Sensation and Perception

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Fact or Falsehood?

1. Advertisers are able to shape our buying habits through subliminal messages.  
2. If we stare at a green square for a while and then look at a white sheet of paper, we see red.  
3. Touching adjacent cold and pressure spots triggers a sense of wetness.  
4. People who are born without the ability to feel pain may die by early adulthood.  
5. Without their smells, a cold cup of coffee may be hard to distinguish from a glass of red wine.  
6. Infants just learning to crawl do not perceive depth.  
7. Persons who have sight in only one eye are totally unable to gauge distances.  
8. A person who is born blind but gains sight as an adult cannot recognize common shapes and forms.  
9. If required to look through a pair of glasses that turns the world upside down, we soon adapt and coordinate our movements without difficulty.  
10. Laboratory evidence clearly indicates that some people do have ESP.

Introduction to Sensation and Perception: Vision

OUTLINE OF RESOURCES

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   Videos: Psychology: The Human Experience, Module 8: Sensation and Perception*
   Moving Images: Exploring Psychology Through Film, Program 10: Sensation Without Perception:
   Visual Prosopagnosia* NEW
   Discovering Psychology, Updated Edition: Sensation and Perception (p. 3)

II. Sensing the World: Some Basic Principles
   A. Thresholds
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   B. Sensory Adaptation
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*Video titles followed by an asterisk are not repeated within the core resource module. They are listed, with running times, in the Preface of these resources and described in detail in their Faculty Guides, which are available at www.worthpublishers.com/mediaroom.
D. Color Vision

Classroom Exercises: The Color Vision Screening Inventory and Color Blindness (p. 9)
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PsychSim 5: Colorful World (p. 9)  NEW

MODULE OBJECTIVES

After completing their study of this module, students should be able to:

1. Contrast sensation and perception, and explain the difference between bottom-up and top-down processing.
2. Distinguish between absolute and difference thresholds, and discuss research findings on subliminal stimulation.
3. Describe the phenomenon of sensory adaptation, and explain its functional value.
4. Describe the characteristics of visible light, and explain the process by which the eye converts light energy into neural messages.
5. Discuss the different levels of processing that occur as information travels from the retina to the brain’s cortex.
6. Explain how the Young-Helmholtz and opponent-process theories help us understand color vision.

MODULE OUTLINE

I. Introducing Sensation and Perception (p. 143)

Lecture/Discussion Topic: Sensation Versus Perception
Sensation refers to how we detect physical energy from the environment and encode it as neural signals. Perception refers to how we select, organize, and interpret this information. Sensation provides the raw information that perception constructs into our experiences.

Douglas Bloomquist suggests using a “puzzle picture” to illustrate the complex nature of perception as opposed to sensation. Distribute a copy of Handout 11–1 to each student. Most will not immediately perceive a meaningful configuration. For the top figure, K. M. Dallenbach states that the picture “appears when first scrutinized as an amorphous blotch without meaning or organization. Clearly, one is receiving stimulation, but it is a meaningless array of black, white, and gray.” Another psychologist likens the experience to what William James described as a baby’s first perceptual experience, that is, “one great, blooming, buzzing confusion.”

Bloomquist argues that in viewing puzzle pictures we readily come to appreciate that perception is an active process. We struggle to impose some organization upon the meaningless array we are sensing. We may even generate hypotheses about the figures, then test them by searching the picture for features that are congruent with those hypotheses. After a few minutes of unsuccessful inspection, we are likely to experience some degree of frustration.

The subject of the picture is a Dalmatian dog. Why is it difficult to see? First, it is not a complete figure. Dallenback suggests that even when asked to see a dog, we may adopt a set to perceive an entire figure, not part of one. A related explanation is that the contours are insufficient to readily differentiate figure from ground. Both figure and ground are made up of irregular spots of black and white.

The bottom figure, which is known as the Fraser Spiral, is provided by Stanley Coren and his colleagues as another example of the distinction between sensation and perception. Although the figure appears to form a spiral, it is actually a set of concentric circles. Instruct students to place one figure on any line composing the spiral. Then have them place a finger from the other hand beside it and begin tracing the circle while holding their first finger in place. Eventually they will return to the first finger confirming the figure to be a circle.

