sensation and perception

3

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CHAPTER 3 ANSWER KEY

Practice Quiz 3.1

1. D; 2. A; 3. D; 4. A

Practice Quiz page 3.2

1. A; 2. B; 3. C; 4. A; 5. B; 6. B

Practice Quiz page 3.3

1. A; 2. C; 3. B; 4. A; 5. D

Practice Quiz page 3.4

1. c; 2. d; 3. d; 4. b

Practice Quiz page 3.5

1. d; 2. a; 3. c; 4. a

Practice Quiz page 3.6

1. b; 2. c; 3. b; 4. c; 5. a; 6. b

Test Yourself 3

1. b; 2. d; 3. a; 4. b; 5. a; 6. c; 7. b; 8. b; 9. a; 10. a; 11. b; 12. b; 13. c;

14. a; 15. a; 16. c; 17. a; 18. d; 19. b; 20. c

▼CHAPTER-AT-A-GLANCE

Detailed Outline	*Instructor Resources*	*Multimedia Resources*
The ABCs of Sensation Transduction Sensory Thresholds Habituation and Sensory Adaptation	**Learning Objectives:** 3.1, 3.2, 3.3 **Lecture Launchers:** 3.1, 3.2, 3.3 **Activities & Exercises:** 3.1, 3.2, 3.3, 3.4 **Handouts:** 3.1, 3.2	**Video:** *The Big Picture: Taking in the World Around Us* (3:50) — Learn about transduction, sense organs, and how our actions and high-level thinking begin with sensations and perceptions. **Video:** *The Basics: In Full Appreciation of the Cookie* (4:34) — Watch how the simple act of eating a chocolate chip cookie involves all of our senses, and several parts of the brain are involved in forming our perception of that experience.
The Science of Seeing Light and the Eye The Visual Pathway Perception of Color	**Learning Objectives:** 3.4, 3.5, 3.6 **Lecture Launchers:** 3.4, 3.5, 3.6, 3.7, 3.8 **Activities & Exercises:** 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12 **Handouts:** 3.3	
The Hearing Sense Soundwaves and the Ear Perceiving Pitch Types of Hearing Impairments	**Learning Objectives:** 3.7, 3.8, 3.9 **Lecture Launchers:** 3.9, 3.10, 3.11, 3.12, 3.13 **Activities & Exercises:** 3.13	
Chemical Senses Gustation: How We Taste the World The Sense of Scents: Olfaction	**Learning Objectives:** 3.10, 3.11 **Lecture Launchers**: 3.14, 3.15, 3.16 **Activities & Exercises:** 3.14, 3.15, 3.16, 3.17, 3.18, 3.19	**Video:** *Thinking Like a Psychologist: Can Smells Alter Mood and Behavior?* (6:49) — Learn how smells can spark vivid memories and have a powerful effect on our mood, both good and bad.
The Other Senses: What the Body Knows Somesthetic Senses Body Movement and Position	**Learning Objectives:** 3.12, 3.13 **Lecture Launchers:** 3.17, 3.18 **Activities & Exercises:** 3.20, 3.21	**Video:** *In the Real World: Managing Pain* (6:40) — See how injury is communicated to the brain, how pain signals can be intensified or blocked, and what the safest, most effective methods are for pain management.
The ABCs of Perception How We Organize Our Perceptions Depth Perception Perceptual Illusions	**Learning Objectives:** 3.14, 3.15, 3.16 **Lecture Launchers:** 3.19, 3.20 **Activities & Exercises:** 3.22, 3.23 **Handout:** 3.4	**Video:** *Special Topics: Recognizing Faces* (4:33) — Find out which regions of the brain are involved in facial recognition and why some people have problems recognizing faces. **Writing Assignment:** The Gestalt psychologists maintained that when people perceive sensory elements their tendency is to see things in terms of the entire form or pattern rather than as individual parts. Identify and describe these basic principles of perceptual organization from the Gestalt perspective: figure-ground, similarity, proximity, and closure.
Applying Psychology to Everyday Life: Beyond "Smoke and Mirrors" – The Psychological Science and Neuroscience of Magic	**Learning Objectives:** 3.17	**Video:** *What's In It For Me? Perceptual Magic in Art and Movies* (7:45) — Investigate the ways in which artists play on and exploit sensation and perception to create works of art and illusion.

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▼LECTURE GUIDE

I. THE ABCs OF SENSATION

Lecture Launchers and Discussion Topics
- ➢ *3.1 - The Sensory System*
- ➢ *3.2 - Setting Thresholds*
- ➢ *3.3 - A Few Animal Facts*

Classroom Activities, Demonstrations, and Exercises
- ➢ *3.1 - Beware of What You Wish For*
- ➢ *3.2 - Variability in the Absolute Threshold*
- ➢ *3.3 - Sensory Adaptation*
- ➢ *3.4 - Sensation*

Video - Special Topics: In Full Appreciation of the Cookie
Video - The Big Picture: Taking in the World Around Us
Animation - Weber's Law

Learning Objective 3.1 - Describe how we get information from the outside world into our brains.

A. What is sensation?
1. Sensation is the activation of receptors located in the eyes, ears, skin, nasal cavities, and tongue
2. Sensory receptors are specialized forms of neurons that are stimulated by different types of energy, such as light, vibration, pressure, temperature, and chemical substances
3. Transduction is the process of converting external stimuli into neural impulses
4. Synesthesia occurs when signals are processed in the wrong cortical areas

Learning Objective 3.2 – Describe the difference and absolute thresholds.

B. Sensory thresholds
1. A "just noticeable difference," or jnd (also referred to as the difference threshold), is the smallest difference between two stimuli that is detectable half the time it is present
    a. Weber's law states that the jnd between two stimuli is always a constant
2. An absolute threshold is the lowest level of stimulation that a person can consciously detect 50 percent of the time the stimulation is present.
3. Subliminal stimuli are stimuli that are below the level of conscious awareness
4. Signal-detection theory provides a method for assessing the accuracy of judgments or decisions under uncertain conditions

Learning Objective 3.3 – Explain why some sensory information is ignored.

C. Habituation and sensory adaptation
1. Habituation occurs when the brain stops attending to a constant, unchanging environmental stimulus
2. Sensory adaptation occurs when sensory receptor cells become less responsive to a constant, unchanging stimulus

Practice Quiz 3.1 Answer Key

1. D; 2. A; 3. D; 4. A

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II. THE SCIENCE OF SEEING

Learning Objective 3.4 - Describe how light travels through the various parts of the eye.

A. Perceptual properties of light
1. Brightness corresponds to the amplitude of light waves
2. Color is largely determined by the length of the light waves
3. Saturation refers to the purity of the color the human eye perceives, which corresponds to the variations in the lengths of visible light waves

B. The structure of the eye
1. Cornea: clear membrane on the surface of the eye
2. Aqueous humor: clear, watery fluid that lay beneath the cornea
3. Pupil: the hole in interior of eye that lets in light
4. Iris: a round muscle that surrounds the pupil; it is the colored part of the eye
5. Lens: the clear, flexible structure behind the iris that changes its shape in order to finish the focusing process
6. Vitreous humor: a large, open space filled with a clear, jelly-like fluid; nourishes the eye and gives it shape
7. Retina: a light-sensitive area at the back of the eye containing three layers:
a. Ganglion cells:
b. Bipolar cells
c. Rods and cones,

C. How rods and cones convert light into vision
1. Rods and cones are special receptor cells (*photoreceptors*) that respond to the various wavelengths of light.
2. Rods detect changes in brightness, but not to changes in wavelengths – hence, they see only black, white, and gray. Rods function best in low levels of light.
a. Found everywhere in the retina except the center, or fovea

3. Cones are sensitive to colors and work best in bright light
    a. Responsible for the sharpness and detail of visual information; found in highest concentration in the fovea

Learning Objective 3.5 - Explain how light information reaches the visual cortex.

D. The visual pathway
1. Light entering the eye separates into left and right visual fields
    a. An upside-down and left-right reversed image falls on the retina
2. Information from the visual fields goes to the contralateral visual cortex
3. Dark adaptation occurs as the eye recovers its ability to see when going from a brightly lit state to a dark state.
4. Light adaptation is the recovery of the eye's sensitivity to visual stimuli in light after exposure to darkness; it occurs more rapidly than dark adaptation

Learning Objective 3.6 - Compare and contrast two major theories of color vision, and explain how color-deficient vision occurs.

