slight delay in coping. In University of Utah driving-simulation experiments, students conversing on cell phones were slower to detect and respond to traffic signals, billboards, and other cars (Strayer & Johnston, 2001; Strayer & others, 2003). Some experienced airline pilots, while attending to data displayed on a flight simulator’s console and windshield, have similarly failed to notice visible airplanes blocking their landing path (Haines, 1991).

From the immense array of visual stimuli constantly before us, we select just a few to process. Ulric Neisser (1979) and Robert Becklen and Daniel Cervone (1983) demonstrated this dramatically. They showed people a one-minute videotape in which the images of three men in black shirts tossing a basketball were superimposed over the images of three men in white shirts doing the same thing. They asked the viewers to press a key every time the black-shirted players passed the ball. Midway through the tape, a young woman carrying an umbrella sauntered across the screen. Most had focused their attention so completely on the black-shirted players that they failed to notice the woman. When the researchers replayed the tape for them, they were astonished to see her. In a recent repeat of the experiment, smart-aleck researchers Daniel Simons and Christopher Chabris (1999) sent a gorilla-suited assistant through the swirl of players (FIGURE 6.2). During its 5- to 9-second cameo appearance, the gorilla paused to thump its chest. Still, half the conscientious pass-counting participants exhibited inattentional blindness. They failed to see it.
In other experiments, people also exhibit a remarkable lack of awareness of happenings in their visual environment. After a brief visual interruption, a big Coke bottle may disappear from the scene, a railing may rise, clothing color may change, and, more often than not, viewers don’t notice (Resnick & others, 1997; Simons, 1996; Simons & Ambinder, 2005). This form of inattentiveness, also called change blindness, has occurred among people giving directions to a construction worker who, unnoticed by two-thirds of them, is replaced by another construction worker (Figure 6.3). Out of sight, out of mind. Change deafness can also occur. In one experiment, 40% of people focused on repeating a list of sometimes challenging words failed to notice a change in the person speaking (Vitevitch, 2003).

An equally astonishing form of inattentional blindness is the phenomenon of choice blindness discovered by a Swedish research team. Petter Johansson and his colleagues (2005) showed 120 volunteers two female faces for 2 to 5 or more seconds and asked them which they thought was more attractive. They then put the photos face down and handed them the one they had chosen, inviting them to explain their choice. On 3 of 15 occasions, the tricky researchers used sleight-of-hand to switch the photos—showing them the face they had not chosen. Not only did the people seldom notice the deception (on only 13 percent of the switches), they readily explained why they preferred the face they had actually rejected. “I chose her because she smiled,” said one person (after picking the solemn-faced one). When asked after the experiment whether, in a “hypothetical experiment,” they would notice such a switch, 84 percent insisted they would. They exhibit a blindness to the phenomenon that the researchers call (can you see the twinkle in their eyes?) choice-blindness blindness.

Yet some stimuli are so powerful that we experience pop-out, when a strikingly distinct stimulus, such as the only smiling face in Figure 6.4 draws our eye. We don’t choose to attend to these stimuli; they demand our attention. Meriwether Lewis couldn’t have missed the attacking bear.
Selective Attention

**OBJECTIVE 1** | Describe the interplay between attention and perception.

In a process traditionally known as sensation, our senses of vision, hearing, taste, smell, and touch detect physical energy from the environment and encode it as neural signals. Aided by knowledge and expectations, our brain perceives meaning in these signals. We selectively attend to, and process, a limited number of the data bombarding our senses and block out the others. This focused attention can result in inattentional or change blindness, and even choice blindness.

**ASK YOURSELF:** Can you recall a recent time when your attention focused on one thing, you were oblivious to something else (perhaps to pain, to someone’s approach, or to background music)?

Perceptual Illusions

**OBJECTIVE 2** | Explain how illusions help us to understand some of the ways we organize stimuli into meaningful perceptions.

Perceptual illusions have long fascinated scientists: Why, even when we know better, do we see illusions? Illusions reveal the ways we normally organize and interpret our sensations. Illusions illuminate. Consider six such perceptual illusions:

*Illusion 1* Below is an adaptation of a classic illusion created in 1889 by Franz Müller-Lyer. Does either line segment—AB or BC—appear longer? To most people the two segments appear to be the same length. Surprise! They are not. As your ruler can verify, line AB is more than one-fourth longer than line BC. Why did your eyes deceive you? (On page 251 you will discover one explanation.)

![Illusion 1](image)

*Illusion 2* Below we have two unretouched photos of the same two girls, in the same room. The camera shows you these scenes much as you would see them if you were viewing the room through a peephole. Why do the girls seem to change size when they switch places? (Page 252 will reveal why.)

![Illusion 2](image)
Illusion 3  Is the St. Louis Gateway Arch—the world’s largest human-made illusion—taller than it is wide? Or wider than it is tall? To most it appears taller. In truth, its height and width are equal. Once again, seeing is deceiving. Why? (On page 247 we will meet this phenomenon again.)

Illusion 4  Here is another brain construction of virtual reality, described in 1935 by Hans Wallach. Do you see, below, a glowing blue worm curving through the black lines? The illusory worm is merely the short blue lines of the left figure with black lines added. Anything else you perceive is a product of your “creative genius” (Hoffman, 1998). (See the discussion of grouping principles on pages 243–244.)

Illusion 5  The real creators of virtual reality are not software developers, but the brains that developers trick into constructing virtual realities. Donald Hoffman’s (1998) ripple is a flat, two-dimensional drawing. But can you perceive it as flat? Not easily. Your brain will persist in creating a ripple that is not there. And it will construe it quite differently if you turn the book upside down. The ripple illusion is in part an assumption about light sources, as you will see on page 248.

"Has your visual system gone off the deep end? It constructs from whole cloth a ripple in space and then proceeds to embellish it with mutable parts. Shall we henceforth distrust the witness of vision, knowing now its penchant to perjure?"

Donald Hoffman, *Visual Intelligence*, 1998
Illusion 6 Illusions occur with the other senses, too, as the German psychologist Wilhelm Wundt pointed out more than a century ago. Wundt was puzzled by people’s hearing the steady beat of a metronome or clock as if it were a repeating rhythm of two, three, or four beats. Rather than hearing an unaccented click-click-click-click-click, one might, for example, hear CLICK-click CLICK-click. Although a steady beat strikes the ear, each listener unconsciously shapes an auditory pattern. What perceptual principle is at work here? (See page 253.)

Psychology’s emphasis on visual illusions reflects vision’s preeminence among our senses. When vision competes with other senses, vision usually wins—a phenomenon called visual capture. If the sound of a movie comes from a projector behind us, we nevertheless perceive it as coming from the screen, where we see the actors talking (much as we perceive a voice from a ventriloquist’s dummy). While watching a roller coaster ride on a wraparound movie screen, we may brace ourselves, though our other senses tell us we’re not moving. In each case, vision captures the other senses.

Hearing can also capture another sense. Kirsten Hötting and Brigitte Röder (2004) invited volunteers to count mechanical touches of their fingers while also hearing multiple tones. When one touch was accompanied by more than one tone, people often reported perceiving more than a single touch. There is more to touch than meets the skin.

Learning Outcomes

Perceptual Illusions

Objective 2 | Explain how illusions help us to understand some of the ways we organize stimuli into meaningful perceptions.

Perceptual illusions fascinate psychologists because they reveal how we normally organize and interpret sensations. When visual and other sensory information conflict, our brain usually resolves the disagreement by accepting the visual data, a tendency known as visual capture. In contests between hearing and touch, hearing may dominate.

Ask Yourself: Have you ever watched a movie where spoken words and people’s facial expressions were out of sync? Which did you think needed to be adjusted—the visual image you were seeing, or the sounds you were hearing?

Perceptual Organization

Objective 3 | Describe Gestalt psychology’s contribution to our understanding of perception.

To transform sensory information into meaningful perceptions, we must organize it: We must perceive objects as distinct from their surroundings, see them as having a meaningful and constant form, and discern their distance and motion. The brain’s rules for constructing perceptions explain some of the puzzling illusions we’ve considered.

Early in the twentieth century, a group of German psychologists became intrigued with how the mind organizes sensations into perceptions. They noticed that when given a cluster of sensations, we tend to organize them into a gestalt, a German word meaning a “form” or a “whole.” The Gestalt psychologists provided compelling demonstrations of gestalt perception and described principles by which we organize our sensations into perceptions. For example, look again at Figure 6.1 on page 237.
Note that the individual elements of the figure are really nothing but eight blue circles, each containing three converging white lines. When we view them all together, however, we see a whole, a form, a Necker cube.