Lecture/Discussion Topic: Top-Down Processing

Christopher Green passed along the following sentences that you might present in class to introduce top-down processing:

Aocedrnig to rscheearch at Cmabridgde Unervtisy, it deosn’t mttaer in waht orer the ltteers in a wrod are, the olny iprmoetnt tihng is taht the frist and lsat ltteer be at the rght pclae. The rezt can be a total mses and you can stll raed it wouthit a porbelm. Tihs is bcuseae the huamn mnid deos not raed ervey ltteer by istlef, but the wrod as a wlohe.

Our experience and expectations enable us to immediately perceive the scrambled letters as meaningful words and sentences.

The notion that higher-level processes guide our perceptions can be traced all the way back to Herman von Helmholtz’s proposed likelihood principle: We will perceive the object that is most likely to be the cause of our sensory stimulation. That is, if a number of different objects could have caused a specific pattern of light and dark on the retina, we will perceive the object that is most likely to occur in that particular situation. For example, in one study participants were shown a kitchen scene and then briefly flashing pictures of a drum, mailbox, and loaf of bread. Most subjects correctly identified the loaf of bread (which, of course, is appropriate to the kitchen scene) but not the mailbox or drum.

A contemporary extension of the likelihood principle is Richard Gregory’s suggestion that perception is governed by hypothesis testing. He states, “We may think of sensory stimulation as providing data for hypotheses concerning the state of the external world.” We may hypothesize that a dimly lit object across the room is a small table but in looking more closely in the corner find the hypothesis is incorrect. On the basis of new data gathered, we revise the hypothesis: the “table” is actually a chest of drawers. In summary, we do not perceive in an automatic, nonthinking way. Rather, as Goldstein concludes, “Our perceptions are determined by a combination of automatic processes that begin with properties of the stimulus, and individualistic processes that depend on a person’s past experiences, knowledge, and expectations.”


Green, C. (2003, September 17). FW: Wkws for me. Message posted to tips@acsun.frostburg.edu.

Video: Discovering Psychology, Updated Edition: Sensation and Perception (Annenberg/CPB Project, 30 minutes)

This program provides an excellent complement to text coverage. After identifying the important structures involved in visual sensation, the program describes how visual information is processed. Nobelist David Hubel, whose work with Torsten Wiesel on feature detectors is described in the text, is interviewed. The program portrays perception as involving an active construction of reality. It reviews the basic principles of perceptual organization and interpretation, paying special attention to the role of expectancy and context effects. A staged bank robbery makes viewers aware of both the complexity of the perceptual process and of human susceptibility to error. The program includes vivid demonstrations of several phenomena described in Modules 13 and 14, including the Ames room, impossible figures, ambiguous figures (saxophonist vs. woman’s face), and perceptual adaptation to disorienting glasses. The entire Discovering Psychology series of 26 half-hour programs is available for $389. Some video programs can also be purchased individually. To order, or simply for more information regarding individual programs, call 1-800-LEARNER.

II. Sensing the World: Some Basic Principles (pp. 143–147)

A. Thresholds (pp. 144–146)

Lecture/Discussion Topic: Gustav Fechner and Psychophysics

In pioneering the study of the relationship between physical energy and psychological experience, Gustav Fechner (1801–1887) was actually attempting to promote his belief that every person, animal, and plant in the universe is composed of both matter and soul. Although trained in medicine, Fechner soon turned his attention to physics and mathematics and held a professorship at the University of Leipzig. As part of his research he discovered that after staring at the sun for a period of time, he would see an afterimage (blue, the complement of yellow). He began to devote all his time to this psychological research. Although his findings were well-received, the work led him to suffer phobia and emotional collapse. Virtually blind, he spent a long period of time in a darkened room where, Morton Hunt reports, “he was tormented by pain, emotional distress, intolerable boredom, and severe digestive problems.” He eventually began to improve and to see again without pain. As he emerged from his room he walked into a garden where the flowers appeared.
brighter, more beautiful, and more intensely colored than ever before. This led him to write a book about the mental life of plants and for the rest of his life he sought to promote his theory that consciousness and matter coexist throughout the world. Hunt describes how this mystical notion led Fechner to his historic work in experimental psychology.

Lying in bed on the morning of October 22, 1850, wondering how to prove that mind and body are two aspects of a fundamental unity, Fechner had a sudden insight. He thought that if somehow he could show a consistent mathematical relationship between the force of stimuli and the intensity of the sensations they produce, he would have established the identity of body and mind. Fechner asked the important question: Is there a consistent mathematical relationship between the magnitude of a stimulus and the magnitude of the sensation it creates? Although he could measure stimulus intensity directly, Fechner thought he faced an enormous problem in measuring sensations. They are subjective. Finally, he realized he could do so indirectly by using sensitivity as the guide. He could determine the smallest increase in stimulus strength that would be just barely noticeable to the subject. “Just barely noticeable” meant the same thing at any level. That measurement of sensation could be compared with the increase in stimulus necessary to produce the awareness.