E. Perception of color
1. Trichromatic theory: three types of cones -- red cones, blue cones, and green cones one for each of the three primary colors of light.
2. Opponent-process theory: Four primary colors (red, green, blue, and yellow) arranged in pairs, with each member of the pair as opponents. Red is paired with its opponent green, and blue is paired with its opponent yellow.
3. Color-deficiency: color perception that is limited to combinations of two cones or colors (to yellows/blues or reds/greens)
instead of experiencing the world with normal vision based on combinations of three cones or colors.
4. Monochrome color blindness, a very rare type of color deficiency, is a total lack of color perception caused when a person either has no cones or has cones that are not working at all.

Practice Quiz page 3.2 Answer Key

1. A; 2. B; 3. C; 4. A; 5. B; 6. B

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III. THE HEARING SENSE: CAN YOU HEAR ME NOW?

Lecture Launchers and Discussion Topics
- *3.9 - Auditory Agnosia: The Case of C.N.*
- *3.10 - Perfect Pitch*
- *3.11 - The Mosquito*
- *3.12 - Is Your MP3 Player Hurting You?*
- *3.13 - Hear, Here, and Over There*

Classroom Activities, Demonstrations, and Exercises
➢ *3.13 - Auditory Localization*

Animation –Structure of the Ear
Animation - The Hearing Sense
Animation – Cochlear Implant
Audio - Psychology in the News: Cochlear Implants

Learning Objective 3.7 - Explain the nature of sound, and describe how it travels through the various parts of the ear.

A. Sound waves and the ear
   1. Sound has three properties: pitch (frequency), amplitude (volume), and timbre (richness in the tone of the sound).
B. The structure of the ear: Follow the vibes
   1. Pinna: external, visible part of the ear
   2. Auditory canal: the short tunnel from pinna to eardrum
   3. Eardrum (tympanic membrane)
   4. Hammer, anvil, and-stirrup: the three tiny bones in the middle ear, collectively referred to as the ossicles; vibration of these three bones amplifies the vibrations from the eardrum.
   5. Oval window: membrane covering the opening of the inner ear
   6. Cochlea: snail-shaped structure of the inner ear
   that is filled with fluid
   7. Basilar membrane: membrane running through the middle of the cochlea
   6. Organ of Corti: contains receptor cells, called hair cells, for the sense of hearing. When the basilar membrane vibrates, it vibrates the organ of Corti,

Learning Objective 3.8 - Summarize three theories of how the brain processes information about pitch.

C. Perceiving pitch
   1. Place theory: Location of hair cells on the organ of Corti correspond to different pitches
   2. Frequency theory: Pitch is related to the speed of vibrations in the basilar membrane
   3. Volley principle: Neurons take turns firing

Learning Objective 3.9 - Identify types of hearing impairment and treatment options for each.

D. Types of hearing impairments
   1. Conduction hearing impairment: refers to problems with the mechanics of the outer or middle ear and means that sound vibrations cannot be passed from the eardrum to the cochlea
   2. Nerve hearing impairment: Damage to the inner ear or to the auditory pathways in the brain

Practice Quiz page 3.3 Answer Key

1. A; 2. C; 3. B; 4. A; 5. D

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IV. CHEMICAL SENSES: IT TASTES GOOD AND SMELLS EVEN BETTER

Lecture Launchers and Discussion Topics
- *3.14 - Sniffing Out the Truth About Fragrance*
- *3.15 - Smell Myths*
- *3.16 - Noses, Aisle 12*

Classroom Activities, Demonstrations, and Exercises
- *3.14 - Odor Identification Test*
- *3.15 - Phenylthiocarbamide*
- *3.16 - The Role of Smell in Determining Flavor*
- *3.17 - The Effects of Visual Cues on Taste*
- *3.18 - Saliva and Taste*
- *3.19 - Let Them Eat Jellybeans!*

Video - Thinking Like a Psychologist: Can Smells Alter Mood and Behavior?
Animation – The Tongue and Taste Buds
Animation – Olfactory Receptors

Learning Objective 3.10 - Explain how the sense of taste works.

A. Gustation: How we taste the world
1. Taste buds are the common name for the taste receptor cells, special kinds of neurons found in the mouth that are responsible for the sense of taste
2. Five basic tastes: Sweet, salty, sour, bitter, umami
3. Differences abound
   a. Different brain regions process different taste properties
   b. Regional and cultural differences in taste preferences
   c. Individual differences in taste sensation (e.g., supertasters)

Learning Objective 3.11 - Explain how the sense of smell works.

B. The sense of scents: Olfaction
1. Olfactory receptor cells in the nasal passages each have about a half dozen to a dozen little "hairs," called cilia, that send signals to the brain when stimulated by the molecules of substances that are in the air moving past them.
2. The olfactory bulbs are located right on top of the sinus cavity on each side of the brain directly beneath the frontal lobes.
   a. The olfactory receptors send their neural signals directly up to these bulbs (bypassing the thalamus), then to the higher cortical areas, including the primary olfactory cortex (the piriform cortex), the orbitofrontal cortex, and the amygdala

Practice Quiz page 3.4 Answer Key

1. c; 2. d; 3. d; 4. b

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V. THE OTHER SENSES: WHAT THE BODY KNOWS

Lecture Launchers and Discussion Topics
- *3.17 - The (Dis)Embodiment of Fear*
- *3.18 - New Hope for the Paralyzed*

Classroom Activities, Demonstrations, and Exercises
- *3.20 - The Body's Sensitivity to Touch*
- *3.21 - The Size-Weight Illusion*

Video: *In the Real World: Managing Pain*

Learning Objective 3.12 - Describe how we experience the sensations of touch, pressure, temperature, and pain.

A. Somesthetic senses
1. Pacinian corpuscles are just beneath the skin and respond to changes in pressure
2. Nerve endings wrapped around hair follicles respond to pain and pressure
3. Free nerve endings, just beneath uppermost layer of skin, respond to pain, pressure, and temperature
4. Visceral pain is pain (and pressure) in the organs
5. Somatic pain is pain sensation in the skin, muscles, tendons, and joints
4. Gate-control theory
   i. When receptors sensitive to pain are stimulated, a neurotransmitter called substance P is released into the spinal cord, activating other pain receptors by opening "gates" in the spinal column and sending the message to the brain.
5. Pain disorders: Congential analgesia, congenital insensitivity to pain with anhidrosis (CIPA)

Learning Objective 3.13 - Describe the systems that tell us about balance and position and movement of our bodies.

B. Body Movement and position
1. Kinesthesia is awareness of the body's own movements
2. Proprioception is awareness of where our body parts are and their position in space
3. The vestibular sense
   a. Otolith organs (up-and-down movement)
   b. Semicircular canals (movement through arcs)
   c. Sensory conflict theory: an explanation of motion sickness in which the information from the eyes conflicts with the information from the vestibular senses, resulting in dizziness, nausea, and other physical discomfort.

Practice Quiz page 3.5 Answer Key

1. d;   2. a;   3. c;   4. a

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VI. THE ABCs OF PERCEPTION

Lecture Launchers and Discussion Topics
- ➢ *3.19 - Early Development of Perceptual Abilities*
- ➢ *3.20 - The Kinetic Depth Effect*

Classroom Activities, Demonstrations, and Exercises
- ➢ *3.22 - Expectancy and Perception*
- ➢ *3.23 - Stimuli and Their Context*

Video: Perception
Animation - Gestalt Laws of Perception
Animation - Monocular Cues
Animation -Binocular Cues
Animation - Ambiguous Figures
Animation - Müller-Lyer Illusion

Learning Objective 3.14 - Describe how perceptual constancies and the Gestalt principles account for common perceptual experiences.

A. How we organize our perceptions
  1. Size constancy: Tendency to perceive objects as always being the same size, no matter how close or far away they are
  2. Shape constancy: Tendency to perceive objects as remaining the same shape even when the shape of the object changes on the retina of the eye
  3. Brightness constancy: Tendency to perceive objects as a certain level of brightness, even when the light changes

B. The Gestalt principles
  1. Figure-ground
  2. Proximity
  3. Similarity
  4. Closure
  5. Continuity
  6. Contiguity
  7. Common region

Learning Objective 3.15 - Explain how we perceive depth using both monocular and binocular cues.