The Gestalt psychologists were fond of saying that in perception the whole may exceed the sum of its parts. Combine sodium, a corrosive metal, with chlorine, a poisonous gas, and something very different emerges—table salt. Likewise, a unique perceived form emerges from a stimulus’ components (Rock & Palmer, 1990). The police officers’ perception of Amadou Diallo was very different from his neighbors’—who would not have perceived a threat in the same scene.

Our yen for assembling visual features into complete forms involves bottom-up processing, starting with entry-level sensory analysis, as well as top-down processing that uses our experiences and expectations to interpret those sensations. But the more we learn about this information-processing system, the fuzzier the distinction grows between sensation and perception. Sensation is not just bottom-up processing, and perception is not just top-down processing. Sensation and perception blend into one continuous process, progressing upward from specialized detector cells and downward from our assumptions.

As you read further about the Gestalt psychologists’ organizational principles, keep in mind the fundamental truth they illustrate: Our brains do more than merely register information about the world. Perception is not just opening a shutter and letting a picture print itself on the brain. We constantly filter sensory information and infer perceptions in ways that make sense to us. Mind matters.

Form Perception

**Objective 4** | Explain the figure-ground relationship, and identify principles of perceptual grouping in form perception.

Imagine designing a video/computer system that, like your eye/brain system, can recognize faces at a glance. What abilities does it need?

**Figure and Ground**

To start with, the system needs to recognize the faces as distinct from their backgrounds. Likewise, our first perceptual task is to perceive any object, called the figure, as distinct from its surroundings, called the ground. Among the voices you hear at a party, the one you attend to becomes the figure; all others, part of the ground. As you read, the words are the figure; the white paper, the ground. In **Figure 6.5**, the figure-ground relationship continually reverses—but always we organize the stimulus into a figure seen against a ground. Such reversible figure-and-ground illustrations demonstrate again that the same stimulus can trigger more than one perception.

**Grouping**

Having discriminated figure from ground, we (and our video/computer system) now have to organize the figure into a meaningful form. Some basic features of a scene—such as color, movement, and light/dark contrast—we process instantly and automatically (Treisman, 1987). To bring order and form to these basic sensations, our minds follow certain rules for grouping stimuli together (**Figure 6.6**, page 244). These rules, identified by the Gestalt psychologists and applied even by infants, illustrate the idea that the perceived whole differs from the sum of its parts (Quinn & others, 2002; Rock & Palmer, 1990):
Organizing stimuli into groups

We could perceive the stimuli shown here in many ways, yet people everywhere see them similarly. The Gestalt psychologists believed this shows that the brain follows rules to order sensory information into wholes.

**Proximity** We group nearby figures together. We see not six separate lines, but three sets of two lines.

**Similarity** We group together figures that are similar to each other. We see the triangles and circles as vertical columns of similar shapes, not as horizontal rows of dissimilar shapes.

**Continuity** We perceive smooth, continuous patterns rather than discontinuous ones. This pattern could be a series of alternating semicircles, but we perceive it as two continuous lines—one wavy, one straight.

**Connectedness** Because they are uniform and linked, we perceive the two dots and the line between them as a single unit.

What's the secret to this impossible doghouse? You probably perceive this doghouse as a gestalt—a whole (though impossible) structure. Actually, your brain imposes this sense of wholeness on the picture. As the photo on page 253 shows, Gestalt grouping principles such as closure and continuity are at work here.

**Closure** We fill in gaps to create a complete, whole object. Thus we assume that the circles (above) are complete but partially blocked by the (illusory) triangle. Add nothing more than little line segments that close off the circles and now your brain stops constructing a triangle.

Usually, these grouping principles help us construct reality. Sometimes, however, they lead us astray, as with our perception of the neon worm in Illusion 4, page 241, or when we look at the doghouse in **FIGURE 6.7**.
Depth Perception

**Objective 5** | Explain the importance of depth perception, and discuss the contribution of visual cliff research to our understanding of this ability.

Two-dimensional images fall on our retinas, yet we somehow organize three-dimensional perceptions. Seeing objects in three dimensions, called depth perception, enables us to estimate their distance from us. At a glance, we estimate the distance of an oncoming car or the height of a house. This ability is partly innate. Eleanor Gibson and Richard Walk (1960) discovered this using a miniature cliff with a drop-off covered by sturdy glass. Gibson’s inspiration for these experiments occurred while she was picnicking on the rim of the Grand Canyon. She wondered: Would a toddler peering over the rim perceive the dangerous drop-off and draw back?

Back in their Cornell University laboratory, Gibson and Walk placed 6- to 14-month-old infants on the edge of a safe canyon—a visual cliff (FIGURE 6.8). Their mothers then coaxed them to crawl out onto the glass. Most refused to do so, indicating that they could perceive depth. Perhaps by crawling age the infants had learned to perceive depth. Yet newborn animals with virtually no visual experience—including young kittens, a day-old goat, and newly hatched chicks—respond similarly.

Each species, by the time it is mobile, has the perceptual abilities it needs. What is more, by 3 months of age, infants are using Gestalt perception principles, by looking more at novel groupings of objects (Quinn & others, 2002). But if biological maturation predisposes our wariness of heights, experience amplifies it. Infants’ wariness increases with their experiences of crawling, no matter when they begin to crawl.

How do we do it? How do we transform two differing two-dimensional retinal images into a single three-dimensional perception? The process begins with depth cues, some that depend on the use of two eyes, and others that are available to each eye separately.

**Binocular Cues**

**Objective 6** | Describe two binocular cues for perceiving depth, and explain how they help the brain to compute distance.

Try this: With both eyes open, hold two pens or pencils in front of you and touch their tips together. Now do so with one eye closed. With one eye the task becomes noticeably more difficult, demonstrating the importance of binocular cues in judging the distance of nearby objects. Two eyes are better than one.
Because our eyes are about 2½ inches apart, our retinas receive slightly different images of the world. When the brain compares these two images, the difference between them—their retinal disparity—provides an important cue to the relative distance of different objects. When you hold your finger directly in front of your nose, your retinas receive quite different views. (You can see this if you close one eye and then the other, or create a finger sausage as in Figure 6.9.) At a greater distance—say, when you hold your finger at arm’s length—the disparity is smaller.

The creators of three-dimensional (3-D) movies simulate or exaggerate retinal disparity by photographing a scene with two cameras placed a few inches apart (a feature we might want to build into our seeing computer). When we view the movie through spectacles that allow the left eye to see only the image from the left camera and the right eye only the image from the right camera, the 3-D effect mimics normal retinal disparity. Similarly, twin cameras in airplanes can take photos of terrain for integration into 3-D maps.

Another binocular cue to distance is convergence, a neuromuscular cue caused by the eyes’ greater inward turn when they view a near object. The brain notes the angle of convergence, then computes whether you are focusing on this printed page or on something else across the room. The greater the inward strain, the closer the object.

**Monocular Cues**

**Objective 7** | Explain how monocular cues differ from binocular cues, and describe several monocular cues for perceiving depth.

How do we judge whether a person is 10 or 100 meters away? In both cases, the retinal disparity and convergence while looking straight ahead are slight. At such distances we depend on monocular cues (available to each eye separately), such as the following:

**Relative size** If we assume that two objects are similar in size, we perceive the one that casts the smaller retinal image as farther away. To a driver, distant pedestrians appear smaller, which also means that small-looking pedestrians (children) may sometimes be misperceived as more distant than they are (Stewart, 2000).

**Interposition** If one object partially blocks our view of another, we perceive it as closer. The painting at the top of page 247 purposefully confuses figure and ground by interposition.
Relative clarity Because light from distant objects passes through more atmosphere, we perceive hazy objects as farther away than sharp, clear objects. In fog or snow, the car in front of you may therefore seem farther away than it is.

Texture gradient A gradual change from a coarse, distinct texture to a fine, indistinct texture signals increasing distance. Objects far away appear smaller and more densely packed.

Relative height We perceive objects higher in our field of vision as farther away. Because we perceive the lower part of a figure-ground illustration as closer, we perceive it as figure (Vecera & others, 2002). Invert the illustration below (right) and the black becomes ground, like a night sky.

Relative height may contribute to the illusion that vertical dimensions are longer than identical horizontal dimensions (as we saw in Illusion 3, page 241, the St. Louis Gateway Arch). No wonder people pour less juice when given a tall, thin glass rather than a short, wide glass (Wansink & van Ittersum, 2003). A tall glass looks as though it has more liquid than it actually does. Is the vertical line in the diagram below (left) longer, shorter, or equal in length to the horizontal line? Measure and see.

Figure this

Thanks to relative height, lower objects seem closer—and thus are usually perceived as figure.
Relative motion (motion parallax) As we move, objects that are actually stable may appear to move. If while riding on a bus you fix your gaze on some object—say, a house—the objects closer than the house (the fixation point) appear to move backward. The nearer the object is to you, the faster it seems to move.

