Unit IV

Sensation and Perception

Modules

"I have perfect vision," explains my colleague, Heather Sellers, an acclaimed writer and teacher. Her vision may be fine, but there is a problem with her perception. She cannot recognize faces.

In her memoir, *You Don't Look Like Anyone I Know,* Sellers (2010) tells of awkward moments resulting from her lifelong *prosopagnosia*—face blindness.

> In college, on a date at the Spaghetti Station, I returned from the bathroom and plunked myself down in the wrong booth, facing the wrong man. I remained unaware he was not my date even as my date (a stranger to me) accosted Wrong Booth Guy, and then stormed out of the Station. I can't distinguish actors in movies and on television. I do not recognize myself in photos or videos. I can't recognize my stepsons in the soccer pick-up line; I failed to determine which husband was mine at a party, in the mall, at the market.

Her inability to recognize faces means that people sometimes perceive her as snobby or aloof. "Why did you walk past me?" a neighbor might later ask. Similar to those of us with hearing loss who fake hearing during trite social conversation, Sellers sometimes fakes recognition. She often smiles at people she passes, in case she knows them. Or she pretends to know the person with whom she is talking. (To avoid the stress associated with such perception failures, people with serious hearing loss or with prosopagnosia often shy away from busy social situations.) But

there is an upside: When encountering someone who previously irritated her, she typically won't feel ill will, because she doesn't recognize the person.

Unlike Sellers, most of us have (as Module 18 explains) a functioning area on the underside of our brain's right hemisphere that helps us recognize a familiar human face as soon as we detect it—in only one-seventh of a second (Jacques & Rossion, 2006). This ability illustrates a broader principle. *Nature's sensory gifts enable each animal to obtain essential information.* Some examples:

- Frogs, which feed on flying insects, have cells in their eyes that fire only in response to small, dark, moving objects. A frog could starve to death knee-deep in motionless flies. But let one zoom by and the frog's "bug detector" cells snap awake.
- Male silkworm moths' odor receptors can detect one-billionth of an ounce of sex attractant per second released by a female one mile away. That is why silkworms continue to be.
- Human ears are most sensitive to sound frequencies that include human voices, especially a baby's cry.

In this unit, we'll look more closely at what psychologists have learned about how we sense and perceive the world around us.

Module 16

Basic Principles of Sensation and Perception

Beau Lark/Corbis

Module Learning Objectives

16-1 Contrast *sensation* and *perception*, and explain the difference between *bottom-up* and *top-down processing.*

16-2 Discuss how much information we can consciously attend to at once.

16-3 Identify the three steps that are basic to all our sensory systems.

16-4 Distinguish between *absolute* and *difference thresholds*, and discuss whether we can sense and be affected by stimuli below the absolute threshold.

16-5 Explain the function of sensory adaptation.

sensation the process by which our sensory receptors and nervous system receive and represent stimulus energies from our environment.

perception the process of organizing and interpreting sensory information, enabling us to recognize meaningful objects and events.

bottom-up processing analysis that begins with the sensory receptors and works up to the brain's integration of sensory information.

top-down processing information processing guided by higher-level mental processes, as when we construct perceptions drawing on our experience and expectations.

selective attention the focusing of conscious awareness on a particular stimulus.

16-1 What are *sensation* and *perception?* What do we mean by *bottom-up processing* and *top-down processing?*

Sellers' curious mix of "perfect vision" and face blindness illustrates the distinction between sensation and perception. When she looks at a friend, her **sensation** is normal: Her senses detect the same information yours would, and they transmit that information to her brain. And her **perception**—the processes by which her brain organizes and interprets sensory input—is almost normal. Thus, she may recognize people from their hair, gait, voice, or particular physique, just not their face. Her experience is much like the struggle you or I would have trying to recognize a specific penguin in a group of waddling penguins.

In our everyday experiences, sensation and perception blend into one continuous process. In this module, we slow down that process to study its parts, but in real life, our sensory and perceptual processes work together to help us decipher the world around us.

- Our **bottom-up processing** starts at the sensory receptors and works up to higher levels of processing.
- Our **top-down processing** constructs perceptions from the sensory input by drawing on our experience and expectations.

As our brain absorbs the information in **FIGURE 16.1**, bottom-up processing enables our sensory systems to detect the lines, angles, and colors that form the flower and leaves. Using top-down processing we interpret what our senses detect.

But *how* do we do it? How do we create meaning from the blizzard of sensory stimuli bombarding our bodies 24 hours a day? Meanwhile, in a silent, cushioned, inner world, our brain floats in utter darkness. By itself, it sees nothing. It hears nothing. It feels nothing. *So, how does the world out there get in?* To phrase the question scientifically: How do we construct our representations of the external world? How do a campfire's flicker, crackle, and smoky scent activate neural connections? And how, from this living neurochemistry, do we create our conscious experience of the fire's motion and temperature, its aroma and beauty? In search of answers to such questions, let's look at some processes that cut across all our sensory systems. To begin, where is the border between our conscious and unconscious awareness, and what stimuli cross that threshold?