C. Depth perception
  1. The ability to see in three dimensions
    a. Monocular cues
      i. Linear perspective
      ii. Relative size
      iii. Overlap
      iv. Aerial (atmospheric) perspective
      v. Texture gradient
      vi. Motion parallax
      vii. Accommodation
    b. Binocular cues
      i. Convergence
      ii. Binocular disparity

Learning Objective 3.16 - Identify some common visual illusions and the factors that influence our perception of them.

D. Perceptual illusions
1. Perceptions that do not correspond to reality or are distortions of visual stimuli
a. The Hermann grid: Feature detectors play a role
b. The Müeller-Lyer illusion: Cultural differences reveal possible origins
c. The moon illusion: the moon when on the horizon appears to be much larger than the moon when high in the sky
d. Illusions of motion: Autokinetic effect, stroboscopic motion, phi phenomenon
E. Other factors that influence perception
1. Perceptual set or perceptual expectancy
2. Top-down processing
3. Bottom-up processing

Practice Quiz page 3.6 Answer Key

1. b; 2. c; 3. b; 4. c; 5. a; 6. b

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VII. APPLYING PSYCHOLOGY TO EVERYDAY LIFE: BEYOND "SMOKE AND MIRRORS"—THE PSYCHOLOGICAL SCIENCE AND NEUROSCIENCE OF MAGIC

Learning Objective 3.17 - Describe how the neuroscientific study of magic can help to explain visual and cognitive illusions.

Video - What's In It For Me: Perceptual Magic in Art and Movies

A. Magicians take advantage of some well-known properties of our visual system to accomplish a variety of tricks and illusions
B. By collaborating with magicians, psychologists and neuroscientists can learn more about various cognitive and perceptual processes.

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VIII. CHAPTER SUMMARY

Classroom Activities, Demonstrations, and Exercises
➢ *3.26 - Crossword Puzzle*
➢ *3.27 - Fill-in-the-Blanks*

Test Yourself 3 Answer Key

1. b; 2. d; 3. a; 4. b; 5. a; 6. c; 7. b; 8. b; 9. a; 10. a; 11. b; 12. b; 13. c;

14. a; 15. a; 16. c; 17. a; 18. d; 19. b; 20. c

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▼LEARNING OBJECTIVES

3.1 Describe how we get information from the outside world into our brains.

3.2 Describe the difference and absolute thresholds.

3.3 Explain why some sensory information is ignored.

3.4 Describe how light travels through the various parts of the eye.

3.5 Explain how light information reaches the visual cortex.

3.6 Compare and contrast two major theories of color vision, and explain how color-deficient vision occurs.

3.7 Explain the nature of sound, and describe how it travels through the various parts of the ear.

3.8 Summarize three theories of how the brain processes information about pitch.

3.9 Identify types of hearing impairment and treatment options for each.

3.10 Explain how the sense of taste works.

3.11 Explain how the sense of smell works.

3.12 Describe how we experience the sensations of touch, pressure, temperature, and pain.

3.13 Describe the systems that tell us about balance and position and movement of our bodies.

3.14 Describe how perceptual constancies and the Gestalt principles account for common perceptual experiences.

3.15 Explain how we perceive depth using both monocular and binocular cues.

3.16 Identify some common visual illusions and the factors that influence our perception of them.

3.17 Describe how the neuroscientific study of magic can help to explain visual and cognitive illusions.

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▼RAPID REVIEW

Sensation allows us to receive information from the world around us. External stimuli activate **sensory receptors** which convert the stimulus into an electrochemical message that our nervous system can understand. This process is called sensory **transduction**. Ernst Weber and Gustav Fechner were two pioneers in the study of sensory thresholds. Weber studied the smallest difference between two stimuli that a person could detect 50 percent of the time, called the **just noticeable difference (jnd)**. Fechner investigated the lowest level of a stimulus that a person could detect 50 percent of the time, called the **absolute threshold**. **Habituation** and **sensory adaptation** are two methods our body uses to ignore unchanging information.

There are three psychological aspects to our experience of light: **Brightness**, **color**, and **saturation**. Light travels through the vitreous humor in the middle of the eyeball to reach the **retina**. The retina contains two types of sensory receptors, **rods** and **cones,** that respond to the various wavelengths of light. Rods detect changes in brightness, but not to changes in wavelengths – hence, they see only black, white, and gray. Rods function best in low levels of light. Cones are sensitive to colors and work best in bright light. Cones are responsible for the sharpness and detail of visual information. The **trichromatic theory** and the **opponent-process theory** are two theories of how the brain perceives color.

Our sense of hearing is activated by the vibrations of molecules in the air. We respond to three properties of sound waves: **pitch**, **amplitude**, and **timbre**. Sound waves enter our auditory system through the **pinna**, travel down the **auditory canal,** and then vibrate the eardrum which causes the hammer, anvil, and stirrup to vibrate. The vibrations of the stirrup cause the oval window to move back and forth which causes the fluid in the **cochlea** to vibrate. The fluid causes the basilar membrane to vibrate which causes the organ of Corti to move up, and this causes the **hair cells** to bend. The hair cells are the sensory receptors of the auditory system, and the movement of the hair cells triggers an action potential. There are three theories that explain how the brain receives information about pitch: **place theory**, **frequency theory**, and the **volley principle**.

The sense of taste, or **gustation**, is activated by chemicals that dissolve in the mouth. The sense of smell, or **olfaction**, is also a chemical sense. The sense of touch is actually composed of several sensations and is more accurately referred to as the **somesthetic senses**; **skin**, **kinesthetic**, and **vestibular**. The skin contains at least six different types of sensory receptors and transmits information about touch, pressure, temperature, and pain. The currently accepted theory about pain is called **gate-control theory** and suggests that pain information is regulated by a number of factors in the brain and spinal cord.

Perception is the interpretation of sensation and seems to follow some basic principles, such as **perceptual constancies** in **size**, **shape**, and **brightness**. Gestalt psychologists hold that people interpret information according to certain expected patterns or rules, such as **figure-ground relationships**, **closure**, **similarity**, **continuity**, **contiguity**, **proximity**, and common region. **Depth perception** appears to be present at a very early age. Visual cues for depth that require the use of one eye are referred to as **monocular cues** and include **linear perspective**, **relative size**, **overlap** or interposition, **aerial perspective**, **texture gradient**, **motion parallax**, and **accommodation**. Visual cues that use two eyes are called **binocular cues** and include

convergence and **binocular disparity**. An **illusion** is a perception that does not correspond to reality. Perceptions can be influenced by **perceptual sets** and approaches to information processing.

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▼CHANGES FROM THE FOURTH EDITION TO THE FIFTH EDITION

Chapter 3 - Sensation and Perception

- Synesthesia is now covered in the section on transduction
- Signal detection theory was added to the sensory thresholds section
- Discussion of a potential 6th taste added to the section on *The Five Basic Tastes*
- Somesthetic senses are now covered separately from kinesthetic and vestibular senses; added key term *proprioception*
- Added new art: Figure 3.6 and Figure 3.7
- New APA Goal 2 feature *Perceptual Influences on Metacognition*

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▼LECTURE LAUNCHERS AND DISCUSSION TOPICS

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Lecture Launcher 3.1 - The Sensory System

There are three different types of sensory systems, each of which performs different functions:

Exteroceptors. These sensory receptors collect data from the external world, and there are two types: distal and proximal receptors. Distal receptors include those associated with vision. Objects rarely make direct contact with the eye; rather they are discerned at a distance, with no need for contact in order to experience the sensation. Proximal receptors are associated with touch, taste, and possibly olfaction. In most instances, proximal systems require direct contact with the stimulus. Thermal radiation does not always require proximity; you can tell that the sun is warm via your distal receptors, without having to touch it.

Interoceptors. These are internal system monitors; they work to keep you aware of the internal workings of your body, such as letting you know when you are hungry, thirsty, in pain, nauseated, fatigued, and so on.