The three methods of experimental measurement used by Fechner continue to be used in psychophysical research. In the method of limits, the researcher begins with a minimal stimulus and increases it until the subject can perceive it. To determine a just noticeable difference the researcher presents a standard stimulus and a comparison stimulus and increases the difference between them by small steps until the subject says it is perceptible.

In the method of right and wrong cases, the experimenter presents identical stimuli repeatedly—either single stimuli at the threshold or pairs of stimuli that are very similar. The subject responds “Yes” (if she perceives it, or the two are different) or “No” (if he does not perceive it or the two are not different). The responses yield averages and these tell how likely it is that at any given stimulus level or difference between stimuli, the subject will perceive the stimulus or the difference.

In the method of adjustment, the researcher or subject adjusts a comparison stimulus until it appears identical to the standard stimulus. Of course, there is always a small margin of error. Every error is recorded and after many trials, the average error is computed. It, too, provides a measure of just noticeable difference.

In recognizing Fechner’s contributions, the great historian of psychology Edwin G. Boring writes, “Fechner, because of what he did and the time at which he did it, set experimental quantitative psychology off upon the course which it has followed. One may call him the “founder” of experimental psychology, or one may assign that title to Wundt. It does not matter. Fechner had a fertile idea which grew and brought forth fruit abundantly.”


Student Project: The Variability of the Absolute Threshold
An absolute threshold is defined as the minimum amount of stimulation a person needs for a particular stimulus to be detected 50 percent of the time. Students can experience the variability of the absolute threshold for sound by placing a kitchen timer on a table in an otherwise quiet room. They should move away so that they can no longer hear the ticking, then gradually move toward the timer until they begin to hear the sound. This is their “momentary” threshold. If they remain where they are, they will notice that occasionally they won’t be able to hear the sound and will need to step forward to reach threshold. At other times the sound will get louder and they will be able to step back. This changing sensitivity indicates that the “absolute threshold” is anything but absolute. Our sensitivity changes from moment to moment and from measurement to measurement. As long ago as 1888, Joseph Jastrow speculated that lapses of attention, slight fatigue, and other psychological changes could cause fluctuations in the absolute threshold.


Lecture/Discussion Topic: Subliminal Persuasion
Anthony Pratkanis notes that at various times a claim regarding subliminal persuasion has been made and, although it has been unsubstantiated or validly criticized on methodological grounds, the original claim has gained acceptance in lay audiences. To understand this acceptance, Pratkanis did a content analysis of popular press articles on subliminal persuasion published between 1955 and 1987. He identified five factors that contribute to their effect on the public’s beliefs regarding subliminal influence. His analysis, first reported in 1990, remains instructive today.

First, popular accounts of subliminal influence appeal to the “pop” psychology of the day. Many Americans believe in a powerful unconscious capable of performing amazing feats. Subliminal influence is portrayed in the media and by proponents as a means of directly communicating to this unconscious.
Second, popular accounts link subliminal influence to the issue of the day. Subliminal influence first emerged as a national concern after the Korean War when brainwashing and hypnotic suggestion captured the nation’s imagination in films such as *The Manchurian Candidate*. In the post-Watergate years, Americans felt that their leaders were involved in devious conspiracies of the type dramatized in *Network*. Wilson Bryan Key, author of *Subliminal Seduction*, capitalized on the idea that big business and big government were conspiring to get us. Today’s producers of subliminal tapes link their products to the growing interest in human potentials and self-enhancement.

Third, those advertisers accused of using subliminal persuasion to manipulate the public are subjected to what can be termed “the witch test.” During the Middle Ages, a woman accused of witchcraft would be bound and thrown into a pond. If she floated, she was a witch. Only if she drowned was her innocence affirmed. How do we know that advertisers use subliminals and that they work? According to writers such as Key, advertisers would not spend so much money on them if they did not work. The fact that subliminal messages cannot be readily identified demonstrates the advertiser’s craftiness. The protestations of the accused are merely signs of guilt. The only way advertisers can prove their innocence is by going out of business. In contrast, the motives of the proponents of subliminal seduction who frequently profit by the sale of more books and tapes are rarely questioned.