Figure 16.1
What's going on here? Our sensory and perceptual processes work together to help us sort out the complex images, including the hidden couple in Sandro Del-Prete's drawing, *The Flowering of Love.*

Selective Attention

16-2 How much information do we consciously attend to at once?

Through **selective attention,** your awareness focuses, like a flashlight beam, on a minute aspect of all that you experience. By one estimate, your five senses take in 11,000,000 bits of information per second, of which you consciously process about 40 (Wilson, 2002). Yet your mind's unconscious track intuitively makes great use of the other 10,999,960 bits. Until reading this sentence, for example, 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 words before you. While focusing on these words, you've also been blocking other parts of your environment from awareness, though your peripheral vision would let you see them easily. You can change that. As you stare at the X below, notice what surrounds these sentences (the edges of the page, the desktop, the floor).

X

A classic example of selective attention is the *cocktail party effect*—your ability to attend to only one voice among many (while also being able to detect your own name in an unattended voice). This effect might have prevented an embarrassing and dangerous situation in 2009, when two commercial airline pilots "lost track of time." Focused on their laptops and conversation, they ignored alarmed air traffic controllers' attempts to reach them as they overflew their Minneapolis destination by 150 miles. If only the controllers had known and spoken the pilots' names.

"Has a generation of texters, surfers, and twitterers evolved the enviable ability to process multiple streams of novel information in parallel? Most cognitive psychologists doubt it." -Steven Pinker, "Not at All," 2010

Selective Attention and Accidents

Text or talk on the phone while driving, or attend to a music player or GPS, and your selective attention will shift back and forth between the road and its electronic competition. But when a demanding situation requires it, you'll probably give the road your full attention. You'll probably also blink less. When focused on a task, such as reading, people blink less than when their mind is wandering (Smilek et al., 2010). If you want to know whether your dinner companion is focused on what you're saying, watch for eyeblinks and hope there won't be too many.

We pay a toll for switching attentional gears, especially when we shift to complex tasks, like noticing and avoiding cars around us. The toll is a slight and sometimes fatal delay in coping (Rubenstein et al., 2001). About 28 percent of traffic accidents occur when people are chatting on cell phones or texting (National Safety Council, 2010). One study tracked long-haul truck drivers for 18 months. The video cameras mounted in their cabs showed they were at 23 times greater risk of a collision while texting (VTTI, 2009). Mindful of such findings, the United States in 2010 banned truckers and bus drivers from texting while driving (Halsey, 2010).

It's not just truck drivers who are at risk. One in four teen drivers with cell phones admit to texting while driving (Pew, 2009). Multitasking comes at a cost: fMRI scans offer a biological account of how multitasking distracts from brain resources allocated to driving. They show that brain activity in areas vital to driving decreases an average 37 percent when a driver is attending to conversation (Just et al., 2008).

Even hands-free cell-phone talking is more distracting than a conversation with passengers, who can see the driving demands and pause the conversation. When University of Sydney researchers analyzed phone records for the moments before a car crash, they found that cell-phone users (even with hands-free sets) were four times more at risk (McEvoy et al., 2005, 2007). Having a passenger increased risk only 1.6 times. This risk difference also appeared in an experiment that asked drivers to pull off at a freeway rest stop 8 miles ahead. Of drivers conversing with a passenger, 88 percent did so. Of those talking on a cell phone, 50 percent drove on by (Strayer & Drews, 2007).

AP® Exam Tip

You may wish to think about how the information on selective attention relates to something a little less dangerous: studying. The same principles apply. The more time you spend texting, tweeting, and Facebooking, the less focused you'll be on the material you're trying to master. A better strategy is to spend 25 minutes doing schoolwork and schoolwork alone. Then you can reward yourself with a few minutes of social networking.

"I wasn't texting. I was building this ship in a bottle."

SALLY FORTH

Driven to distraction In driving-simulation experiments, people whose attention is diverted by cell-phone conversation make more driving errors.

Most European countries and American states now ban hand-held cell phones while driving (Rosenthal, 2009). Engineers are also devising ways to monitor drivers' gaze and to direct their attention back to the road (Lee, 2009).

Selective Inattention

At the level of conscious awareness, we are "blind" to all but a tiny sliver of visual stimuli. Researchers demonstrated this **inattentional blindness** dramatically by showing people a 1-minute video in which images of three black-shirted men tossing a basketball were superimposed over the images of three white-shirted players (Neisser, 1979; Becklen & Cervone, 1983). The viewers' supposed task was to press a key every time a black-shirted player passed the ball. Most focused their attention so completely on the game that they failed to notice a young woman carrying an umbrella saunter across the screen midway through the video (**FIGURE 16.2**). Seeing a replay of the video, viewers were astonished to see her (Mack & Rock, 2000). This inattentional blindness is a by-product of what we are really good at: focusing attention on some part of our environment.