Proprioceptors. These receptors monitor the position of the body or limbs relative to some reference point. They let you know where you are physically located in space. Proprioceptors are found in the vestibular system (where they permit maintenance of your physical position), in the pressure receptors of the skin, in the muscle stretch receptors of your muscles, and in the joint movement receptors of your limbs.

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Lecture Launcher 3.2 - Setting Thresholds

The methods for establishing thresholds have a long history, dating to the work of the original German psychophysicists:

· *Method of limits*. The presentation of a stimulus that is clearly noticeable is followed by the presentation of increasingly weaker stimuli until observers are unable to detect the stimulus. For example, using the method of limits to establish an auditory threshold might involve presenting a clearly detectable tone, followed by tones of decreasing amplitude until the participant reports hearing no tone at all. This method then involves alternating trials of “no detection” with trials presenting increasingly stronger stimuli. In our example, after establishing the lowest level of detection, tones of increasing amplitude would be presented. These *descending* and *ascending series* of trials are typically repeated several times with one observer.

· *Method of adjustment*. Observers control the intensity of stimulus until it is just barely noticeable. For example, the channel surfer who commandeers the remote control might turn the volume on the television set down until it is just barely audible. The distinguishing feature of this method is the self-adjustment by the perceiver.

· *Method of constant stimuli.* This technique involves presenting a preselected set of stimuli in a random order to perceivers. The stimuli are chosen so that at least one is clearly below the sensory threshold (established previously, perhaps, by the method of adjustment) and at least one is clearly above the sensory threshold. In a hearing test, for example, a set of tones of varying amplitudes might be presented to a perceiver at random, and the perceiver’s ability to discriminate among them would be measured.

Fechner, G. T. (1860). *The elements of psychophysics*. Leipzig: Breitkopf & Harterl.
Foley, H. J., & Matlin, M. W (2009). *Sensation and perception* (5th ed.). Upper Saddle River, NJ: Pearson.

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Lecture Launcher 3.3 - A Few Animal Facts

It’s interesting to compare the visual abilities of animals and humans. The senses of animals have evolved to give members of some species an optimum chance for survival. Here are a few examples:

Some animals, such as cats, have a reflective surface on the back of the eye behind the sensory receptors. When light first enters the eye, some light is detected by the sensory receptors. The light not detected by the sensory receptors continues onto the reflective surface at the back of the eye. This light is then reflected outward toward the sensory receptors, providing a second opportunity for detection. This feature produces two results. First, the outward reflection results in the shining of the cat’s eye when a light beam is falls onto it. The second result is that the cat’s night vision efficiency is doubled over that of animals with a nonreflective rear surface, such as humans.

Diurnal animals, such as fish and birds, have all or mostly cones on their retinas. Their superior color vision is a strong advantage during daylight, but they are nearly blind at night. Nocturnal animals, such as rats and bats, have all or mostly rods on their retinas; therefore they have no color vision, but they can see at night. The retinas of humans contain both rods and cones; therefore humans can see things at night and with color during the day.

Most herbivores and prey animals have their eyes placed far to the side of the head to give them a wide range of vision, whereas carnivores, including humans, have their eyes closer together so the overlapping visual fields can provide good depth perception. This is easy to remember using the old saying, "Eyes wide, likes to hide; eyes front, likes to hunt."

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Lecture Launcher 3.4 - Visual Agnosia: The Case of P.T.

While in his thirties, patient P.T. had experienced a severe stroke that affected his left hemisphere; then, when in the hospital, he experienced another stroke that affected his right hemisphere. Although P.T. seemed to recover from some of the physical effects of the second stroke (e.g., dizziness, muscular weakness on the right side of his body), he still dragged his left leg slightly, but he was completely unaware of it.

Upon returning to his small family farm, he had difficulty readjusting to daily routines. Specifically, he had difficulty recognizing objects and places. He would work on his farm, then look across the landscape and not be able to recognize it. He could not discriminate among cows, which is necessary for choosing which cows to milk. Most noticeable was his inability to recognize faces, even that of his wife. Furthermore, he knew that another's arms, legs, head, and body went together as a person; however, he could not recognize who that person was. He could recognize that his wife moving across the room was still his wife, thus maintaining some perceptual constancies. Interestingly, only his visual perception was impaired; he could readily recognize the sound of his wife's voice, and he could identify objects by touch or smell. For example, when presented with a candle, he reported that it was a "long object." When he was allowed to hold the candle, he labeled it a crayon, and when he smelled it, he correctly recognized it as a candle.

Gazzaniga, M. S., Ivry, R. B., & Mangun, G. R. (2013). *Cognitive neuroscience: The biology of the mind.*(4th ed.). New York: W. W. Norton & Company.

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Lecture Launcher 3.5 - Hey Man…Light Show! Cool!

Most colors, including white, gray, and all the desaturated pastels, as well as the nonspectral colors, can be seen only when two or more different wavelengths are mixed. This raises the important question of how colors combine. The answer varies, depending on whether lights or paints are mixed. Here, we will discuss light mixture.

The result of mixing lights of two colors in color space will fall somewhere along a line drawn between them in the color spindle. If they are mixed in equal amounts, the result will be a color midway between them; if the mixture contains more of one than the other, the resulting color is correspondingly closer to the heavier contributor but nonetheless along the line connecting them.

One very important fact about light mixture is that any hue can be produced by some combination of three other appropriately-chosen lights. As amazing as it seems, the colors on a TV screen are actually made by adding together just three lights - usually varying amounts of red, green, and blue. (On old-school largeprojection TVs you can see the three separate lights that combine on the screen to produce all the colors you see in the picture. Other cathode ray TVs work the same way, but the three colored beams are inside the picture tube so that you can't see them directly, only their mixtures on the screen.) Thus, when you used to adjust the color control knobs on your TV, you were actually changing colors by mixing different amounts of these three lights.

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Lecture Launcher 3.6 - Eyes and Camera Lenses

A popular belief among laypeople (and, for a time, even among scientists) was that the eye worked like a film camera. That's understandable; there are some similarities in the functioning of the eye and the original design of a camera. For instance, both the pupil of the eye and the aperture of a camera contract and expand in response to a respective increase or decrease in the amount of light entering the apparatus. But when you compare the human eye to a traditional film camera, some of the differences between the two are striking.

Perhaps the strangest difference between the eye and a camera is the positioning of the retina and analogous film. For a camera to be like the human eye, we would have to load our film into the camera backwards. That is, the photoreceptors actually pick up the light off the back surface of the eyeball.

A camera must be held relatively steady to capture a clear image, but when the eyeball is held steady, the image disappears.

Both the camera and the eye have a lens that focuses an image on a surface, but they have different methods of focusing. The lens in a camera moves closer to or farther from the film in order to focus the image on the film; the lens of the eye changes shape to focus the image on the retina. This process in the eye is called accommodation.

An upsidedown mirror image is focused on both the film and the retina. The film and the retina differ, though, in that film records an image exactly as projected. The photoreceptors in the retina receive information from the visual stimuli that is analyzed and reconstructed as it moves through the visual system from the retina to the cortex. What we perceive is a picture that is *not* identical to the item we are looking at. Photographs in which people have their feet extended closer to the camera in front of them are comical because the feet look so big. When the eye processes the same scene, the feet do not look unwieldy because we take relative distances into account and perceive the feet as being a constant size.

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Lecture Launcher 3.7 - The Eye Exam

Ask students to share their experiences with eye exams. Those who have ever been fitted for eyeglasses will have experienced a type of difference threshold. Examinees look through a large pair of "binoculars" to check for the best lenses. Ask if students remember being asked as they looked at the visual display, "Can you tell the difference between Lens 1 and Lens 2? Lens 1? Lens 2?" The doctor was, in effect, checking for a just noticeable difference (JND). Ask students to share how well they believe they were able to perceive the difference between alternative lenses if they felt rushed by the doctor. Their responses will help you introduce the idea that sensations and perceptions, though governed by psychophysical laws, are influenced to some degree by emotions. But before discussing such factors, it's important to grasp the basic processes of sensation and perception. To begin with, it's important to understand the difference between the two: sensation is the physical experience of seeing or hearing or sensing in some other way; perception is the psychological process of giving meaning to what has been sensed.