Fourth, many of the popular articles fail to report scientific evidence that is critical of claims for subliminal persuasion. If negative information is given, it is often presented at the end of the article, giving the reader the impression that, at best, the claims for subliminal effectiveness are somewhat controversial.

Finally, belief in subliminal persuasion may serve a need for many individuals. We live in an age of persuasion. The average American is likely to see over 6 million ads in a lifetime, yet he or she knows little or nothing about the persuasion process. Subliminal persuasion is presented as an irrational force outside the control of the message recipient. In this way, it takes on a supernatural “the devil made me do it” quality capable of explaining why Americans engage in irrational consumer behavior. “Why did I buy this worthless product at such a high price?” Subliminal sorcery!


**Classroom Exercise: Backmasking—A Tape for the Classroom**

Classroom discussion of subliminal stimulation often leads students to ask about the phenomenon of “backmasking”—recording corruptive messages backward into rock music. John Vokey and Don Read’s research provides a fascinating look into whether listeners derive meaning from, or can be influenced by, backward messages. Vokey and Read have made an audiocassette tape for class demonstrations. It can be obtained by sending a blank cassette tape to John R. Vokey, Department of Psychology and Neuroscience, University of Lethbridge, Alberta, T1K 3M4 Canada. The tape contains parts of Jabberwocky and the 23rd Psalm played backwards. More dramatically, the tape also suggests how and why listeners may “hear” diabolical messages in rock music. Students are prepared to “discover” certain messages, and they do so. Thus, the tape is a marvelous demonstration of the effects of perceptual set as well as backmasking.


**Student Project: Understanding Weber’s Law**

Stanley Coren and his associates suggest a simple demonstration of Weber’s law for the perception of heaviness. Students need three quarters, two envelopes, and a pair of shoes. Have them place one quarter in one envelope and the remaining two quarters in the other. Lifting each envelope, they can easily determine which is heavier. Now have them put each envelope in a shoe. When they lift the shoes, one at a time, the weight difference will be imperceptible. Weber’s principle: Difference thresholds grow with the magnitude of the stimulus.

Students can also try a more precise weight discrimination task to demonstrate Weber’s law. Art Kohn and Max Brill describe how students can prepare an ascending scale of weights by inserting increasing numbers of BBs from a pop gun, or other similar items, into 35 mm film canisters. The weights must differ by exactly equal increments and should be noted on the bottom of each cannister. Volunteers can then be asked to arrange the cannisters from lightest to heaviest. Difficulty in discrimination will increase as the cannisters get heavier.


**Lecture/Discussion Topic: Applying Weber’s Law**

Weber’s law can be applied to many situations. For example, a $10-per-hour worker may require a 50-cent pay raise to notice the difference; a $20-per-hour worker may need to receive a $1 raise to notice.
Robert Cialdini illustrates the principle for sales. Assume that a man wants to buy a three-piece suit and a sweater. If you were the salesperson, which should you show him first in order to get him to spend the most money? You might think it best to sell the sweater first. Having spent a lot on a suit, the customer might be reluctant to spend more on a sweater. However, sales motivation analysts suggest the opposite. Sell the suit first because the additional cost of the sweater will not be so readily noticed. If the man has just paid $500 for a suit, an additional $75 for a sweater will not seem excessive. The same applies to other accessories, such as a shirt or shoes. As a rule, people will almost always pay more for accessories if they buy them after rather than before a more expensive purchase.

The same principle holds for the purchase of accessories on a new car. After paying $32,000 for the car, the customer will hardly notice $700 for a sound system to go with it. The trick, of course, is to mention these accessories independently so that each addition will seem negligible in comparison to the much larger commitment already made.


**B. Sensory Adaptation** (pp. 146–147)

*Student Project: Sensory Adaptation*

Adaptation to the taste of one substance can affect the taste of another, either decreasing or increasing our sensitivity to it. This phenomenon has sometimes been called “cross-adaptation.” After drinking tea with lemon, for example, a grapefruit will not taste sour. After eating a sweet roll, on the other hand, grapefruit juice may taste extremely sour.

The variability in the taste of ordinary tap water following adaptation to various substances will surprise many students. Have them mix a strong solution of water and salt and hold it in their mouth for a time; it will gradually taste less salty. If they then take a glass of fresh water, it will taste bitter or sour. Conversely, if they first take a mouthful of diluted vinegar or strong, caffeinated coffee, the glass of water will taste sweet.