Objects beyond the fixation point appear to move with you, and the farther away those objects are, the faster they will move. Your brain uses these speed and direction clues to compute the objects’ relative distances.

Linear perspective Parallel lines, such as railroad tracks, appear to converge with distance. The more the lines converge, the greater their perceived distance. Linear perspective can contribute to rail-crossing accidents by leading people to overestimate a train’s distance (Leibowitz, 1985).

Light and shadow Nearby objects reflect more light to our eyes. Given two identical objects, the dimmer one seems farther away. This illusion can also contribute to accidents, as when a fog-shrouded vehicle, or one with only its parking lights on, seems farther away than it is. Shading, too, produces a sense of depth consistent with the assumed light source. (Recall the ripples of illusion 5, on page 241.) Invert the illustration below and the hollow becomes a hill, because our brain follows a simple rule that works well on Planet Earth: Assume that light comes from above.
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FIGURE 6.10
Perspective techniques
By the time that “Bristol, Broad Quay” was painted (c. 1730, Anonymous), techniques for depicting three dimensions on a flat surface were well established. Note the effective use of distance cues such as texture gradient, interposition, linear perspective, and relative size and height.

Artists use monocular cues to convey depth on a flat canvas (FIGURE 6.10). To you and me, the drawing in FIGURE 6.11 clearly indicates that the elephant is far away, rather than about to be speared—which is how it was perceived a half-century ago by many South African Bantus who had minimal experience with photos and drawings (Deregowski, 1972; Hudson, 1960).

FIGURE 6.11
What’s for dinner?
Monocular depth cues such as relative size and distance indicate to people familiar with artistic and photographic use of such cues that it’s not the elephant. (From Deregowski, 1972.)

Motion Perception

Objective 8 | State the basic assumption we make in our perceptions of motion, and explain how these perceptions can be deceiving.

Imagine that you could perceive the world as having color, form, and depth but that you could not see motion. Not only would you be unable to bike or drive, you might even have trouble writing, eating, and walking.

Fortunately, you can perceive motion (sometimes, as in the drawing of the pendulum on page 236, even when there is none). Normally your brain computes motion based partly on its assumption that shrinking objects are retreating (not getting smaller) and enlarging objects are approaching. But you are imperfect at motion perception. Large objects, such as trains, appear to move more slowly than smaller objects, such as cars moving at the same speed. (Perhaps at an airport you’ve noticed that jumbo jets seem to land more slowly than little jets going the same speed or slower.)

To catch a fly ball, softball or cricket players (unlike drivers) want to achieve a collision—with the ball that’s flying their way. To accomplish that, they follow a simple rule: By keeping the ball at a constant angle of gaze, a fielder will run through the point of its return as it arrives (McBeath & others, 1995). A dog catching a Frisbee does the same (Shaffer & others, 2004).
As film animation artists know well, the brain will also perceive continuous movement in a rapid series of slightly varying images (a phenomenon called stroboscopic movement). A motion picture creates this illusion by flashing 24 still pictures each second. The motion we see is not in the film, which merely presents a superfast slide show. The motion is constructed in our heads.

Marquees and holiday lights create another illusion of movement using the phi phenomenon. When two adjacent stationary lights blink on and off in quick succession, we perceive a single light moving back and forth between them. Lighted signs exploit the phi phenomenon with a succession of lights that creates the impression of, say, a moving arrow. This reinforces a fundamental lesson: Perception is not merely projecting the world onto our brain. Rather, sensations are disassembled into information bits that the brain then reassembles into its own functional model of the external world. Our brain constructs our perceptions.

### Perceptual Constancy

**Objective 9** | Explain the importance of perceptual constancy.

So far, we have noted that our video/computer system must first perceive objects as we do—as having a distinct form, location, and perhaps motion. Its next task is even more challenging: to recognize the object without being deceived by changes in its shape, size, brightness, or color. Perceptual constancy enables us to perceive an object as unchanging despite a changing stimulus. Thanks to this top-down process, we can identify things regardless of the angle, distance, and illumination by which we view them. You glance at someone ahead of you on the sidewalk and instantly recognize a classmate. In less time than it takes to draw a breath, information reaching your eyes has been sent to your brain, where work teams comprising millions of neurons have extracted the essential features, compared them with stored images, and identified the person. Replicating this human perceptual feat, which has intrigued perception researchers for decades, provides a monumental challenge for our perceiving computer.

### Shape and Size Constancies

**Objective 10** | Describe the shape and size constancies, and explain how our expectations about perceived size and distance contribute to some visual illusions.

Sometimes an object whose actual shape cannot change seems to change shape with the angle of our view (FIGURE 6.12). More often, thanks to shape constancy, we perceive the form of familiar objects as constant even while our retinal images of them change. When a door opens, it casts a changing shape on our retinas, yet we still manage to perceive the door as having a constant doorlike shape (FIGURE 6.13).

Thanks to size constancy we perceive objects as having a constant size, even while our distance from them varies. Size constancy leads us to perceive a car as large enough to carry people, even when we see its tiny image from two blocks away. This illustrates the
close connection between an object’s perceived distance and perceived size. Perceiving an object’s distance gives us cues to its size. Likewise, knowing its general size—that the object is, say, a car—provides us with cues to its distance.

**Size-Distance Relationship** It is a marvel how effortlessly size perception occurs. Given an object’s perceived distance and the size of its image on our retinas, we instantly and unconsciously infer the object’s size. Although the monsters in **Figure 6.14a** cast the same retinal images, the linear perspective tells our brain that the monster in pursuit is farther away. We therefore perceive it as larger.

This interplay between perceived size and perceived distance helps explain several well-known illusions. For example, can you imagine why the Moon looks up to 50 percent larger near the horizon than when high in the sky? For at least 22 centuries, scholars have wondered and have argued about reasons for the **Moon illusion** (Hershenson, 1989). One reason is that cues to objects’ distances at the horizon make the Moon behind them seem farther away than the Moon high in the night sky (Kaufman & Kaufman, 2000). Thus, the horizon Moon—like the distant monster in Figure 6.14a and the distant bar in the **Ponzo illusion** in Figure 6.14b—seems larger. Take away these distance cues—by looking at the horizon Moon (or each monster or each bar) through a paper tube—and the object immediately shrinks.

The size-distance relationship helps us understand two illusions demonstrated earlier. Illusion 1, the Müller-Lyer illusion concerning the lengths of straight lines between arrow tips, has been the subject of more than 1250 scientific publications, yet psychologists still debate its explanation. One is that our experience with the corners of rooms or buildings prompts us to interpret the vertical line on the ticket booth in **Figure 6.15** as close: to us and therefore shorter, and the same-length vertical line by the door as farther away and therefore longer. Thus, what appears as an illusion when isolated in a line drawing actually enables correct depth perception in our three-dimensional world.

**FIGURE 6.14**
**The interplay between perceived size and distance**
(a) The monocular cues for distance (such as linear perspective and relative height) make the pursuing monster look larger than the pursued. It isn’t.
(b) This visual trick, called the Ponzo illusion, is based on the same principle as the fleeing monsters. The two red bars cast identical-sized images on our retinas. But experience tells us that a more distant object can create the same-sized image as a nearer one only if it is actually larger. As a result, we perceive the bar that seems farther away as larger.

**FIGURE 6.15**
**The Müller-Lyer Illusion**
Richard L. Gregory (1968) suggested that the corners in our rectangularly carpentered world teach us to interpret “outward” or “inward” pointing arrowheads at the ends of a line as a cue to the line’s distance from us and so to its length. The red line defined by the corner at the ticket booth looks shorter than the red line defined by the room corner. But if you measure them, you will see that both are the same length.
Culture and perception
Rural Africans who did not live in an environment of constructed rectangular buildings—such as people in South African Zulu round houses shown here—were less vulnerable to the Müller-Lyer illusion.

Experience supports this theory. People have been more susceptible to the Müller-Lyer illusion if, unlike some mid-twentieth-century rural Africans, they have lived in a carpentered world of rectangular shapes (Segall & others, 1990). The phenomenon reflects cultural experience, not race. Africans who live in cities are more vulnerable to the illusion than are their rural counterparts in uncarpentered environments. Our experience in rectangular contexts helps us construct our perceptions, top-down.

Size-distance relationships also explain Illusion 2, page 240, the shrinking and growing girls. As Figure 6.16 reveals, the room is distorted. Viewed with one eye through a peephole, its trapezoidal walls produce the same images as those of a normal rectangular room viewed with both eyes. Presented with the camera’s one-eyed view, the brain makes the reasonable assumption that the room is normal and that each of the girls is therefore the same distance from us. And given the different sizes of the images on the retina, our brain ends up calculating that the girls are very different in size.