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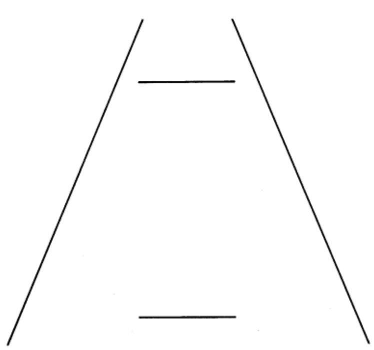
Lecture Launcher 3.8 - 2D, 3D…Can it Produce 4K Ultra HD?

Many of the so-called *geometric illusions* (e.g., the Ponzo illusion or the Muller-Lyer illusion, pictured below) are a result of the massive and critical task of transforming two-dimensional retinal images into a three-dimensional percept. In the case of the Ponzo illusion, the line at the top (in the middle of the converging lines) is seen as longer than the line at the bottom (although they are both physically the same length). The explanation is that, in the natural environment, images become smaller and parallel lines (e.g., train tracks) converge with increasing distance from us. Therefore, in the "real world," when two objects have the same image size on the retina and one is perceived as being much farther away than the other, the one that is farther away must be larger. Via the 2-D to 3-D transformation by the visual system, we perceive the top line in the Ponzo illusion as being farther away, thus it appears compellingly longer.

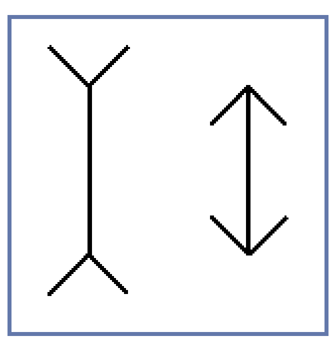
For the Muller-Lyer illusion, the lines drawn between the angles are physically the same length. The line bisecting the angles flanked outward, however, appears longer. Again, the explanation involves the visual system's conversion from 2-D to 3-D. These kinds of angles (although not readily perceived) are found in corners of rooms—the outward flanked angles are most often perceived as belonging to a corner of a room that is pointed away, whereas the inward flanked angles are most often perceived as a corner that is pointed toward us. Because we assume that the corner that is pointed away from us is farther away, the line belonging to that image (although physically equivalent) appears longer than the line belonging to the corner that is pointed toward us.

A discussion of the 2-D to 3-D conversion, including these illusions and explanations, will serve to enhance students' concept of perceptual representation. It should also lead students to critically examine their own beliefs regarding perception versus reality.

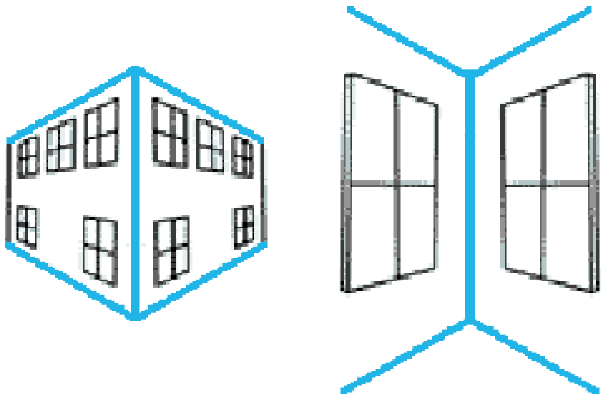
The Ponzo illusion



The Muller-Lyer illusion



Another version of the Muller-Lyer illusion



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Lecture Launcher 3.9 - Auditory Agnosia: The Case of C.N.

A counterpart to P.T. (mentioned above) is C.N. Here's her story:

Over a three-month period, a 35-year-old nurse, C.N., suffered two aneurysms, one in the left middle cerebral artery and another in the right middle cerebral artery. After surgery to drain the "ballooning" of the arteries, she complained that her perception of music was impaired, despite her ability to comprehend and produce speech and detect tones. She could not recognize melodies from her own music collection, nor could she recognize familiar, popular songs, including the Canadian national anthem, "O Canada." Further tests confirmed her *amusia*, or impairment of music abilities with no impairments of long-term memory. Interestingly, she could identify the song title if given the written lyrics, and could name the artist when told the song title. C.N. was able to recognize environmental sounds, such as human voices, transportation sounds, and animal cries. Furthermore, it appears that C.N.'s *amusia* is limited to recognizing melodies; she performed as well as normal subjects when asked to judge if two tones were of the same rhythm. And, despite her inability to recognize melodies, she still loved to dance.

Gazzaniga, M. S., Ivry, R. B., & Mangun, G. R. (2013). *Cognitive neuroscience: The biology of the mind.* (4th ed.). New York: W. W. Norton & Company.

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Lecture Launcher 3.10 - Perfect Pitch

Absolute pitch, or what is commonly called "perfect pitch," is the ability to identify the pitch of a musical tone without the need to hear another tone for reference. Absolute pitch occurs in about 0.1% of the population, and those who have it tend to have been raised in a musical family and their absolute pitch had been discovered before age 10 (Profita & Bidder, 1988). Individuals with absolute pitch are more likely to become eminent musicians and composers compared to individuals without absolute pitch. Additionally, individuals who do not have absolute pitch apparently cannot develop it later in life, suggesting a critical period for the development of absolute pitch. Profita and Bidder found that absolute pitch is inherited, suggesting that it may be at least partly determined by a single dominant gene. The dominant gene may trigger brain development that better allows for pitch analysis.

There are differences in brain anatomy in individuals with perfect pitch compared to those without perfect pitch. In most individuals a section of the temporal lobe, called the *planum temporale*, is larger in the left hemisphere than in the right hemisphere; Wernicke's area is located in the left *planum temporale*. Generally, the left hemisphere is specialized for making absolute, categorical judgments, such as distinguishing between *r* and *s* sounds. The right hemisphere is specialized for making relative judgments, such as judging whether one line is shorter than another. Because individuals with perfect pitch are able to make absolute judgments about the pitch of a musical tone, one might predict that some area(s) of the left hemisphere, which specializes in absolute judgments, may be larger or different in individuals with perfect pitch. Although research is underway, one study gives us an inkling into the brain areas associated with perfect pitch.

Schlaug et al. (1995) found that this asymmetry was much greater among musicians with absolute pitch than among musicians without absolute pitch or nonmusicians. Specifically, they found the surface area of the left *planum temporale* was 80% larger than that of the right *planum temporale* in musicians with absolute pitch. By comparison, the surface area of the left *planum temporale* was 26% greater than the right for musicians without absolute pitch and 23% greater than the right for nonmusicians. Schlaug and colleagues suggest that individuals have this pitch-analyzing machinery in the left hemisphere, as opposed to the right hemisphere, and this allows these individuals to utilize the left hemisphere to make absolute, categorical judgments about pitch.

Münte, T. F., Altenmüller, E., & Jäncke, L. (2002). The musician's brain as a model of neuroplasticity. *Nature Reviews Neuroscience, 3*, 473-478.
Profita, J., & Bidder, T. G. (1988). Perfect pitch. *American Journal of Medical Genetics, 29,* 763-771.
Sacks, O. (2010). *Musicophilia: Tales of music and the brain*. New York: Random House.
Schlaug, G., Janke, L., Yanxiong, H., & Steinmetz, H. (1995). *In vivo* evidence of structural brain asymmetry in musicians. *Science, 267,* 699-701.

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Lecture Launcher 3.11 - The Mosquito

As we age, damage to the hair cells in the cochlea results in gradual hearing loss. This age related hearing loss, called *presbycusis*, preferentially affects higher frequency hearing. For example, people younger than 20 can usually hear tones in the 15-18 kHz range, whereas adults older than 25 or 30 usually cannot.

Recently, the fact that teenagers can hear sounds that older adults cannot has been used in several creative ways. In 2005, an inventor named Howard Stapleton created a device called the "Mosquito," which is designed to keep rowdy teenagers from loitering around shops and in other places they may cause trouble. It works by emitting a high frequency noise that older people cannot hear, but that teenagers find annoying. However, use of the Mosquito has been controversial, with some even claiming that the device violates the human rights of teenagers and younger adults. Others are concerned that exposure to the loud, high-frequency noise produced by the mosquito might actually damage the hearing of children.