In a repeat of the experiment, smart-aleck researchers Daniel Simons and Christopher Chabris (1999) sent a gorilla-suited assistant through the swirl of players. During its 5- to 9-second cameo appearance, the gorilla paused to thump its chest. Still, half the conscientious pass-counting viewers failed to see it. In another follow-up experiment, only 1 in 4 students engrossed in a cell-phone conversation while crossing a campus square noticed a clown-suited unicyclist in their midst (Hyman et al., 2010). (Most of those not on the phone *did* notice.) Attention is powerfully selective. Your conscious mind is in one place at a time.

Given that most people miss someone in a gorilla or clown suit while their attention is riveted elsewhere, imagine the fun that magicians can have by manipulating our selective attention. Misdirect people's attention and they will miss the hand slipping into the pocket. "Every time you perform a magic trick, you're engaging in experimental psychology," says Teller, a magician and master of mind-messing methods (2009).

Magicians also exploit a form of inattentional blindness called **change blindness.** By selectively riveting our attention on their left hand's dramatic act, we fail to notice changes made with their other hand. In laboratory experiments, viewers didn't notice that, after a brief visual interruption, a big Coke bottle had disappeared, a railing had risen, or clothing color had changed (Chabris & Simons, 2010; Resnick et al., 1997). Focused on giving directions to a construction worker, two out of three people also failed to notice when he was replaced by another worker during a staged interruption (**FIGURE 16.3**). Out of sight, out of mind.

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

change blindness failing to notice changes in the environment.

Figure 16.2
Testing selective attention In this classic experiment, viewers who were attending to basketball tosses among the black-shirted players usually failed to notice the umbrella-toting woman sauntering across the screen. (From Neisser, 1979.)

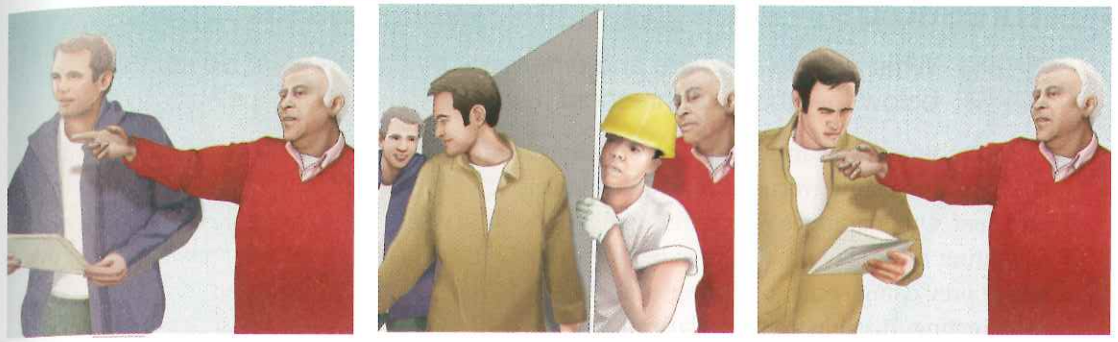

Figure 16.3
Change blindness While a man (white hair) provides directions to a construction worker, two experimenters rudely pass between them. During this interruption, the original worker switches places with another person wearing different-colored clothing. Most people, focused on their direction giving, do not notice the switch.

An equally astonishing form of inattention is *choice blindness*. At one Swedish supermarket, people tasted two jams, indicated their preference, and then tasted again their preferred jam and explained their preference. Fooled by trick jars (see **FIGURE 16.4**) most people didn't notice that they were actually "retasting" their *non*preferred jam.

Image is from the research paper by Lars Hall, Petter Johansson, and colleagues (2010).

Figure 16.4
Marketplace magic Prankster researchers Lars Hall, Petter Johansson, and colleagues (2010) invited people to sample two jams and pick one to retaste. By flipping the jars after putting the lids back on, the researchers actually induced people to "resample" their nonchosen jam. Yet, even when asked whether they noticed anything odd, most tasters were choice blind. Even when given markedly different jams, they usually failed to notice the switch.

Some stimuli, however, are so powerful, so strikingly distinct, that we experience *pop-out,* as when we notice an angry face in a crowd. We don't choose to attend to these stimuli; they draw our eye and demand our attention.

Our selective attention extends even into our sleep, as we will see.

Transduction

16-3 What three steps are basic to all our sensory systems?