Our occasional misperceptions reveal the workings of our normally effective perceptual processes. The perceived relationship between distance and size is generally valid, but under special circumstances it can lead us astray—as when helping to create the Moon illusion, the Müller-Lyer illusion, and the distorted-room illusion.

**Figure 6.16**
The illusion of the shrinking and growing girls
This distorted room, designed by Adelbert Ames, appears to have a normal rectangular shape when viewed through a peephole with one eye. The girl in the near corner appears disproportionately large because we judge her size based on the false assumption that she is the same distance away as the girl in the far corner.
Lightness Constancy

**Objective 1.** Discuss lightness constancy and its similarity to color constancy.

White paper reflects 90 percent of the light falling on it; black paper, only 10 percent. In sunlight a black paper may reflect 100 times more light than does a white paper viewed indoors, but it still looks black (McBurney & Collings, 1984). This illustrates lightness constancy (also called brightness constancy); we perceive an object as having a constant lightness even while its illumination varies. Perceived lightness depends on relative luminance—the amount of light an object reflects relative to its surroundings. If you view sunlit black paper through a narrow tube so nothing else is visible, it may look gray, because in bright sunshine it reflects a fair amount of light. View it without the tube and it is again black, because it reflects much less light than the objects around it. The phenomenon is similar to that of color constancy (pages 213–214). As light changes, a red apple in a fruit bowl retains its redness, because our brain computes the light reflected by any object relative to its surrounding objects.

Perceived lightness stays roughly constant, given an unchanging context. But what happens when the surrounding context changes? As Figure 6.17 shows, the visual system computes brightness and color relative to surrounding objects. Thus, perceived lightness changes with context.

Form perception, depth perception, motion perception, and perceptual constancy illuminate how we organize our visual experiences. Perceptual organization applies to other senses, too. It explains why we group a clock’s steady clicking into patterns (Illusion 6, page 242). Listening to an unfamiliar language, we have trouble hearing where one word stops and the next one begins. Listening to our own language, we automatically hear distinct words. This, too, is a form of perceptual organization. But it is more, for we even organize a string of letters—THEDOGATEMEAT—into words that make an intelligible phrase, more likely “The dog ate meat” than “The do gate me at” (McBurney & Collings, 1984). This process involves not only organization but interpretation—discerning meaning in what we perceive.

## Learning Outcomes

**Perceptual Organization**

**Objective 3.** Describe Gestalt psychology’s contribution to our understanding of perception.

Gestalt psychologists searched for rules by which the brain organizes fragments of sensory data into gestalts (from the German word for “whole”), or meaningful forms. In pointing out that the whole is more than the sum of its parts, these researchers showed that we constantly filter sensory information and infer perceptions in ways that make sense to us. This truth remains valid, even though contemporary research demonstrates that sensation and perception are parts of a continuous information processing system, involving both bottom-up and top-down processing.

**Objective 4.** Explain the figure-ground relationship, and identify principles of perceptual grouping in form perception.

To recognize an object, we must first perceive it (see it as a figure) as distinct from its surroundings (the ground). We bring order and form to stimuli by organizing them into meaningful groups, following the rules of proximity, similarity, continuity, connectedness, and closure.

**Objective 5.** Explain the importance of depth perception, and discuss the contribution of visual cliff research to our understanding of this ability.

Depth perception is our ability to see objects in three dimensions, even though our retinas receive two-dimensional images. Without depth perception, we would be unable to judge
distance, height, or depth. The visual cliff research with 6- to 14-month-olds demonstrated that depth perception is in part innate. Many species perceive the world in three dimensions at, or very soon after, birth.

**Objective 6** Describe two binocular cues for perceiving depth, and explain how they help the brain to compute distance.

Binocular cues are depth cues that rely on information from both eyes. In the retinal disparity cue, the brain computes the relative distance of an object by comparing the slightly different images the object casts on our two retinas. The greater the difference, the closer the object must be. In the convergence cue, the brain calculates the degree of neuromuscular strain when our two eyes turn inward to look at a nearby object. The greater the strain (or the angle of convergence), the closer the object.

**Objective 7** Explain how monocular cues differ from binocular cues, and describe several monocular cues for perceiving depth.

Monocular cues let us judge depth using information transmitted by only one eye; binocular cues require information from both eyes. Monocular cues include

- **relative size** (smaller is more distant).
- **interposition** (an object that blocks another is closer than the blocked object).
- **relative clarity** (a hazy object is farther away than an object seen clearly).
- **texture gradient** (when texture changes, coarse distinct objects are close and fine indistinct objects are distant).
- **relative height** (objects higher in our field of vision are farther away).
- **relative motion or motion parallax** (when you are moving, objects closer than a fixation point appear to move backward—the nearer the object, the faster it moves; objects beyond the fixation point appear to move with you).
- **linear perspective** (the more two parallel lines converge, the farther: away they are).
- **light and shadow** (nearby objects reflect more light than faraway objects).

**Objective 8** State the basic assumption we make in our perceptions of motion, and explain how these perceptions can be deceiving.

As objects move across or toward our retinas, our basic assumption is that shrinking objects are retreating, and enlarging objects are approaching. But our perception of motion is not always trustworthy. We may miscalculate the speed of movement of large objects or objects picked up by our peripheral vision. A quick succession of images on the retina can create an illusion of movement, as in stroboscopic movement (triggered by a rapid series of slightly varying images) or the phi phenomenon (triggered by the rapid on-off blinking of two adjacent stationary lights).

**Objective 9** Explain the importance of perceptual constancy.

Perceptual constancy is necessary in vision to recognize an object, regardless of its changing angle, distance, or illumination. Because of this ability, we perceive objects as having unchanging characteristics despite the changing images they cast on our retinas.

**Objective 10** Describe the shape and size constancies, and explain how our expectations about perceived size and distance contribute to some visual illusions.

**Shape constancy** is our ability to perceive familiar objects (such as an opening door) as unchanging in shape, and **size constancy** is perceiving objects as unchanging in size, despite the changing images they cast on our retinas. There is a close relationship between perceived size and perceived distance. Knowing an object's size gives us clues to its distance; knowing its distance gives clues about its size. This interplay sometimes misleads us, as when we misread monocular distance cues and reach the wrong conclusions, as in the Moon, Ponzo, and Müller-Lyer illusions.

**Objective 11** Discuss lightness constancy and its similarity to color constancy.

**Lightness** (or **brightness**) constancy is our ability to perceive an object as having a constant lightness even when its illumination—the light cast upon it—changes. Color constancy enables us to perceive the color of an object as unchanging even when its illumination changes. In both cases, the brain perceives the quality (lightness or color) relative to surrounding objects.

**ASK YOURSELF**: Try drawing a realistic depiction of the scene from your window. How many monocular cues will you use in your drawing?

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**Perceptual Interpretation**

Philosophers have debated whether our perceptual ability should be credited to our nature or our nurture. To what extent do we learn to perceive? German philosopher Immanuel Kant (1724–1804) maintained that knowledge comes from our *inborn* ways of organizing sensory experiences. Indeed, we come equipped to process sensory information. But British philosopher John Locke (1632–1704) argued that through our experiences we also learn to perceive the world. Indeed, we learn to link an object's distance with its size. So, just how important is experience? How radically does it shape our perceptual interpretations?
Sensory Deprivation and Restored Vision

**Objective 12** | Describe the contribution of restored-vision and sensory deprivation research in our understanding of the nature-nurture interplay in our perceptions.

Writing to John Locke, William Molyneux wondered whether “a man born blind, and now adult, taught by his touch to distinguish between a cube and a sphere” could, if made to see, visually distinguish the two. Locke’s answer was no, because the man would never have learned to see the difference.

Molyneux’s hypothetical case has since been put to the test with a few dozen adults who, though blind from birth, have gained sight (Gregory, 1978; von Senden, 1932). Most had been born with cataracts—clouded lenses that allowed them to see only diffused light, rather as you or I might see a diffuse fog through a Ping-Pong ball sliced in half. When their cataracts were surgically removed, the patients could distinguish figure from ground and could sense colors—suggesting that these aspects of perception are innate. But much as Locke supposed, the formerly blind patients often could not recognize by sight objects that were familiar by touch.

You and I perceive and recognize individual faces as a whole. Show us the same top half of a face paired with two different bottom halves (as in Figure 6.18), and the identical top halves will seem different. People deprived of visual experience during infancy surpass the rest of us at recognizing that the top halves are the same, because they didn’t learn to process faces as a whole (Le Grand & others, 2004). For example, one 43-year-old man, whose sight was recently restored after 40 years of blindness, could associate people with distinct features (“Mary’s the one with red hair”) but could not instantly recognize a face. He also lacked perceptual constancy: As people walk away from him they seem to be shrinking in size (Bower, 2003). Vision, such cases make clear, is partly an acquired sense.