(A way to make anything taste sweet is to eat miracle markers and whiff. In a class of 30, Raap reports that 3 experienced cross-adaptation (smelled nothing); the remaining students easily smelled the new stimulus. Many of them actually experienced facilitation (heightened intensity) of the new smell.


**Classroom Exercise: Eye Movements**

The text notes that our eyes are always moving, quivering just enough to guarantee that the retinal image continually changes. If our eyes were to stop moving, sense receptors would be fatigued and images would vanish.

The figures in Handout 11–2 will vividly demonstrate these eye movements, as well as their importance in maintaining vision. Fixating on the center of the pattern of (a) leads immediately to the perception of movement. After students stare at it for 30 seconds, they should stare at a white surface (e.g., a piece of paper or a wall). Most will see an afterimage of rotary motion, owing in part to the involuntary eye movements during fixation. Next, have your students stare at the small black dot in the middle of (b) for about 60 seconds and then look at the white dot. Even if they try very hard to look steadily at the white dot, they will see an image of the grid pattern jiggling on top of the figure. Again, this jiggling is due to involuntary eye movements. Finally, have them stare at the fuzzy-contoured disc on the right in (c). If they keep their eyes very still for about 30 seconds, the disc will disappear. They will find that it is very difficult, if not impossible, to do this with the sharp-contoured disc on the left side of the figure. The explanation for this difference? The image of the fuzzy disc jiggling on the retina causes only slight changes in the amount of light stimulating the receptors near the contour. If the eyes are kept still enough, the small change in stimulation caused by movement of this fuzzy contour is not enough to maintain perception and the disc fades from view. When looking at the sharp disc, the slight jiggling of the eyes causes the sharp contour to fall first on some receptors and then on others. Thus, the amount of light stimulating the receptors is constantly changing and the disc remains visible.

In a picture from Isia Leviant’s Enigma series, represented in black and white in (d), most observers see spinning rings after about 10 seconds of viewing. The pattern is, of course, very similar to (a), and some argue that the mechanical instability of the eyes again explains the effect. But why then do we experience a stable circular movement? Leviant suggests that neural circuits responsible for detecting motion may be influenced by nearby neural circuits dedicated to the analysis of spatial orientations.
Finally, ask students to count the points in each line of Bourdon’s figure represented in (e). They will find it nearly impossible to do because of lack of precision in guiding the movement of the eyes.


III. Vision (pp. 147–155)

Classroom Exercise/Student Project: Physiology of the Eye—A CD-ROM for Teaching Sensation and Perception

Interactive exercises, full-color 3D animations, visual illusions, and various eye tests are all important components of this CD (a revision of Human Vision) available through Interactive Eye at www.iknow.net. In addition to the topics covered in the text such as the structure of the eye and principles of visual information processing, the CD explores the development of vision, 40 of the most common eye disorders, principles of light, and optics. You can more fully sample the CD’s content at the Web site above. A single CD can be purchased at the educational rate of $89. A five-pack is $249. Larger quantities are available at reduced rates.

A. The Stimulus Input: Light Energy (pp. 147–148)

B. The Eye (pp. 148–150)

Student Project: Locating the Retinal Blood Vessels

The term “retina” is derived from a Latin word meaning “net” and refers to the intricate network of blood vessels that nourish the retina’s nerve cells. Students will be fascinated to learn that they look through these blood vessels all the time. With a flashlight and a light-colored wall they can see and even map their own retinal blood vessels. Have them stand in a darkened room and look at the wall, then hold the flashlight near the outer edge of their left or right eye and jiggle it around. If they are patient, they will eventually see a netlike pattern on the wall. It helps if they hold their head slightly downward while staring upward at an angle of about 45 degrees. By steadily shaking the flashlight with one hand and tracing the shadows with the other, students will be able to map their own blood vessels. If they focus intently on the image, they will also see that the blood vessels converge in the center. This is the beginning of the optic nerve, the area producing the blind spot, as described in the text.


Classroom Exercise: The Hermann Grid

Both (b) of Handout 11–2 and (a) of Handout 11–3 provide an interesting illusion that can be used to teach something important about the nature and function of retinal ganglion cells.

Randolph Blake and Robert Sekuler note that some years ago, Northwestern University published a catalog of its course offerings that elicited an unexpected public response. After looking at the cover, several students called local physicians complaining of mysterious spots in their vision. When the students tried to look directly at one of these spots to be sure it was not imaginary, it disappeared. Your students will also see gray spots where the vertical and horizontal white stripes meet. However, if they try to focus on any single spot, it will disappear. This pattern is known as a Hermann grid, after Ludimar Hermann, the German physiologist who first described it in the nineteenth century.