Every second of every day, our sensory systems perform an amazing feat: They convert one form of energy into another. Vision processes light energy. Hearing processes sound waves. All our senses

- *receive* sensory stimulation, often using specialized receptor cells.
- *transform* that stimulation into neural impulses.
- *deliver* the neural information to our brain.

The process of converting one form of energy into another that your brain can use is called **transduction.** Later in this unit, we'll focus on individual sensory systems. How do we see? Hear? Feel pain? Taste? Smell? Keep our balance? In each case, we'll consider these three steps—receiving, transforming, and delivering the information to the brain. We'll also see what **psychophysics** has discovered about the physical energy we can detect and its effects on our psychological experiences.

First, though, let's explore some strengths and weaknesses in our ability to detect and interpret stimuli in the vast sea of energy around us.

transduction conversion of one form of energy into another. In sensation, the transforming of stimulus energies, such as sights, sounds, and smells, into neural impulses our brain can interpret.

psychophysics the study of relationships between the physical characteristics of stimuli, such as their intensity, and our psychological experience of them.

Thresholds

16-4 What are the *absolute* and *difference thresholds,* and do stimuli below the absolute threshold have any influence on us?

At this moment, you and I are being struck by X-rays and radio waves, ultraviolet and infrared light, and sound waves of very high and very low frequencies. To all of these we are blind and deaf. Other animals with differing needs detect a world that lies beyond our experience. Migrating birds stay on course aided by an internal magnetic compass. Bats and dolphins locate prey using sonar, bouncing echoing sound off objects. Bees navigate on cloudy days by detecting invisible (to us) polarized light.

The shades on our own senses are open just a crack, allowing us a restricted awareness of this vast sea of energy. But for our needs, this is enough.

absolute threshold the minimum stimulation needed to detect a particular stimulus 50 percent of the time.

signal detection theory a theory predicting how and when we detect the presence of a faint stimulus *(signal)* amid background stimulation *(noise)*. Assumes that there is no single absolute threshold and that detection depends partly on a person's experience, expectations, motivation, and alertness.

Try This

Try out this old riddle on a couple of friends. "You're driving a bus with 12 passengers. At your first stop, 6 passengers get off. At the second stop, 3 get off. At the third stop, 2 more get off but 3 new people get on. What color are the bus driver's eyes?" Do your friends detect the signal—who is the bus driver?—amid the accompanying noise?

Absolute Thresholds

To some kinds of stimuli we are exquisitely sensitive. Standing atop a mountain on an utterly dark, clear night, most of us could see a candle flame atop another mountain 30 miles away. We could feel the wing of a bee falling on our cheek. We could smell a single drop of perfume in a three-room apartment (Galanter, 1962).

German scientist and philosopher Gustav Fechner (1801–1887) studied our awareness of these faint stimuli and called them our **absolute thresholds**—the minimum stimulation necessary to detect a particular light, sound, pressure, taste, or odor 50 percent of the time. To test your absolute threshold for sounds, a hearing specialist would expose each of your ears to varying sound levels. For each tone, the test would define where half the time you could detect the sound and half the time you could not. That 50-50 point would define your absolute threshold.

Detecting a weak stimulus, or signal, depends not only on the signal's strength (such as a hearing-test tone) but also on our psychological state—our experience, expectations, motivation, and alertness. **Signal detection theory** predicts when we will detect weak signals (measured as our ratio of "hits" to "false alarms") **(FIGURE 16.5)**. Signal detection theorists seek to understand why people respond differently to the same stimuli (have you ever noticed that some teachers are much more likely than others to detect students texting during class?) and why the same person's reactions vary as circumstances change. Exhausted parents will notice the faintest whimper from a newborn's cradle while failing to notice louder, unimportant sounds. Lonely, anxious people at speed-dating events also respond with a low threshold and thus tend to be unselective in reaching out to potential dates (McClure et al., 2010).

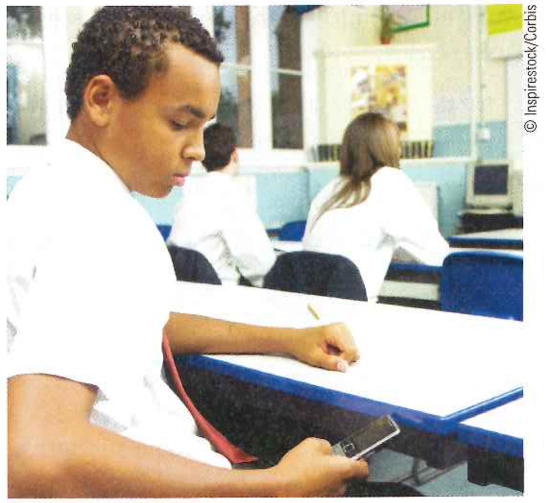
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Figure 16.5
Signal detection What three factors will make it more likely that you correctly detect a text message?

ANSWER: (1) You are expecting a text message. (2) It is important that you see the text message and respond. (3) You are alert.