Seeking to gain more control than is provided by clinical cases, researchers have conducted Molyneux’s imaginary experiment with infant kittens and monkeys. In one experiment, they outfitted them with goggles through which the animals could see only diffuse, unpatterned light (Wiesel, 1982). After infancy, when their goggles were removed, these animals exhibited perceptual limitations much like those of humans born with cataracts. They could distinguish color and brightness, but not the form of a circle.

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**Figure 6.18**

**Perceiving composite faces**

To most people, the top halves of these two faces, created by Richard Le Grand and his colleagues (2004), look different. Actually, they are the same, though paired with two different lower face halves. People deprived of visual experience early in life have more difficulty perceiving whole faces, which ironically enables their superiority at recognizing that the top halves of these faces are identical.
CHAPTER 6: PERCEPTION

Learning to see

At age 3, Mike May lost his vision in an explosion. On March 7, 2000, after a new cornea restored vision to his right eye, he got his first look at his wife and children. Alas, although signals were reaching his long dormant visual cortex, it lacked the experience to interpret them. Faces, apart from features such as hair, were not recognizable. Expressions eluded him. Yet he can see an object in motion and is gradually learning to navigate his world and to marvel at such things as dust floating in sunlight (Abrams, 2002).

Perceptual adaptation

"Oops, missed," thinks researcher Hubert Dolezal as he views the world through inverting goggles. Yet, believe it or not, kittens, monkeys, and humans can adapt to an inverted world.

Perceptual Adaptation

Objective 13 | Explain how the research on distorting goggles increases our understanding of the adaptability of perception.

Given a new pair of glasses, we may feel slightly disoriented, even dizzy. Within a day or two, we adjust. Our perceptual adaptation to changed visual input makes the world seem normal again. But imagine a far more dramatic new pair of glasses—one that shifts the apparent location of objects 40 degrees to the left. When you first put them on and toss a ball to a friend, it sails off to the left. Walking forward to shake hands with the person, you veer to the left.

Could you adapt to this distorted world? Chicks cannot. When fitted with such lenses, they continue to peck where food grains seem to be (Hess, 1956; Rossi, 1968). But we humans adapt to distorting lenses quickly. Within a few minutes your throws would again be accurate, your stride on target. Remove the lenses and you would experience an aftereffect: At first your throws would err in the opposite direction, sailing off to the right; but again, within minutes you would readapt.

Indeed, given an even more radical pair of glasses—one that literally turns the world upside down—you could still adapt. Psychologist George Stratton (1896) experienced this when he invented, and for eight days wore, optical headgear that flipped left to right and up to down, making him the first person to experience a right-side-up retinal image while standing upright. The ground was up, the sky was down.

At first, Stratton felt disoriented. When he wanted to walk, he found himself searching for his feet, which were now "up." Eating was nearly impossible. He became nauseated and depressed. But Stratton persisted, and by the eighth day he could comfortably reach for something in the right direction and walk without bumping into things. When Stratton finally removed the headgear, he readapted quickly.

from that of a square. Their eyes had not degenerated; their retinas still relayed signals to their visual cortex. But lacking stimulation, the cortical cells had not developed normal connections. Thus, the animals remained functionally blind to shape.

In both humans and animals, a similar period of sensory restriction does no permanent harm if it occurs later in life. Cover the eye of an animal for several months during adulthood, and its vision will be unaffected after the eye patch is removed. Remove cataracts that develop after early childhood, and a human, too, will enjoy normal vision. The effects of visual experiences during infancy in cats, monkeys, and humans suggest there is a critical period (page 156) for normal sensory and perceptual development. Experience guides, sustains, and maintains the brain's neural organization.

Human infants born today with an opaque lens (cataract) will typically have corrective surgery within a few months. The brain network responsible for the corrected eye then rapidly develops, enabling improved visual acuity with as little as one hour's visual experience (Maurer & others, 1999). Congenitally deaf kittens and infants given cochlear implants exhibit a similar "awakening" of the pertinent brain area (Klinke & others, 1999; Sirenteanu, 1999). Nurture sculpts what nature has endowed.

Experiments on perceptual limitations and advantages produced by early sensory deprivation provide a partial answer to our question about experience, which we also debated in Chapters 3 and 4: Does the effect of early experience last a lifetime? For some aspects of visual perception, the answer is clearly yes: "Use it soon or lose it." We retain the imprint of early visual experiences far into the future.
Later experiments replicated Stratton’s experience (Dolezal, 1982; Kohler, 1962). After a period of adjustment, people wearing the optical gear have even been able to ride a motorcycle, ski the Alps, and fly an airplane. Did all these people adjust by perceptually converting their strange worlds to “normal” views? No. Actually, the world around them still seemed above their heads or on the wrong side of them. But by actively moving about in these topsy-turvy worlds, they adapted to the context and learned to coordinate their movements.

Perceptual Set

**Objective 14** | Define perceptual set, and explain how it influences what we do or do not perceive.

As everyone knows, to see is to believe. As we also know, but less fully appreciate, to believe is to see. Our experiences, assumptions, and expectations may give us a perceptual set, or mental predisposition, that greatly influences what we perceive (top-down). People perceive an adult-child pair as looking more alike when told they are parent and child (Bressan & Dal Martello, 2002). And consider: Is the image in the center picture of Figure 6.19 a man playing a saxophone or a woman’s face? What we see in such a drawing can be influenced by first looking at either of the two unambiguous versions (Boring, 1930).

![Figure 6.19 Perceptual set](image)

What do you see in the center picture: a male saxophonist or a woman’s face? Glancing first at one of the two unambiguous versions of the picture is likely to influence your interpretation.

Once we have formed a wrong idea about reality, we have more difficulty seeing the truth. Even scientists, striving for objectivity, perceive reality through the lenses of their theories. When first viewing the “canals” on Mars through telescopes, some people perceived them as the product of intelligent life. They were—but the intelligence was on the viewing end of the telescope.

Everyday examples of perceptual set abound. In 1972, a British newspaper published genuine, unretouched photographs of a “monster” in Scotland’s Loch Ness—“the most amazing pictures ever taken,” stated the paper. If this information creates in you the same perceptual set it did in most of the paper’s readers, you, too, will see the monster in the photo reproduced in Figure 6.20a (page 258). But when Steuart Campbell (1986) approached the photos with a different perceptual set, he saw a curved tree trunk—very likely the same tree trunk others had seen in the water the day the photo was shot. Moreover, with this different perceptual set, you may now notice that the object is floating motionless, without any rippling water or wake around it—hardly what we would expect of a lively monster. Apparently aided by perceptual set, thousands of others have marveled at a face on the Moon, Mother Teresa on a cinnamon bun, and Jesus on a pancake.

Perceptual set can also influence what we hear. Consider the kindly airline pilot who, on a takeoff run, looked over at his depressed co-pilot and said, “Cheer up.” The co-pilot heard the usual “Gear up” and promptly raised the wheels—before they left...

> The temptation to form premature theories upon insufficient data is the bane of our profession.”

_Sherlock Holmes, in Arthur Conan Doyle's_ The Valley of Fear, 1914

When shown the phrase: *Mary had a little lamb* many people perceive what they expect, and miss the repeated word. Did you?
CHAPTER 6: PERCEPTION

FIGURE 6.20
Believing is seeing
What do you perceive in these photos? (a) Is this Nessie, the Loch Ness monster, or a log? (b) Are these flying saucers or clouds? We often perceive what we expect to see.

(a) (b)

the ground (Reason & Mycielska, 1982). Clearly, much of what we perceive comes not just from the world “out there” but also from what’s behind our eyes and between our ears.

What determines our perceptual set? Through experience we form concepts, or schemas, that organize and interpret unfamiliar information. Our preexisting schemas for male saxophonists and women’s faces, for monsters and tree trunks, for airplane lights and UFOs all influence how we interpret ambiguous sensations with top-down processing. Confronted with an ambiguous moving object in the sky, different people may therefore apply different schemas: “It’s a bird.” “It’s a plane.” “It’s Superman!”

Children’s drawings give us a way to glimpse their developing perceptual schemas. A preschoo1er can draw circles and angled lines but cannot combine them to create an elaborate human figure. The child’s difficulty is not clumsiness. A right-handed adult asked to draw with the left hand will create an awkward drawing, but it will be unlike the child’s drawing in FIGURE 6.21. Part of the difference lies in the challenge for children to represent visually what they see. The main difference, however, lies in the child’s simplified schema for essential human characteristics. To 3- and 4-year-olds, a face is a more important human feature than a body. From ages 3 to 8, children’s schemas for bodies become more elaborate, and so do their drawings.