The illusory gray spots seem best explained in terms of the receptive fields of retinal ganglion cells. Some of these cells are composed of an ON center enclosed by an OFF surround. Light has opposite, or antagonistic, effects on this donut-shaped composite. The ON region responds to an increase in light, while the OFF region responds to a decrease in light. It follows that the cell responds most vigorously when the ON region receives increased light and the OFF region receives decreased light.

Handout 11–3b shows how this helps explain the illusory gray spots at most intersections. While all the ON centers of cells, both those between the intersections and those in the intersections, receive the same stimulation, the OFF surrounds receive different amounts of stimulation. The fact that light falling on an OFF region reduces that cell’s activity means that the cell whose receptive field is centered in the intersection will respond less than the cell whose receptive field is centered between the intersections. Thus, between the intersections the white stripes will look relatively brighter.

Handout 11–3c explains why the gray spot disappears when you focus directly on an intersection. The size of the cells and thus the receptive fields tend to be smallest at the center of the retina. When you look directly at an intersection, the OFF and ON regions are so small that both fit within the width of a stripe. Thus, all the cells around the region of fixation give the same response, whether in the intersection or not.

The scintillating grid illusion, represented in Handout 11–3d, is similar to the Hermann grid illusion. The squares are separated by grey rather than white, and a white circle fills each intersection to cancel the illusory spots of the Hermann grid. Discov ered by Elke Lingebach in 1994, these subtle differences change the Herm grid illusion in several ways and make its effects more powerful. As students move their eyes around the image, the junctions scintillate, or twinkle, and they appear as black dots moving from junction to
juncture. As is true for the Hermann grid illusion, staring at any intersection causes the flashing to stop in that area.

Al Seckel suggests that small timing differences between our responses to the black center area and to the lines surrounding the area account for the twinkling effect. The “center” responses are faster and more transient than the “surround” responses, and this causes the dots at the intersections to scintillate. As we scan the image, the cells that signal white at the intersections first give a strong center signal in response to the white dots at the intersections, but then their signal is weakened as the surround inhibition takes place. This reduction is perceived as a darkening of the spot.


C. Visual Information Processing (pp. 150–153)

Classroom Exercise/Student Project: Movement Aftereffects

Michael Levine and Jeremy Shefner cite movement aftereffects (MAEs) as evidence for the presence of direction-specific movement detectors in the human visual system. Many students will be familiar with MAEs in one form or another. Perhaps they have stared at a waterfall and then, looking away, experienced the illusion of everything floating upward. Or, as passengers in a train that has come to a stop, they may have had the feeling of the train moving backward. Or, after watching a movie’s closing credits move up the TV screen, they may have had the sensation that the entire TV was moving downward.

One of the most dramatic MAEs (sure to elicit a chuckle) is the plateau spiral illusion, which can be demonstrated with Handout 11–4 (cut out the spiral and glue it to a cardboard disk of the same size). Rotate the spiral on a color wheel, turntable, or even the end of a pencil so that it appears to be receding. Have students stare at the center of the spiral for about one minute, then look at your face. They will have a striking impression of your head swelling in size. (Rotating the circle in the opposite direction will create a shrinking head.)

MAEs are apparently caused by the adaptation of motion-specific detectors that are tuned to the direction of the movement of the stimuli being viewed. For example, in watching a waterfall, all the detectors sensitive to downward movement are continuously stimulated. These detectors gradually adapt and become less sensitive. Thus, shifting our gaze will activate the movement detectors sensitive to upward movement more than the downward-movement detectors; as a result, objects will appear to be moving upward.

Lecture/Discussion Topic: Blindsight

You might extend the text discussion of blindsight with the following examples and possible explanations for its existence. Those with blindsight, argues Anthony Marcel of Cambridge University, have superb vision but they don’t know they can see. Employing a high-speed camera, Marcel tracked the vectors of subjects’ arms, hands, and fingers as they reached for objects they could not consciously see. The films indicate that their reach was quite precise. This suggests that their vision remains intact; only the neural areas that bring vision into awareness are impaired.

Psychologist Lawrence Weiskrantz and his colleagues at Oxford University have investigated blindsight extensively. They report, for example, that 20 years ago, a young male patient who had lost the left half of his vision because of damage to the visual cortex could nonetheless identify things in the blind field. For instance, he could distinguish between an X and an O and tell whether a line of light was vertical or horizontal. However, he did this only when the researchers urged him to guess. He would be astonished that his answers were correct: “I couldn’t see anything, not a darn thing.”