In an interesting twist, some teenagers have taken the anti-teenager Mosquito technology and turned it to their advantage. By recording the Mosquito’s high frequency sound, they were able to create a ring-tone called “teen buzz” for their cell phones that cannot be heard by most adults. This means that students using the special ringtone can leave their cell phones on and receive text-message alerts while at school, without the teacher hearing the phones ringing. In a similar application, the developers of the mosquito system created a dance track with a secret melody embedded in the song that only younger listeners can hear!

Block, M. (2006, May 26). Teens turn 'repeller' into adult-proof ringtone. Retrieved on November 20, 2009, from http://www.npr.org/templates/transcript/transcript.php?storyId=5434687

Calls to ban 'anti-teen' device (2008, February 12). Retrieved on November 20, from http://news.bbc.co.uk/2/hi/uk_news/7240180.stm

Lyall, S. (2005, November 30). Rowdies buzz off as the Mosquito bites. Retrieved on November 20, 2009, from http://www.theage.com.au/news/world/rowdies-buzz-off-as-the-mosquito-bites/2005/11/29/1133026467657.html

Secret alarm becomes dance track (2006, September 26). Retrieved on November 20, 2009, from http://news.bbc.co.uk/2/hi/uk_news/wales/south_east/5382324.stm

http://www.freemosquitoringtones.org/
http://www.noiseaddicts.com/2011/06/mosquito-ringtones/
http://www.youtube.com/watch?v=1H75hBXvjsw

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Lecture Launcher 3.12 - Is Your MP3 Player Hurting You?

Anyone who has ever worked in a noisy environment, such as on a factory floor, knows that there are often strict rules about how loud the sounds workers are exposed to can be, and for how long workers can be exposed. This is because long-term exposure to loud sounds can damage the sensitive hair cells in the inner ear. After they are damaged, hair cells are not replaced, resulting in permanent hearing loss.

Although noise exposure in the workplace is a long acknowledged danger, a much more recent concern is listening to personal music players (such as the iPod) through headphones. The popularity of these devices, combined with the number of hours many people -- especially teenagers -- use them, have led many hearing specialists to worry about the safety of the players. There is evidence to suggest that 5%-15% of headphone users listen to their music players at levels and lengths of time that are considered unsafe. Potentially, this could lead to an epidemic of hearing disabilities in the future.

Given the potential long-term danger to hearing, some experts have recommended limiting by law the maximum volume on personal music players. Others, however, feel that this might be an oversimplification of the issue. This is because the risk to the listener is not just a function of the device’s volume, but other factors as well. For example, a 90 dB sound may be considered a relatively safe level when listening to music through headphones for a few hours, but exposure to 90 dB for 8 hours in a day may cause hearing loss. Also, the type of headphones used can increase or decrease the loudness. Earbud style headphones tend to increase the loudness of the music compared to other styles of headphones when the volume control is kept at the same level. (Although earbud headphones can increase the maximum volume possible, studies have shown that, when using earbud-style headphones, listeners typically keep the volume setting lower than those who use headphones which do not enter the ear canal. This indicates that earbud headphones are probably of no greater risk to users.)

After introducing students to the potential dangers of personal music players to their long-term hearing, ask students to debate what policies, if any, should be implemented to prevent a potential epidemic of hearing loss. In particular, encourage students to share their opinions on whether the maximum volume of these devices should be regulated. What are some problems with this approach? Is there a danger that it could create the false impression that listening to music at the maximum legal volume setting is safe for extended periods at a time?

Fligor, B. (2007). Hearing loss and iPods: What happens when you turn them to 11? *The Hearing Journal, 6* (10) , 10-16.
Kenna, M. A. (2015). Acquired hearing loss in children. Otolaryngologic Clinics of North America, 48(6), 933-953.
Walker, E. J., Lanthier, S. N., Risko, E. F., & Kingstone, A. (2012). The effects of personal music devices on pedestrian behaviour. *Safety Science, 50(1)*, 123-128.

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Lecture Launcher 3.13 - Hear, Here, and Over There

We use our ears to point our eyes in the direction of soundproducing events. For this to happen, the auditory system must be able to perceive the direction from which a sound is coming, and its perception of space must somehow be integrated with the visual system's perception of space. Unlike an eye, however, an ear has no direct coding of spatial direction. Information about the sound's direction is perceived by comparing the stimulation in one ear with that in the other. In this respect, sound localization is a lot like the visual depth cue of binocular disparity.

There are two basic sources of information about sound coming from the left or right: the sound entering one ear differs from that entering the other in both *intensity* and *time*. When a sound comes from directly in front of your head, its intensity is equal at your two ears. In the case of highfrequency sounds coming from the side, your head creates a "sound shadow," making the sound less intense at the far ear than at the near one. It is only for high frequencies that there is information about how far to one side or another a sound is located.

The other primary source of information about the horizontal direction of a sound is the time at which it arrives at your two ears. When a sound comes from directly in front of your head, the arrival times are the same because your two ears are the same distance away from the sound. When it comes from the side, however, the sound wave must travel farther to reach the ear on the far side. Even though this extra distance takes only a little extra time - less than one thousandth of a second - it is enough to tell us which side sound is coming from.

The direction of sounds from left to right is probably the most important part of spatial hearing, but it isn't the only part. You can also tell whether a sound is coming from above or below: the sound of a jet streaking overhead or of an object dropped at your feet. You are not able to perceive vertical direction from simple arrival times or intensities, however. It is the shape of the external ear (or pinna) that apparently allows you to perceive the vertical dimension of space.

We are left with the problem of perceiving the third dimension of depth: how far away the source of a sound is from us. A sound that is near is louder than one that is far away, so you might think that intensity would provide all the information you need about the distance (or depth) of the source of a sound. Unfortunately, it is not so easy. A lowintensity sound at the ear might have come from either a loud sound far away or a soft one nearby. (The situation here is analogous to the relations among retinal size, object distance, and object size in visual perception.) If the sound is one whose usual intensity you know (such as someone speaking in a normal voice or the sound of an average car engine), you can perceive its approximate distance auditorily using intensity information. If the sound is one whose usual intensity you do not know, however, you can't tell how far away it is by hearing it: you have to look. But because you can hear the direction a sound is coming from, you can use your ears to point your eyes, which can then do the job judging the distance. This is a good example of how your senses work together to provide you with knowledge of the world.

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Lecture Launcher 3.14 - Sniffing Out the Truth About Fragrance

Devotees of New Age practices such as aromatherapy claim that various fragrances can have a dramatic impact on one's health, well-being, and psychological state. Makers of the air fresheners pretty much claim the same thing, except that the peace of mind comes from successfully masking offensive odors in the environment. Although both camps agree that aromas can impact behavior and mental states, neither has been that forthcoming with proof of these claims.

Social psychologist Robert A. Baron of Oklahoma State University long ago rose to the challenge of investigating such claims, and conducted several studies on the effects of fragrance on behavior. For example, participants in one study were angered or not angered by either a male or female confederate. The participants were later given the opportunity to aggress against the instigator under one of three conditions; in the presence of perfume (a very pleasant scent), in the presence of pine-scented aerosol (a mildly pleasant scent), or in the absence of any pleasant scent. When the confederate was a man, results indicated that aggression was enhanced in the perfume condition if the participants had been angered, but reduced in this same condition if the participants had not been angered. When the confederates were women, however, aggressive retaliation was enhanced by the perfume regardless of whether participants had been previously angered. These findings may be attributed in part to the heightened arousal that is often experienced in the presence of fragrances. In a subsequent set of studies, Baron investigated the effects of pleasant fragrances on the work environment. Participants completed a word task under conditions of either high or low stress, and in the presence or absence of a pleasant fragrance (*Powder Fresh* or *Spiced Apple* air fresheners). In both stress conditions, the presence of the fragrance significantly enhanced performance.

What causes fragrances to have such effects? Baron suggests that pleasant fragrances act as a mild mood enhancer, one at least as effective as other mood manipulations. An additional experiment, for example, had participants complete an anagram task under low or moderate stress and in the presence or absence of a fragrant air freshener (lemon and floral scents were used). In this experiment, a small gift of candy was also presented to some participants. The results revealed that both the fragrances and the small gift significantly improved performance on the word task, under conditions of either moderate or low stress. In short, the effects of the fragrance seemed to match those of the gift (a known positive mood enhancer). In fact, both the fragrance and the gift increased participants' willingness to help the experimenter in this study as an unpaid volunteer.