Our schemas for faces prime us to see facial patterns even in random configurations, such as the lunar landscape. Kieran Lee, Graham Byatt, and Gillian Rhodes (2000) demonstrated how we recognize people by facial features that cartoonists can caricature.

FIGURE 6.21
Schemas
Children’s drawings reflect their schemas of reality, as well as their abilities to represent what they see. This drawing by 4-year-old Anna illustrates that the face has far greater importance than the body in young children’s schemas of essential human characteristics.

 Courtesy of Anne Elizabeth Vukic
For but a fraction of a second they showed University of Western Australia students three versions of familiar faces—the actual face, a computer-created caricature that accentuated the differences between this face and the average face, and an “anticaricature” that muted the distinctive features. As Figure 6.22 shows, the students more accurately recognized the caricatured faces than the actual ones. A caricatured Arnold Schwarzenegger is more recognizably Schwarzenegger than Schwarzenegger himself!

Peter Thompson (1980) at the University of York discovered that our face recognition is especially attuned to the expressive eyes and mouth. Portrait artists seem to understand this. Two-thirds of portraits sampled from the last five centuries have an eye at or within 5 percent of the painting’s exact centerline (Figure 6.23). We are so attuned to eyes that we have trouble imagining what Madonna’s inverted eyes and mouth will look like when we turn her face upright (Figure 6.24).

**Figure 6.22**
Recognizing faces
When briefly flashed, a caricature of Arnold Schwarzenegger was more accurately recognized than Schwarzenegger himself. Ditto for other familiar male faces.

**Figure 6.23**
Ay for an eye
Christopher Tyler (1998) discovered that artists, when trying to capture a sense of the person, consciously or unconsciously place one eye on the painting’s centerline.

**Figure 6.24**
Face schemas
Which of these is the real Madonna? Slowly rotate the page to find out. As you do so, you will reach a point where you suddenly cannot assimilate her mouth and eyes into your schema for faces.
Context Effects

**Objective 15** | Explain why the same stimulus can evoke different perceptions in different contexts.

A given stimulus may trigger radically different perceptions, partly because of our differing schemas, but also because of the immediate context. Some examples:

- Imagine hearing a noise interrupted by the words “eel is on the wagon.” Likely, you would actually perceive the first word as wheel. Given “eel is on the orange,” you would hear peel. This curious phenomenon, discovered by Richard Warren, suggests that the brain can work backward in time to allow a later stimulus to determine how we perceive an earlier one. The context creates an expectation that, top-down, influences our perception as we match our bottom-up signal against it (Grossberg, 1995).

- Did the pursuing monster in Figure 6.14a on page 251 look aggressive? Did the identical pursued one seem frightened? If so, you experienced a context effect.

- Is the “magician’s cabinet” in Figure 6.25 sitting on the floor or hanging from the ceiling? How we perceive it depends on the context defined by the rabbits.

Soviet film director Lew Kulechov believed that skilled directors evoke emotion in an audience by defining a context in which viewers interpret an actor’s expressions. He once produced three short films, each depicting one of three contexts, followed by identical clips of an actor with a neutral expression (Wallbott, 1988). Shown a film of a dead woman, viewers of the clip were struck by the actor’s sadness. Shown a dish of soup, viewers judged the actor thoughtful. Shown a playing child, viewers said the actor appeared happy. Even hearing sad rather than happy music can predispose people to perceive a sad meaning in spoken homophonic words—mourning rather than morning, die rather than dye, pain rather than pane (Halberstadt & others, 1995).

**FIGURE 6.25**
Context effects: The magician’s cabinet
Is the box in the far left frame lying on the floor or hanging from the ceiling? What about the one on the far right? In each case, the context defined by the inquisitive rabbits guides our perceptions.
From Shepard, 1990.

**Culture and context effects**
What is above the woman’s head? In one study, nearly all the East Africans who were questioned said the woman was balancing a metal box or can on her head and that the family was sitting under a tree. Westerners, for whom corners and boxlike architecture are more common, were more likely to perceive the family as being indoors, with the woman sitting under a window. (Adapted from Gregory & Gombrich, 1973.)
Emotional contexts also color our social perceptions. Spouses who feel loved and appreciated perceive less threat in stressful marital events—“He’s just having a bad day” (Murray & others, 2003). If told a soccer team has a history of aggressive behavior, professional referees will assign more penalty cards after watching videotaped fouls (Jones & others, 2002). Lee Ross invites us to recall our own perceptions in different contexts: “Ever notice that when you’re driving you hate pedestrians, the way they saunter through the crosswalk, almost daring you to hit them, but when you’re walking you hate drivers?” (Jaffe, 2004).

The effects of perceptual set and context show how experience helps us construct perception. “We hear and apprehend only what we already half know,” said Thoreau. In everyday life, for example, stereotypes about gender (another instance of perceptual set) can color the context. Without the obvious cues of pink or blue, people will struggle over whether to call the new baby “he” or “she.” But told an infant is “David,” people (especially children) may perceive “him” as bigger and stronger than if the same infant is called “Diana” (Stern & Karraker, 1989). Some differences, it seems, exist merely in the eyes of their beholders.

To return to the question “Is perception innate or learned?” we can answer: It’s both. The river of perception is fed by two streams: sensation and cognition. And that is why we need multiple levels of analysis (FIGURE 6.26). “Simple” perceptions are the brain’s creative products.

Perception and the Human Factor

**Objective 16** Describe the role human factors psychologists play in creating user-friendly machines and work settings.

I love my new bedside clock-radio, though I struggle to remember which buttons are Snooze, Alarm Off, and Radio On. Our stove is also wonderful, except for the moments I spend puzzling over which control works which burner. The push-bar doors on our campus buildings are sturdy, though occasionally frustrating when I push the wrong end. The extra buttons on my phone are handy, though when transferring a call I still must look up which buttons to press.

**Human factors psychologists** help to design appliances, machines, and work settings that fit our natural perceptions. Psychologist Donald Norman (1988) suggests how simple design changes could reduce some of our frustrations. For example, by exploiting “natural mapping,” we could design stove controls that require no labels (FIGURE 6.27, page 262). ATM machines are internally more complex than VCRs ever were, yet, thanks to human factors psychologists working with engineers, ATMs are easier to operate. TiVo has solved the TV recording problem with a simple point-and-click menu system (“record that one”).

Have you ever noticed that anyone driving slower than you is an idiot, and anyone going faster is a maniac?”

George Carlin, George Carlin on Campus, 1984
Norman (2001), who hosts a Web site (jnd.org) on designing equipment to fit people, bemoaned the complexity of assembling his new high-definition TV, receiver, speakers, digital recorder, DVD player, VCR, and seven remotes into a usable home theater system. "I was VP of Advanced Technology at Apple," says Norman, an MIT alumnus with a Ph.D. "I can program dozens of computers in dozens of languages. I understand television, really, I do. . . . It doesn't matter: I am overwhelmed." If only the makers of home entertainment equipment would minimize cords and cables by bundling audio, visual, control, and power lines into a single cable. If only a single control could operate a point-and-click menu. If only engineers would routinely work with human factors psychologists to test their designs and instructions on real people.

Technology developers often suffer the "curse of knowledge," which leads them to mistakenly assume that others share their expertise—that what's clear to them will similarly be clear to others (Camerer & others, 1989; Nickerson, 1999). (Recall from Chapter 1 that once we know an anagram's solution—WREAT is WATER—it seems that it should be obvious to others, too.) When you know a thing, it's hard to mentally simulate what it's like not to know.

Understanding human factors can do more than enable us to design for reduced frustration; it can help avoid disaster. Two-thirds of commercial air accidents, for example, have been caused by human error (Nickerson, 1998). After beginning commercial flights in the late 1960s, the Boeing 727 was involved in several landing accidents caused by pilot error. Psychologist Conrad Kraft (1978) noted a common setting for these accidents: All took place at night, and all involved landing short of the runway after crossing a dark stretch of water or unilluminated ground. Kraft reasoned that, beyond the runway, city lights would project a larger retinal image if on a rising terrain. This would make the ground seem farther away than it was. By re-creating these conditions in flight simulations, Kraft discovered that pilots were deceived into thinking they were flying higher than their actual altitudes (FIGURE 6.28). Aided by
Kraft’s finding, the airlines began requiring the co-pilot to monitor the altimeter—
calling out altitudes during the descent—and the accidents diminished.

Later Boeing psychologists worked on other human factors problems (Murray, 1998): How should airlines best train and manage mechanics to reduce the maintenance errors that underlie about 50 percent of flight delays and 15 percent of accidents? What illumination and typeface would make on-screen flight data easiest to read? How would warning messages be most effectively worded—as an action statement (“Pull Up”) rather than a problem statement (“Ground Proximity”)?