AJ Photo/Science Source

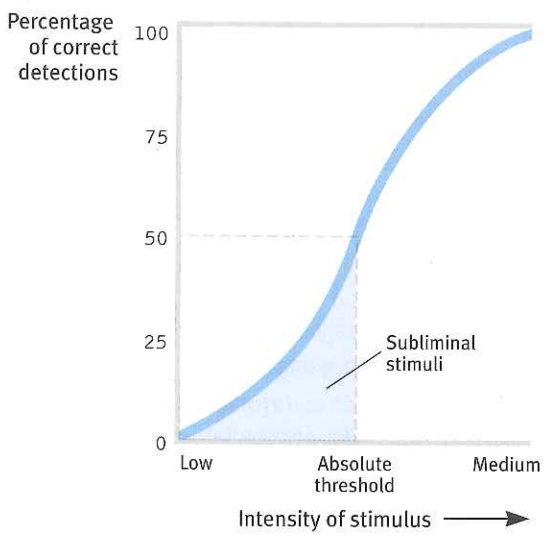


Figure 16.6
Absolute threshold Can I detect this sound? An *absolute threshold* is the intensity at which a person can detect a stimulus half the time. Hearing tests locate these thresholds for various frequency levels. Stimuli below your absolute threshold are subliminal.

Stimuli you cannot detect 50 percent of the time are **subliminal**—below your absolute threshold **(FIGURE 16.6)**. Under certain conditions, you can be affected by stimuli so weak that you don't consciously notice them. An unnoticed image or word can reach your visual cortex and briefly **prime** your response to a later question. In a typical experiment, the image or word is quickly flashed, then replaced by a *masking stimulus* that interrupts the brain's processing before conscious perception (Van den Bussche et al., 2009). For example, one experiment subliminally flashed either emotionally positive scenes (kittens, a romantic couple) or negative scenes (a werewolf, a dead body) an instant before participants viewed slides of people (Krosnick et al., 1992). The participants consciously perceived either scene as only a flash of light. Yet the people somehow looked nicer if their image immediately followed unperceived kittens rather than an unperceived werewolf. As other experiments confirm, we can evaluate a stimulus even when we are not aware of it—and even when we are unaware of our evaluation (Ferguson & Zayas, 2009).

subliminal below one's absolute threshold for conscious awareness.

priming the activation, often unconsciously, of certain associations, thus predisposing one's perception, memory, or response.

"The heart has its reasons which reason does not know." -Pascal, *Pensées*, 1670

How do we feel or respond to what we do not know and cannot describe? An imperceptibly brief stimulus often triggers a weak response that *can* be detected by brain scanning (Blankenburg et al., 2003; Haynes & Rees, 2005, 2006). Only when the stimulus triggers synchronized activity in several brain areas does it reach consciousness (Dehaene, 2009). Once again we see the dual-track mind at work: *Much of our information processing occurs automatically, out of sight, off the radar screen of our conscious mind.*

So can we be controlled by subliminal messages? For more on that question, see Thinking Critically About: Can Subliminal Messages Control Our Behavior? on the next page.

Difference Thresholds

To function effectively, we need absolute thresholds low enough to allow us to detect important sights, sounds, textures, tastes, and smells. We also need to detect small differences among stimuli. A musician must detect minute discrepancies when tuning an instrument. Students in the hallway must detect the sound of their friends' voices amid all the other voices. Even after living two years in Scotland, sheep *baa*'s all sound alike to my ears. But not to those of ewes, which I have observed streaking, after shearing, directly to the *baa* of their lamb amid the chorus of other distressed lambs.


Eric Isselée/Shutterstock

Thinking Critically About

Can Subliminal Messages Control Our Behavior?

Hoping to penetrate our unconscious, entrepreneurs offer audio and video programs to help us lose weight, stop smoking, or improve our memories. Soothing ocean sounds may mask messages we cannot consciously hear: "I am thin"; "Smoke tastes bad"; or "I do well on tests—I have total recall of information." Such claims make two assumptions: (1) We can unconsciously sense subliminal (literally, "below threshold") stimuli. (2) Without our awareness, these stimuli have extraordinary suggestive powers. Can we? Do they?

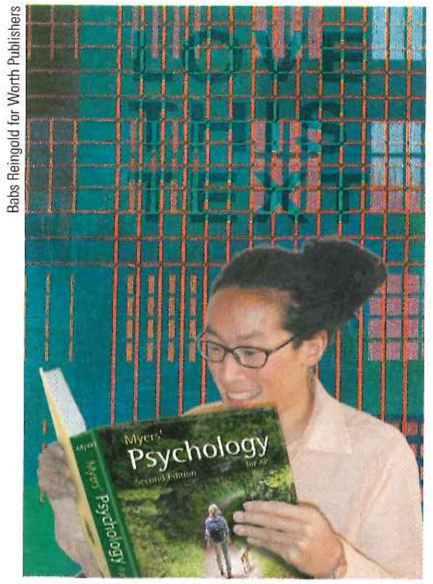
As we have seen, subliminal *sensation* is a fact. Remember that an "absolute" threshold is merely the point at which we can detect a stimulus *half the time*. At or slightly below this threshold, we will still detect the stimulus some of the time.