Researchers disagree on the cause of blindsight. Research has indicated that certain animals can see without a visual cortex; they use a more primitive visual processing center. While this primitive structure may still provide information about the location of objects, it does so below the level of awareness. Weiskrantz argues that blindsight is similarly produced in portions of the brain other than the primary visual cortex. He notes that fat bundles of fibers from each optic nerve never reach the visual cortex but instead travel to the midbrain, which controls involuntary, unconscious actions. Other fibers bypass the primary visual cortex and enter different cortical regions. These regions may produce the unconscious vision.

Michael Gazzaniga of the University of California, Davis, has challenged the notion that blindsight is derived from visual pathways diverted to the midbrain. He reports discovering that a patient with blindsight has live, functioning neurons in the portion of the visual cortex that presumably had been destroyed. These islands of healthy tissue, argues Gazzaniga, account for blindsight; because the preserved areas are so slight, the signals patients receive are too small to trigger a conscious reaction. Gazzaniga does not find this surprising. “Lots of studies suggest that we’re not consciously aware of what goes on in the cortex, probably a good deal of our psychological life.”

Weiskrantz acknowledges that there may well be individual cases in which the ability to make visual discrimination is the result of small intact islands of vision, but, he says, this is not always true. He cites the case of G. Y., a patient who demonstrated blindsight. According to Weiskrantz, G. Y.’s ability to respond to pathways of movement with perfect accuracy would require many widely distributed intact islands. Yet a high-resolution MRI scan revealed only a small patch of intact visual cortex near the back of the brain. A PET scan also found no activity in the visual cortex as G. Y. viewed a moving visual display; however, the scan detected activity in the visual association areas and other brain regions.


D. Color Vision (pp. 154–155)

PsychSim 5: Colorful World

This activity reviews the principles of color sensation, including a comparison of the trichromatic and opponent-process theory of color vision. Students demonstrate some aspects of color sensation with their own eyes.

Classroom Exercise: The Color Vision Screening Inventory and Color Blindness

Handout 11–5 is the Color Vision Screening Inventory developed by Coren and Hokstian, which can be used as a preliminary test for color blindness. Students should answer all the questions as directed, then score their responses as follows: 1 for Never, 2 for Seldom, 3 for Occasionally, 4 for Frequently, and 5 for Always. Those students whose total scores are above 16 have an 81 percent likelihood of failing a standard screening test for color vision. Students with such scores may want to get their vision tested by a doctor or in a perception laboratory.

Color vision defects provide an interesting lecture topic. Just over 8 percent of all males show color weaknesses, but slightly less than .05 percent of all females show similar deficits. Color defects are genetically transmitted; recent research has conclusively mapped the pattern of this transmission.

Monochromats have either no functioning cones or only one functioning cone type and respond to light in much the same way that a black and white film does. All colors are recorded simply as gradations in intensity. Those who have no functioning cones are likely to

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find daylight very uncomfortable; those with one cone type see comfortably under both daylight and dim levels of illumination, but they still lack the ability to discriminate colors. Only a very small percentage of people actually suffer from this form of color blindness.

**Dichromats** have one malfunctioning cone system. John Dalton, an eighteenth-century English chemist, discovered that he was a dichromat when he wore a scarlet robe to receive his doctoral degree. As a Quaker, he was expected to shun bright colors. Critics were silenced only after they learned that crimson and dark blue-green appeared to be the same color to him. Dalton's color defect—an insensitivity to long wavelengths normally perceived as red light—is referred to as protanopia. Dalton described his experiences when viewing the spectrum as follows: “I see only two or at most three distinctions. These I should call yellow and blue, or yellow, blue, and purple. My yellow comprehends the red, orange, yellow, and green of others and my blue and purple coincide with theirs.”

Deuteranopia, the most common form of dichromacy, is a malfunction in the green cone system. People with this deficiency are able to respond to green light but cannot distinguish green from certain combinations of red and blue.

Tritanopia, an absence or malfunction of the blue cone system, was not discovered until about 1950, when a magazine article with a color vision plate appeared as part of an intensive search throughout England. The 17 individuals with this disorder, instead of seeing the spectrum as composed of blues and yellows as do other dichromats, see the longer wavelengths as red and the shorter ones as bluish green. The discovery of persons with this defect provided strong support for a trichromatic theory of color vision.