In studying human factors issues, psychologists’ most powerful tool is research. If an organization wonders what sort of Web design (emphasizing content? speed? graphics?) would most effectively draw in visitors and entice them to return, the psychologist will want to test responses to several alternatives. If NASA (National Aeronautics and Space Administration) wonders what sort of spacecraft design would best facilitate sleeping, work, and morale, their human factors psychologists will want to test the alternatives (FIGURE 6.29).

Consider, finally, the available “assistive listening” technologies in various auditoriums, places of worship, and theaters. One technology, commonly available in the United States, requires people with hearing loss to use a headset attached to a pocket-sized receiver that detects infrared or FM signals from the room’s sound system. The well-meaning people who design, purchase, and install these systems correctly understand that the technology puts sound directly into the user’s ears. Alas, few people with hearing loss undergo the hassle and embarrassment of locating, requesting, wearing, and returning a conspicuous headset. Most such units therefore sit in closets. Britain, the Scandinavian countries, and Australia have instead installed “loop systems” that broadcast customized sound directly through a person’s own hearing aid. When suitably equipped, a discrete touch of a switch can transform hearing aids into in-the-ear loudspeakers. A loop system (a special amplifier attached to a wire encircling an audience) can also work in homes, enabling TV sound or phone conversation to broadcast directly through hearing aids (see www.hearingloop.org). When offered convenient, inconspicuous, personalized sound, many more people elect to use assistive listening.

The point to remember: Designers and engineers should consider the human factor, by designing things to fit people, being mindful of the curse of knowledge, and user-testing their inventions before production and distribution.

**Learning Outcomes**

**Objective 12** Describe the contribution of restored-vision and sensory deprivation research in our understanding of the nature-nurture interplay in our perceptions.

If all aspects of visual perception were entirely inborn, people who were born blind but regained sight after surgery should have normal visual perception. They do not. After cataract surgery, for example, adults who had been blind from birth are able to distinguish figure from ground and to perceive colors, but they lack the experience to recognize shapes, forms, and complete faces. Further evidence comes from animals reared with severely restricted visual input, who suffered enduring visual handicaps when their visual exposure was returned to normal. Clinical and experimental evidence indicates that there is a critical period for some aspects of sensory and perceptual development. Without the stimulation provided by early visual experiences, the brain’s neural organization does not develop normally.

**Objective 13** Explain how the research on distorting goggles increases our understanding of the adaptability of perception.

When people are given glasses that shift the world slightly to the left or right, or even turn it upside down, they are initially disoriented, but they manage to adapt to their new context and, with practice, to move about with ease. This research demonstrates our ability to adjust to an artificially altered visual field and coordinate our movements in response to that new world.
**Objective 14** | Define perceptual set, and explain how it influences what we do or do not perceive.

Perceptual set is a mental predisposition that functions as a lens through which we perceive the world. Once again, nature and nurture interact: Our sensory input bounces off our experiences, learned assumptions, and beliefs. Because our learned concepts (schemas) prime us to organize and interpret ambiguous stimuli in certain ways, our perceptions reflect our version of reality. Thus, some of us "see" monsters, faces, and UFOs or "hear" messages that others do not.

**Objective 15** | Explain why the same stimulus can evoke different perceptions in different contexts.

In perceiving a given stimulus that we could interpret by means of several different schemas, we scan the immediate context for information. Context creates expectations that guide our perceptions. Emotional context can color our interpretation of other people's behaviors—and our own. Perceptual set and context effects interact to help us construct our perceptions.

**Objective 16** | Describe the role human factors psychologists play in creating user-friendly machines and work settings.

Human factors psychologists encourage developers and designers to consider human perceptual abilities, to avoid the curse of knowledge (the mistaken assumption that others share our expertise and will behave as we would), and to schedule user-testing to reveal perception-based problems before production and distribution. Human factors psychologists have contributed to improved safety in air and space travel; better-designed appliances, equipment, and workplaces; and easier-to-use assistive listening.

**Ask Yourself:** Can you recall a time when your expectations have predisposed how you perceived a person (or group of people)?

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**Is There Extrasensory Perception?**

**Objective 17** | Identify the three most testable forms of ESP, and explain why most research psychologists remain skeptical of ESP claims.

Can we perceive only what we sense? Or, without sensory input, are we capable of extrasensory perception (ESP)? Are there indeed people—any people—who can read minds, see through walls, or foretell the future? Five British universities have parapsychology units staffed by Ph.D. graduates of Edinburgh University's parapsychology program (Turpin, 2005). Sweden's Lund University, the Netherlands' Utrecht University, and Australia's University of Adelaide also have added faculty chairs or research units for parapsychology. But other research psychologists and scientists—including 96 percent of the scientists in the U.S. National Academy of Sciences—are skeptical (McConnell, 1991). If ESP is real, we would need to overturn the scientific understanding that we are creatures whose minds are tied to our physical brains and whose perceptual experiences of the world are built of sensations. Sometimes new evidence does overturn our scientific preconceptions. Science, as we will see throughout this book, offers us various surprises—about the extent of the unconscious mind, about the effects of emotion on health, about what heals and what doesn't, and much more. Before we evaluate claims of ESP, let's review them.

**Claims of ESP**

Claims of paranormal phenomena include astrological predictions, psychic healing, communication with the dead, and out-of-body experiences. But the most testable and (for a perception chapter) most relevant claims are for three varieties of ESP:
Telepathy, or mind-to-mind communication—one person sending thoughts to another or perceiving another’s thoughts.

Clairvoyance, or perceiving remote events, such as sensing that a friend’s house is on fire.

Precognition, or perceiving future events, such as a political leader’s death or a sporting event’s outcome.

Closely linked with these are claims of psychokinesis, or “mind over matter,” such as levitating a table or influencing the roll of a die (FIGURE 6.30). (The claim is illustrated by the wry request, “Will all those who believe in psychokinesis please raise my hand?”)

### Premonitions or Pretensions?

Can psychics see into the future? Although one might wish for a psychic stock forecaster, the tallied forecasts of “leading psychics” reveal meager accuracy. No greedy— or charitable—psychic has been able to predict the outcome of a lottery jackpot, or to make billions on the stock market. During the 1990s, tabloid psychics were all wrong in predicting surprising events. (Madonna did not become a gospel singer, the Statue of Liberty did not lose both its arms in a terrorist blast, Queen Elizabeth did not abdicate her throne to enter a convent.) And the new-century psychics missed the big-news events such as the Florida presidential ballot controversy, the whereabouts and capture of Saddam Hussein, and the horror of 9/11. (Where were the precogs on 9/10 when we needed them?) Gene Emery (2004), who has tracked annual psychic forecasts for 26 years, reports that almost never have unusual predictions come true and virtually never have psychics anticipated any of the year’s headline events.

Analyses of psychic visions offered to police departments reveal that these, too, are no more accurate than guesses made by others (Reiser, 1982). Psychics working with the police do, however, generate hundreds of predictions. This increases the odds of an occasional correct guess, which psychics can then report to the media. Moreover, vague predictions can later be interpreted (“retrofitted”) to match events that provide a perceptual set for interpreting them. Nostradamus, a sixteenth-century French psychic, explained in an unguarded moment that his ambiguous prophecies “could not possibly be understood till they were interpreted after the event and by it.”

Police departments are wise to all this. When Jane Ayers Sweat and Mark Durm (1993) asked the police departments of America’s 50 largest cities whether they ever used psychics, 65 percent said they never had. Of those that had, not one had found it helpful.
Things that happen by chance are events in search of causes."


Thousands of psychics reportedly overwhelmed police with mispredictions of the whereabouts of Washington, D.C., intern Chandra Levy, whose body was discovered by a jogger on a wooded hill a year after her disappearance (Radford, 2002).

Are the spontaneous “visions” of everyday people any more accurate? Consider our dreams. Do they foretell the future, as about half of university students have believed (Messer & Griggs, 1989)? Or do they only seem to do so because we are more likely to recall or reconstruct dreams that seem to have come true? Two Harvard psychologists (Murray & Wheeler, 1937) tested the prophetic power of dreams after aviator Charles Lindbergh’s baby son was kidnapped and murdered in 1932, but before the body was discovered. When the researchers invited the public to report their dreams about the child, 1300 visionaries submitted dream reports. How many accurately envisioned the child dead? Five percent. And how many also correctly anticipated the body’s location—buried among trees? Only 4 of the 1300. Although this number was surely no better than chance, to those 4 dreamers the accuracy of their apparent precognitions must have seemed uncanny.