But does this mean that claims of subliminal *persuasion* are also facts? The near-consensus among researchers is *No*. The laboratory research reveals a *subtle, fleeting* effect. Priming thirsty people with the subliminal word *thirst* might therefore, for a moment, make a thirst-quenching beverage ad more persuasive (Strahan et al., 2002). Likewise, priming thirsty people with Lipton Iced Tea may increase their choosing the primed brand (Karremans et al., 2006; Veltkamp et al., 2011; Verwijmeren et al., 2011a,b). But the subliminal-message hucksters claim something different: a *powerful, enduring* effect on behavior.

To test whether subliminal recordings have this enduring effect, researchers randomly assigned university students to listen daily for 5 weeks to commercial subliminal messages claiming to improve either self-esteem or memory (Greenwald et al., 1991, 1992). But the researchers played a practical joke and switched half the labels. Some students who thought they were receiving affirmations of self-esteem were actually hearing the memory-enhancement message. Others got the self-esteem message but thought their memory was being recharged.

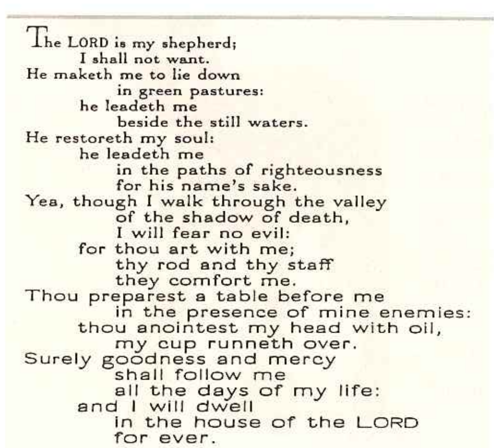
Were the recordings effective? Students' test scores for self-esteem and memory, taken before and after the 5 weeks, revealed no effects. Yet the students *perceived* themselves receiving the benefits they *expected*. Those who *thought* they had heard a memory recording *believed* their memories had improved. Those who thought they had heard a self-esteem recording believed their self-esteem had grown. (Reading this research, one hears echoes of the testimonies that ooze from ads for such products. Some customers, having bought what is not supposed to be heard [and having indeed not heard it!] offer testimonials like, "I really know that your recordings were invaluable in reprogramming my mind.")

Over a decade, Greenwald conducted 16 double-blind experiments evaluating subliminal self-help recordings. His results were uniform: Not one of the recordings helped more than a placebo (Greenwald, 1992). And placebos, you may remember, work only because we *believe* they will work.



Babs Reingold for Worth Publishers

Subliminal persuasion? Although subliminally presented stimuli *can* subtly influence people, experiments discount attempts at subliminal advertising and self-improvement. (The playful message here is not actually subliminal—because you can easily perceive it.)



The LORD is my shepherd;
I shall not want.
He maketh me to lie down
in green pastures:
he leadeth me
beside the still waters.
He restoreth my soul:
he leadeth me
in the paths of righteousness
for his name's sake.
Yea, though I walk through the valley
of the shadow of death,
I will fear no evil:
for thou art with me;
thy rod and thy staff
they comfort me.
Thou preparest a table before me
in the presence of mine enemies:
thou anointest my head with oil,
my cup runneth over.
Surely goodness and mercy
shall follow me
all the days of my life:
and I will dwell
in the house of the LORD
for ever.

The difference threshold In this computer-generated copy of the Twenty-third Psalm, each line of the typeface increases slightly. How many lines are required for you to experience a just noticeable difference?

The **difference threshold** (or the *just noticeable difference [jnd]*) is the minimum difference a person can detect between any two stimuli half the time. That difference threshold increases with the size of the stimulus. Thus, if you add 1 ounce to a 10-ounce weight, you will detect the difference; add 1 ounce to a 100-ounce weight and you probably will not.

In the nineteenth century, Ernst Weber noted something so simple and so widely applicable that we still refer to it as **Weber's law.** This law states that for an average person to perceive a difference, two stimuli must differ by a constant minimum *percentage* (not a constant *amount*). The exact proportion varies, depending on the stimulus. Two lights, for example, must differ in intensity by 8 percent. Two objects must differ in weight by 2 percent. And two tones must differ in frequency by only 0.3 percent (Teghtsoonian, 1971). For example, to be perceptibly different, a 50-ounce weight must differ from another by about an ounce, a 100-ounce weight by about 2 ounces.

difference threshold the minimum difference between two stimuli required for detection 50 percent of the time. We experience the difference threshold as a *just noticeable difference* (or *jnd*).