Based on his research, Baron for a time developed and marketed the PPS® (Personal Productivity/Privacy System), a small unit that provides filtration of allergens, generates white noise to mask conversations, and releases a pleasant fragrance into the air.

Baron, R. A. (1980). Olfaction and human social behavior: Effects of pleasant scents on physical aggression. *Basic and Applied Social Psychology*, *1*, 163-172.

Baron, R. A., & Bronfen, M. I. (1994). A whiff of reality: Empirical evidence concerning the effects of pleasant fragrances on work-related behavior. *Journal of Applied Social Psychology*, *24*, 1179-1203.

Baron, R. A., & Thomley, J. (1994). A whiff of reality: Positive affect as a potential mediator of the effects of pleasant fragrances on task performance and helping. *Environment and Behavior*, *26*, 766-784.

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Lecture Launcher 3.15 - Smell Myths

Human smell has often been characterized as being deficient when compared to the smell abilities of some lower organisms. Summarized below are four myths about human smell that have been contradicted by research.

Myth 1: Human smell is less sensitive than that of other animals

Research indicates that the individual smell receptor cells in humans will respond to a single odorant molecule. The difference in overall sensitivity appears to be due to the fact that some lower organisms, such as dogs, have more smell receptors.

Myth 2: Humans have a relatively poor ability to detect changes in smell intensity

Although earlier research indicated that the difference threshold for smell was the largest of all the senses, more recent research, carefully controlling the concentrations of the smell stimuli, indicated that difference thresholds were equal to or lower in size than those for other senses.

Myth 3: Odor identification ability is poor in humans

Although early research indicated that the ability to recognize previously presented odors was poor, this result may be related to the fact that unfamiliar odors were used as the stimuli. Odor identification accuracy is primarily a function of labeling, not smell. That is, if subjects are given the correct label of an odor when they are first exposed to it, their ability to later identify the odor is significantly improved.

Myth 4: Although many animals use odors to communicate, humans do not

Several studies have demonstrated that individuals are able to identify correctly about 75% of the time whether odors associated with sweat or breath came from a male or female. Menstrual synchrony, a phenomenon in which women who live in close proximity for a period of time begin to have similar starting times for menstruation, has also been found to be related to smell.

Goldstein, E. B. (1989). *Sensation and perception* (3rd ed.). Belmont, CA: Wadsworth.

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Lecture Launcher 3.16 - Noses, Aisle 12

A childish joke runs something like this:

Puerile yuckster: "Did you pick your nose when you were a kid?"
Unsuspecting patsy: "Yeah, sure."
Puerile yuckster: "Well, why didn't you pick one that was smaller?!"

If chemist Nate Lewis has his way, soon we all can pick noses smaller than a dime to sniff out scents as large as we please. And he's not joking.

Lewis and his colleagues at the California Institute of Technology developed an artificial nose, research motivated partly by the challenge and partly by practicality. The challenge is that smell remains the least studied and least understood of the senses. Although relatively primitive (compared to the sophisticated intricacies of vision), scientists still don’t have a complete understanding of the rules governing how smell works. To that end, Lewis and his colleagues have created a variety of artificial noses, ranging from tiny “noselets” to bookcase-size monstrosities. Each is dedicated to the task of detecting various scents, odors, and stinks in the environment.

That’s where the practicality comes in. Smell is big business, from truffle-sniffing pigs to deodorant testers to perfume evaluators to rotten food detectors. Currently this work is done by humans (well, not the truffle-finding) whose noses tire quickly and who aren’t equally sensitive to all odors. A reliable artificial nose would allow industry to perform a variety of important tasks cheaply and efficiently. What’s more, Lewis envisions a day when small artificial noses will detect carbon monoxide in your home, rotting foods in your refrigerator, leaking fluids in your car, or peptic upset from your breath. In fact, John Glenn’s 1998 NASA mission included a prototype of Lewis’ artificial nose to sniff space air for potential health hazards.

Here’s how it works. Chemists have known for some time that industrial plastics swell when they absorb a chemical odor. This is not earth-shaking; all polymers do that. However, specialized plastics that conduct electricity could be used to create a unique pattern of electrical activity for each chemical scent. By combining different plastics that generate different electrical signals, a fairly accurate “scentprint” would result for each odor. However, there are a finite number of electricity-generating plastics, so Lewis and his team have switched instead to cheap industrial plastics combined with soot particles to generate electric current. When hundreds or thousands of these units are combined in a single detector, the result is a cheap, mass produced, rugged, yet highly sensitive nose.

Some of these developments are years away, but several research and industry teams have joined the search for an artificial nose. Unfortunately, the answer may not be as plain as …well, you know.

Burl, M. C., Doleman, B. J., Schaffer, A., & Lewis, N. S. (2001). Assessing the ability to predict human percepts of odor quality from the detector responses of a conducting polymer composite-based electronic nose. *Sensors and Actuators B-Chemical*, *72*, 149-159.

Doleman, B. J., & Lewis, N. S. (2001). Comparison of odor detection thresholds and odor discriminablities of a conducting polymer composite electronic nose versus mammalian olfaction. *Sensors and Actuators B-Chemical*, *72*, 41-50.

Matzger, A. J., Lawrence, C. E., Grubbs, R. H., & Lewis, N. S. (2000). Combinatorial approaches to the synthesis of vapor detector arrays for use in an electronic nose. *Journal of Combinatorial Chemistry*, *2*, 301-304

McFarling, U. L. (1999, February 20). Chemist wants to place noses in your car, house. *Austin American-Statesman*, A21, A24.

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Lecture Launcher 3.17 - The (Dis)embodiment of Fear

Summaries of research on sensation and perception traditionally have focused on vision and hearing as the two "main" human senses, often to the exclusion of an extended discussion of the chemical and motion senses. Although the present chapter provides good examples of the workings and importance of the "other" senses, your students might gain a better appreciation of their significance through a case study.

Oliver Sacks reported the following case of the "disembodied lady," a woman suffering from a total disruption of her proprioceptive system. A day before gallbladder surgery, a young woman of 27 suddenly experienced bizarre symptoms unrelated to her medical condition. She was unable to hold anything in her hands, was unsteady on her feet, and found that her arms flailed about whenever her attention was directed elsewhere. She lay motionless and expressionless in the hospital bed, complaining of experiencing a strange sense of disembodiment. After initial psychiatric opinions of preoperative anxiety and hysterical conversion, it was determined that the woman was suffering from *acute polyneuritis.* An extremely rare condition, it is characterized by a shutting down of the proprioceptive receptors; in short, a lack of muscle, tendon, and joint sense. As a consequence, the young woman lacked position sense, leaving her literally with one hand not knowing what the other was doing. In fact, she didn't know where her hands *were*, or legs, or arms, for that matter. In absence of feedback from the proprioceptive system her parietal lobes, though functioning quite normally, had no data to function on, leaving her in a truly "disembodied" state.

Many senses contribute to the experience of one's body: Vision, vestibular senses, proprioception. With the disruption of one of these the others became more vital. In order to "know" the location and arrangement of her own body parts, the woman had to have them in direct sight. Thus, seeing her hands in front of her face supplied the only information about where her hands were. Similarly, walking, eating, talking, expressing emotion, or performing any of the other simple bodily actions we take for granted required the utmost diligence and concentration. Her sense of disembodiment was just that; she was left feeling much like a lump of clay.

Although this case is rare, and certainly bizarre, it provides food for thought. We can close our eyes to simulate blindness, or wear plugs to provide hearing or olfactory impairment, but it is difficult to imagine how not to experience one's body. But in imagining how this might feel (or, *not* feel, as the case might be), we can better appreciate the importance of these "hidden" senses.

Sacks, O. (1985). *The man who mistook his wife for a hat*. New York: HarperCollins.

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Lecture Launcher 3.18 - New Hope for the Paralyzed

Christopher Reeve’s life and death prompted a re-examination of treatments for paralysis. Several avenues of research hold the promise of breakthroughs in therapeutic techniques.