What do colors look like to a dichromat? We have provided some insight by a rare person who was deuteranope in her left eye but color-normal in her right eye. Researchers had her adjust the color seen by her normal eye so that it appeared to be the same hue as the color seen by her defective eye. The colors over the entire range from red to green (red, orange, yellow, green) all appeared to have the same yellow hue, and the colors blue and violet appeared to be blue. Blue-green appeared to be a neutral gray.


**Classroom Exercise: Subjective Colors**

John Kremer’s *Turntable Illusions* is a wonderful source of material for classroom demonstrations of illusions. (Most apply to the section on perception. One exception is the experience of subjective colors, utilizing the Fechner-Benham disc described below.) The book includes 40 discs that, when rotated, demonstrate a variety of perceptual phenomena. Kremer provides explanations for each. Although the title of his book suggests that the discs be played on an old record player, using a variable speed drill to display them works even better. Many also work well when simply rotated on the tip of a pin. Often the stationary patterns are intriguing in their own right.

Handout 11–6, the Fechner-Benham disc, can be used to extend the text discussion of color vision; it illustrates subjective colors (colors that appear in the absence of the appropriate wavelengths of light). The pattern is adapted from a design first used in the 1890s on a popular children's toy called a Benham top, named after its inventor. (German physicist and psychologist Gustav Fechner first reported subjective colors in 1838. Thus, they are sometimes called Fechner colors and the black and white patterns that produce the colors are known as Fechner discs or Fechner-Benham discs.) When the disc is rotated at 33 or 45 rpm, the black lines within the white spaces will appear colored. For many, the colors are surprisingly vivid.

Subjective colors remain somewhat of a puzzle. Harvey Schiffman suggests that the patterns of black and white alternations in the disc bypass the contribution of the retina. Patterns of excitation beyond the retina may be set up that produce a sequence of neural events mimicking the different temporal patterns of neural activity that normally result from viewing colored stimuli. Stanley Coren and his colleagues state that, at least on the surface, the existence of subjective colors is more consistent with the idea that some sort of Morse code carries color information, rather than with the concept of a spatial opponent-process system that contemporary data seem to support.

A second figure, Handout 11–7, demonstrates how a black and white stationary pattern can also produce subjective colors. Have students examine the center of the figure. A faint, shimmering pattern of pastel streaks will appear. For many people they will run vertically up and down the pattern crossing both white and black lines. Others will see a fishnet-like pattern over the grid. As we view the pattern, small voluntary and involuntary eye movements occur. These movements displace the image of the diagonal lines over the retinal receptors and create a pattern of receptor activity that typically occurs from viewing colored stimuli.


Handout 11-2

The Perception of Movement
HANDOUT 11–2 (continued)
HANDOUT 11–3 (continued)

Color Vision Screening Inventory

For each question you should select the response that best describes you and your behaviors. Circle the letter corresponding to the first letter of one of the following response alternatives:

- **N**ever (or almost never)
- **S**eldom
- **O**ccasionally
- **F**requently
- **A**lways (or almost always)

Then score your responses as follows: 1 for Never, 2 for Seldom, 3 for Occasionally, 4 for Frequently, and 5 for Always. Add your scores for the 10 questions; if your score is 16 or higher, you have an 81 percent likelihood of failing a standard screening test for color vision. If your score is in this range, you might want to get your color vision tested by your doctor or in a perception laboratory.

1. Do you have difficulty discriminating between yellow and orange?
   - N
   - S
   - O
   - F
   - A

2. Do you have difficulty discriminating between yellow and green?
   - N
   - S
   - O
   - F
   - A

3. Do you have difficulty discriminating between gray and blue-green?
   - N
   - S
   - O
   - F
   - A

4. Do you have difficulty discriminating between red and brown?
   - N
   - S
   - O
   - F
   - A

5. Do you have difficulty discriminating between green and brown?
   - N
   - S
   - O
   - F
   - A

6. Do you have difficulty discriminating between pale green and pale red?
   - N
   - S
   - O
   - F
   - A

7. Do you have difficulty discriminating between blue and purple?
   - N
   - S
   - O
   - F
   - A

8. Do the color names that you use disagree with those that other people use?
   - N
   - S
   - O
   - F
   - A

9. Are the colors of traffic lights difficult to distinguish?
   - N
   - S
   - O
   - F
   - A

10. Do you tend to confuse colors?
    - N
    - S
    - O
    - F
    - A