Weber's law the principle that, to be perceived as different, two stimuli must differ by a constant minimum percentage (rather than a constant amount).

sensory adaptation diminished sensitivity as a consequence of constant stimulation.

Sensory Adaptation

16-5 What is the function of sensory adaptation?

Entering your neighbors' living room, you smell a musty odor. You wonder how they can stand it, but within minutes you no longer notice it. **Sensory adaptation** has come to your rescue. When we are constantly exposed to a stimulus that does not change, we become less aware of it because our nerve cells fire less frequently. (To experience sensory adaptation, move your watch up your wrist an inch: You will feel it—but only for a few moments.)

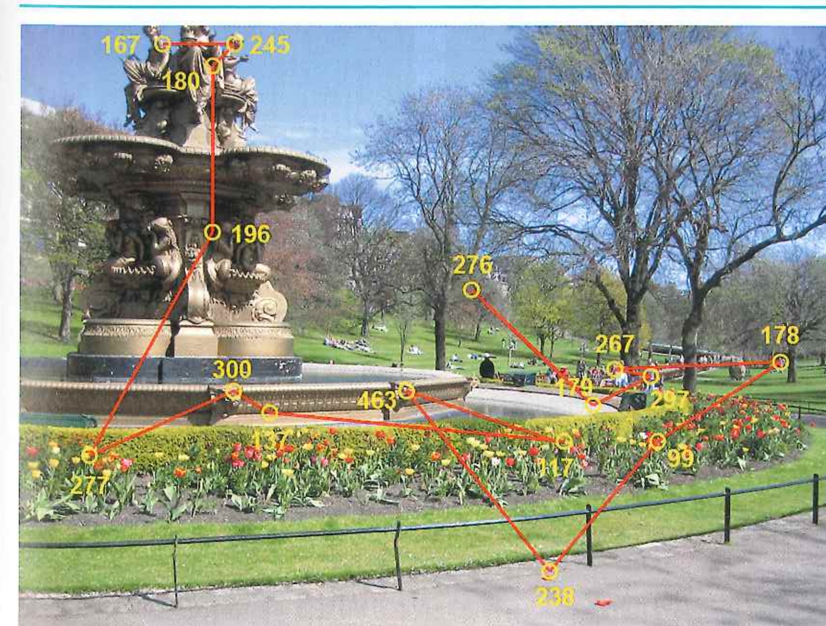
Why, then, if we stare at an object without flinching, does it *not* vanish from sight? Because, unnoticed by us, our eyes are always moving. This continual flitting from one spot to another ensures that stimulation on the eyes' receptors continually changes (**FIGURE 16.7**).

What if we actually could stop our eyes from moving? Would sights seem to vanish, as odors do? To find out, psychologists have devised ingenious instruments that maintain a constant image on the eye's inner surface. Imagine that we have fitted a volunteer, Mary, with one of these instruments—a miniature projector mounted on a contact lens (**FIGURE 16.8a** on the next page). When Mary's eye moves, the image from the projector moves as well. So everywhere that Mary looks, the scene is sure to go.

If we project images through this instrument, what will Mary see? At first, she will see the complete image. But within a few seconds, as her sensory system begins to fatigue, things get weird. Bit by bit, the image vanishes, only to reappear and then disappear—often in fragments (Figure 16.8b).

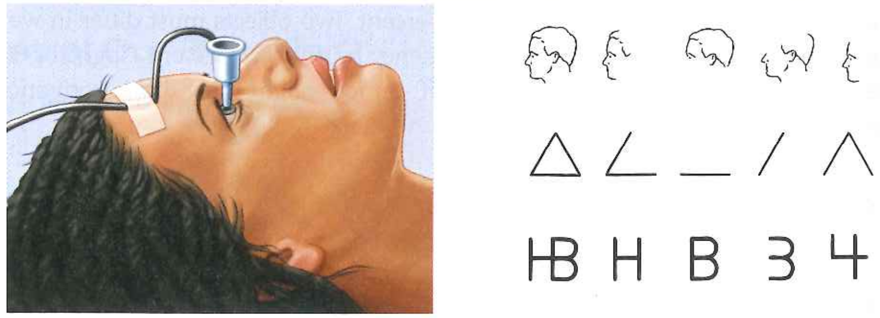
Although sensory adaptation reduces our sensitivity, it offers an important benefit: freedom to focus on *informative* changes in our environment without being distracted by background chatter. Stinky or heavily perfumed classmates don't notice their odor because, like you and me, they adapt to what's constant and detect only change. Our sensory receptors

"We need above all to know about changes; no one wants or needs to be reminded 16 hours a day that his shoes are on."
-NEUROSCIENTIST DAVID HUBEL (1979)



John M. Henderson

Figure 16.7
The jumpy eye Our gaze jumps from one spot to another every third of a second or so, as eye-tracking equipment illustrated in this photograph of Edinburgh's Princes Street Gardens (Henderson, 2007). The circles represent fixations, and the numbers indicate the time of fixation in milliseconds (300 milliseconds = three-tenths of a second).