Throughout the day, each of us imagines many events. Given the billions of events in the world each day, and given enough days, some stunning coincidences are sure to occur. By one careful estimate, chance alone would predict that more than a thousand times a day someone on Earth will think of someone and then within the ensuing five minutes will learn of the person’s death (Charpak & Broch, 2004). With enough time or people, the improbable becomes inevitable.

That has been the experience of comics writer John Byrne (2003). Six months after his Spider-Man story about a New York blackout appeared, New York suffered its massive blackout. A subsequent Spider-Man storyline involved a major earthquake in Japan “and again,” he recalls, “the real thing happened in the month the issue hit the stands.” Later, when working on a Superman comic book, he “had the Man of Steel fly to the rescue when disaster beset the NASA space shuttle. The Challenger tragedy happened almost immediately thereafter” (with time for the issue to be redrawn). “Most recently, and chilling, came when I was writing and drawing Wonder Woman and did a story in which the title character was killed as a prelude to her becoming a goddess.” The issue cover “was done as a newspaper front page, with the headline ‘Princess Diana Dies.’ (Diana is Wonder Woman’s real name.) That issue went on sale on a Thursday. The following Saturday . . . I don’t have to tell you, do I?”

**Putting ESP to Experimental Test**

In the past, there have been all kinds of strange ideas—that bumps on the head reveal character traits, that bloodletting is a cure-all, that each sperm cell contains a miniature person. When faced with such claims—or with claims of mind reading or out-of-body travel or communication with the dead—how can we separate bizarre ideas from those that sound bizarre but are true? At the heart of science is a simple answer: Test them to see if they work. If they do, so much the better for the ideas. If they don’t, so much the better for our skepticism.

This scientific attitude has led both believers and skeptics to agree that what parapsychology needs to give it credibility is a reproducible phenomenon and a theory to explain it. Parapsychologist Rhea White (1998) acknowledges that “the image of parapsychology that comes to my mind, based on nearly 44 years in the field, is that of a small airplane [that] has been perpetually taxiing down the runway of the Empirical Science Airport since 1882 . . . its movement punctuated occasionally by lifting a few feet off the ground only to bump back down on the tarmac once again. It has never taken off for any sustained flight.”
Seeking a reproducible phenomenon, how might we test ESP claims in a controlled experiment? An experiment differs from a staged demonstration. In the laboratory, the experimenter controls what the “psychic” sees and hears. On stage, the psychic controls what the audience sees and hears. Time and again, skeptics note, so-called psychics have exploited unquestioning audiences with mind-blowing performances in which they appeared to communicate with the spirits of the dead, read minds, or levitate objects—only to have it revealed that their acts were nothing more than the illusions of stage magicians.

The search for a valid and reliable test of ESP has resulted in thousands of experiments. One controlled procedure has invited “senders” to telepathically transmit one of four visual images to “receivers” deprived of sensation in a nearby chamber (Bem & Honorton, 1994). The result? A reported 32 percent accurate response rate, surpassing the chance rate of 25 percent. But follow-up studies have (depending on who was summarizing the results) failed to replicate the phenomenon or produced mixed results (Bem & others, 2001; Milton & Wiseman, 2002; Storm, 2000, 2003).

One skeptic, magician James Randi, has a longstanding offer—now U.S. $1 million—“to anyone who proves a genuine psychic power under proper observing conditions” (Randi, 1999). French, Australian, and Indian groups have parallel offers of up to 200,000 euros to anyone with demonstrable paranormal abilities (CFI, 2003). And $50 million was available for information leading to Osama bin Laden’s capture. Large as these sums are, the scientific seal of approval would be worth far more to anyone whose claims could be authenticated. To refute those who say there is no ESP, one need only produce a single person who can demonstrate a single, reproducible ESP phenomenon. (To refute those who say pigs can’t talk would take but one talking pig.) So far, no such person has emerged. Randi’s offer has been publicized for three decades and dozens of people have been tested, sometimes under the scrutiny of an independent panel of judges. Still, nothing.

Why, then, are so many people predisposed to believe that ESP exists? In part, such beliefs may stem from understandable misperceptions, misinterpretations, and selective recall. But some people also have an unsatisfied hunger for wonderment, an itch to experience the magical. In Britain and the United States, the founders of

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**Testing psychic powers in the British population**

Hertfordshire University psychologist Richard Wiseman created a “mind machine” to see if people can influence or predict a coin toss. Using a touch-sensitive screen, visitors to festivals around the country were given four attempts to call heads or tails. Using a random-number generator, a computer then decided the outcome. When the experiment concluded in January 2000, nearly 28,000 people had predicted 110,972 tosses—with 49.8 percent correct.

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“A psychic is an actor playing the role of a psychic.”

Psychologist-magician Daryl Bem (1984)

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“People’s desire to believe in the paranormal is stronger than all the evidence that it does not exist.”

Susan Blackmore, “Blackmore’s first law,” 2004
parapsychology were mostly people who, having lost their religious faith, began searching for a scientific basis for believing in the meaning of life and in life after death (Alcock, 1985; Beloff, 1985). In the upheaval after the collapse of autocratic rule in Russia, there came an “avalanche of the mystical, occult, and pseudoscientific” (Kapitza, 1991). In Russia as elsewhere, “extrasensory” healers and seers have fascinated the awestruck public. “Many people,” declared a statement by 32 leading Russian scientists in 1999, “believe in clairvoyance, astrology, and other superstitions to compensate for the psychological discomforts of our time.”

To feel awe and to gain a deep reverence for life, we need look no further than our own perceptual system and its capacity for organizing formless nerve impulses into colorful sights, vivid sounds, and evocative smells. As Shakespeare’s Hamlet recognized, “There are more things in Heaven and Earth, Horatio, than are dreamt of in your philosophy.” Within our ordinary perceptual experiences lies much that is truly extraordinary—surely much more than has so far been dreamt of in our psychology. A century of research has revealed many of the secrets of sensation and perception, yet for future generations of researchers there remain profound and genuine mysteries to solve.

We have now examined the first steps in our processing of information, from receiving sensory input to constructing meaningful perceptions. But our skull’s 3-pound information-processing system does much more: Under the influence of sleep, hypnosis, or drugs, it will construct unreal images (Chapter 7). It learns from our experiences, recalling them long afterward (Chapters 8 and 9). It thinks and makes plans (Chapters 10 and 11). Between our sensing and acting lies an unimaginably complex information system that, more than ever, beckons explorers of our mind’s inner space.

>> Learning Outcomes

**Is There Extrasensory Perception?**

**Objective 17** | Identify the three most testable forms of ESP, and explain why most research psychologists remain skeptical of ESP claims.

ESP (extrasensory perception) is one form of purported paranormal phenomena. (Another form is psychokinesis [PK].) The three most testable forms of ESP are telepathy (mind-to-mind communication), clairvoyance (perceiving remote events), and precognition (perceiving future events). Most research psychologists’ skepticism focuses on two points. First, to believe in ESP, you must believe the brain is capable of perceiving without sensory input. Second (and most important in terms of critical inquiry), parapsychologists have been unable to replicate (reproduce) ESP phenomena under controlled conditions.

**Ask yourself:** Have you ever had an ESP experience? Can you think of an explanation other than ESP for that experience?
Review Chapter 6: Perception

Test Yourself

1. Your friend insists that he did call you to dinner as you intently watched TV. What principle explains your not perceiving him?
2. How does the study of illusions inform our understanding of normal perceptions?
3. What do we mean when we say that, in perception, the whole is greater than the sum of its parts?
4. What type of evidence shows that, indeed, "there is more to perception than meets the senses"?
5. What psychic ability is being claimed by the sports channel in the cartoon to the right?

Answers to the Test Yourself questions can be found in Appendix B at the end of the book.

Terms and Concepts to Remember

selective attention, p. 237
inattentional blindness, p. 238
visual cliff, p. 245
binocular cues, p. 245
perceptual adaptation, p. 256
perceptual set, p. 257
human factors psychology, p. 261
extrasensory perception (ESP), p. 264
parapsychology, p. 264
visual capture, p. 242
retinal disparity, p. 246
convergence, p. 246

WEB

To continue your study and review of Perception, visit this book's Web site at www.worthpublishers.com/myers. You will find practice tests, review activities, and many interesting articles and Web links for more information on topics related to Perception.
Night wasn't over when the moon stood beside my bed and said, “You've drunk your sleep to the dregs, your share of that wine is finished for this night.”

My eyes tore themselves from a dream of passion—they said farewell to my lover's image, still lingering in the night's stagnant waters that were spread, like a sheet, over the earth.

Silver whirlpools began their dervish dance as lotuses of stars fell from the moon's hands. Some sank. Some rose to the surface, floated, and opened their petals. Night and daybreak had fallen desperately into each other's arms.