(a) (b)

Figure 16.8
Sensory adaptation: Now you see it, now you don't!
(a) A projector mounted on a contact lens makes the projected image move with the eye. (b) Initially, the person sees the stabilized image, but soon she sees fragments fading and reappearing. (From "Stabilized images on the retina," by R. M. Pritchard.

are alert to novelty; bore them with repetition and they free our attention for more important things. We will see this principle again and again: *We perceive the world not exactly as it is, but as it is useful for us to perceive it.*

Our sensitivity to changing stimulation helps explain television's attention-grabbing power. Cuts, edits, zooms, pans, sudden noises—all demand attention. The phenomenon is irresistible even to TV researchers. One noted that even during interesting conversations, "I cannot for the life of me stop from periodically glancing over to the screen" (Tannenbaum, 2002).

Sensory adaptation even influences our perceptions of emotions. By creating a 50-50 morphed blend of an angry and a scared face, researchers showed that our visual system adapts to a static facial expression by becoming less responsive to it (Butler et al., 2008) (**FIGURE 16.9**).

Sensory adaptation and sensory thresholds are important ingredients in our perceptions of the world around us. Much of what we perceive comes not just from what's "out there" but also from what's behind our eyes and between our ears.

Figure 16.9
Emotion adaptation Gaze at the angry face on the left for 20 to 30 seconds, then look at the center face (looks scared, yes?). Then gaze at the scared face on the right for 20 to 30 seconds, before returning to the center face (now looks angry, yes?).

Before You Move On

▶ 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)?

▶ TEST YOURSELF

Explain how Heather Sellers' experience of prosopagnosia illustrates the difference between sensation and perception.

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

Module 16 Review

16-1 What are *sensation* and *perception?* What do we mean by *bottom-up processing* and *top-down processing?*

- *Sensation* is the process by which our sensory receptors and nervous system receive and represent stimulus energies from our environment. *Perception* is the process of organizing and interpreting this information, enabling recognition of meaningful events. Sensation and perception are actually parts of one continuous process.
- *Bottom-up processing* is sensory analysis that begins at the entry level, with information flowing from the sensory receptors to the brain. *Top-down processing* is information processing guided by high-level mental processes, as when we construct perceptions by filtering information through our experience and expectations.

16-2 How much information do we consciously attend to at once?

- We *selectively attend* to, and process, a very limited portion of incoming information, blocking out much and often shifting the spotlight of our attention from one thing to another.
- Focused intently on one task, we often display *inattentional blindness* (including *change blindness*) to other events and changes around us.

16-3 What three steps are basic to all our sensory systems?

- Our senses (1) receive sensory stimulation (often using specialized receptor cells); (2) transform that stimulation into neural impulses; and (3) deliver the neural information to the brain. *Transduction* is the process of converting one form of energy into another.
- Researchers in *psychophysics* study the relationships between stimuli's physical characteristics and our psychological experience of them.

16-4 What are the *absolute* and *difference thresholds,* and do stimuli below the absolute threshold have any influence on us?

- Our *absolute threshold* for any stimulus is the minimum stimulation necessary for us to be consciously aware of it 50 percent of the time. *Signal detection theory* predicts how and when we will detect a faint stimulus amid background noise. Individual absolute thresholds vary, depending on the strength of the signal and also on our experience, expectations, motivation, and alertness.
- Our *difference threshold* (also called *just noticeable difference,* or *jnd*) is the difference we can discern between two stimuli 50 percent of the time. *Weber's law* states that two stimuli must differ by a constant percentage (not a constant amount) to be perceived as different.
- *Priming* shows that we can process some information from stimuli below our absolute threshold for conscious awareness. But the effect is too fleeting to enable people to exploit us with *subliminal* messages.

16-5 What is the function of sensory adaptation?

- *Sensory adaptation* (our diminished sensitivity to constant or routine odors, sights, sounds, and touches) focuses our attention on informative changes in our environment.

Multiple-Choice Questions

1. What occurs when experiences influence our interpretation of data?

a. Selective attention
b. Transduction
c. Bottom-up processing
d. Top-down processing
e. Signal detection theory

2. What principle states that to be perceived as different, two stimuli must differ by a minimum percentage rather than a constant amount?

a. Absolute threshold
b. Different threshold
c. Signal detection theory
d. Priming
e. Weber's law