Hocoma AG, a Swiss company, has developed a device called the Lokomat. It is an exoskeleton that allows patients with partial damage to the spinal cord to walk on a treadmill, improve cardiovascular function, reduce swelling in the legs, and generally build confidence. Confidence doesn’t come cheap: A Lokomat runs about $250,000. In comparison to a team of physical therapists and other specialized equipment that are currently used in rehabilitation, that price may be cheap in the long run…in fact, a small price to pay for the promise of restored mobility.

Meanwhile, researchers at Duke University have reported success with a brain implant that allows monkeys (and, in trials, some humans) to move a robotic arm using their thoughts alone. This science fiction scenario holds the promise of remote action in specialized situations (such as mentally controlling a bomb-defusing robot), but also has day-to-day applications in the life of the paralyzed. Imagine being able to send a mental command to a robotic arm to feed oneself, or, possibly, sending mental signals to an exoskeleton to cue coordinated muscle movements to accomplish walking. Right now, the monkeys who have been tested are successful at performing simple tasks, comparable to their earlier training using a joystick. But more complex applications, such as using wireless devices, processors with greatly enhanced power, or even commands sent over the Internet, remain in the realm of possibility.

Finally, on a related note, researchers from the Georgia Institute of Technology and the University of Western Australia have created a robotic arm that creates "art" from signals generated from rat brain cells. Weird? You betcha! The brain cells are kept in a Petri dish in a lab in Atlanta, and their impulses are sent over the Internet to the mechanical arm that translates the signals into abstract squiggles and lines. Although the creations won't win any blue ribbons, the scientists are much more interested in the biology of it all than the artistic merits. By studying how brain impulses work in concert with one another, the work may eventually lead to breakthroughs in the mental control of remote behavior.

Keefe, B. (July 13, 2003). What is a 'semi-living artist?' Rat brain cells and a robot arm. *Austin American-Statesman*, A17.
Stengle, J. (October 18, 2004). Exoskeleton helps paralyzed Dallas man walk again. *Austin American-Statesman*, B6.
Weiss, R. (October 13, 2003). In study, monkeys move robotic arm with thoughts. *Austin American-Statesman*, A1, A12.

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Lecture Launcher 3.19 - Early Development of Perceptual Abilities

Does the world look pretty much the same to a newborn as it does to you, or do babies have a vastly different visual experience? If it is different, how is it different? These questions lie at the heart of the nativist/empiricist controversy: Do things appear as they do because we learn to see them that way through experience or because we simply are born with the right kind of neural structure?

One way to approach the nativism/empiricism question is to study people who were blind from birth and then had their vision suddenly restored. It was hoped that they would be able to describe what they experienced so that psychologists could discover what perceptual abilities they had in their first visual experiences (that thus must be innate), and what ones they didn't (that thus had to have been learned).

Cataract Patients Some people are born with such severe cataracts (cloudy or opaque lenses) in both eyes that they are essentially blind; at best, they see only a haze of diffuse light. When surgery to correct this condition was perfected, adults who had been blind all their lives could suddenly see.

Right after the bandages were removed, almost all patients reported that their first visual experience was a bewildering array of colors with little if any structure. Testing with simple stimuli revealed, however, that their vision was not completely chaotic. They seemed to be able to segregate regions by color, distinguish figure from ground, locate and scan figures in space, and follow moving figures with their eyes.

Other perceptual abilities were strikingly absent. The patients were totally unable to recognize objects visually, even objects they knew quite well by touch. They could not even tell a square from a triangle, for instance, without feeling it at the same time or counting its corners visually. Most of these people eventually learned to identify shapes visually but only with great difficulty and only in specific situations. Seemingly irrelevant changes in things such as color, orientation, or position of a simple figure would often keep the patients from identifying it correctly.

These reports have often been interpreted sweepingly as evidence *for* empiricism and *against* nativism. There are two problems with this conclusion, however. First, it ignores the fact that several perceptual abilities were present immediately, including many of the most basic ones, such as region segregation and figure-ground organization. These must have been either innate or learned through whatever minimal, diffuse, cloudy vision was experienced before the cataracts were removed. It is hard to know which of these explanations is correct because the amount of vision the patients had before their operations was seldom well-documented.

The second problem in interpreting the results from these patients is that the many years with cataracts could actually have destroyed some visual abilities that were present at birth; lack of normal stimulation could have caused degeneration of the visual nervous system. Indeed, the fact that many of these cataract patients never learned to identify shapes well, even with practice, suggests that some deterioration of perceptual abilities must have taken place. After all, newborn babies cannot identify squares and triangles, but they do manage to learn to do so later.

Effects of Visual Deprivation Controlled studies have been conducted with animals to find out whether visual deprivation from birth does cause perceptual deterioration. These studies have shown conclusively that deprivation dramatically impairs visual abilities, sometimes permanently, and that the severity of the impairment depends on the length of deprivation. If monkeys spend their first week or two in complete darkness, their perceptual development is about the same as that of newborn monkeys. But if the first year is spent in darkness, the deprived monkeys are much worse at identifying objects visually. Much like the cataract patients, they never acquire normal depth perception.

Further studies have identified parts of the visual nervous system that degenerate after prolonged deprivation. For instance, in the visual cortex of light-deprived monkeys, researchers found far fewer neurons that responded to visual stimulation than in normal newborn monkeys. Such results suggest that the visual system requires appropriate stimulation to develop normally.

In this restricted sense, the empiricist position is correct: organisms need environmental stimulation to develop normal perceptual abilities. This does not necessarily mean that nativism is wrong, however; infants may still have important perceptual abilities at birth. The deprivation results mean only that whatever innate abilities are present require use to ensure retention or further development of those skills.

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Lecture Launcher 3.20 - Kinetic Depth Effect

The importance of motion in the perception of form can be readily appreciated after experiencing the kinetic depth effect. This demonstration shows how the shadow of a wire form looks flat until the form begins to move, and how the shadow then takes on a three-dimensional aspect in the perception of the viewer. To build the apparatus, you will need a cardboard box, some tissue paper, a flashlight, and a few coat hangers. The box must be open at both ends, and then one end must be covered with tissue paper to provide a screen for the shadow. Each coat hanger should be bent to create a form of some kind, with a straight shaft formed from one end of the wire. Make a hole on one side of the box so that the straight shaft of the wire coat hanger form can be inserted and rotated when the time comes. The wire form inside the box should be as close to the screen as possible, but with enough room to rotate it freely. Place the box on a table with the screen facing the students and darken the room if possible. Use the flashlight to cast a shadow on the wire form for several seconds without rotating it. Then slowly begin to rotate it to bring out the kinetic depth effect. A collection of several different forms will add to the demonstration's effectiveness. Students should be instructed to close their eyes while the form is positioned and open them and guess the shape of the form before rotation begins. For more information, consult the reference given below.

Wallach, H., & O'Connell, D. N. (1953). The kinetic depth effect. *Journal of Experimental Psychology, 45,* 205-217.

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▼CLASSROOM ACTIVITIES, DEMONSTRATIONS, AND EXERCISES

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Activity 3.1 - Beware of What You Wish For

This exercise encourages creativity and stimulates students to think about the evolutionary functions of sensation, and meditate on how an optimal level of sensory acuity depends on the purposes for which the senses are needed. The student handout for this exercise, in which students imagine how their sensory world would change if their sensory receptors were more acute, is included as **Handout Master 3.1**. Suggested answers are listed below.

1. Instead of a world of substantial objects, you might see groups of colliding molecules, and as a result, you might hesitate to sit on a chair because it would not look solid. You might see through walls, like Superman. It would be disconcerting to see your lover's liver and kidneys at work. You might lose the illusion of solid patches of color on TV if yellow appeared as rows of red and green dots. You might lose the illusion of movement in movies and television, by seeing the individual frames with pauses between. Spontaneous activity in the visual cortex might cause you to see flashes and spots of light when you close your eyes or are in complete darkness. You might see ultraviolet, infrared, and radio

waves. You might see germs and bacteria on everyone; nothing would ever look clean again.

2. You might hear your heart beating, the blood pumping through your arteries and veins, the food in your stomach being digested, your intestines at work—and perhaps even molecules banging against each other. You might hear your next-door neighbors talking about you, and music emanating from the houses on your block and passing cars. The sounds of airplanes, leaf blowers, jack hammers, etc., might be unbearable. You might hear water passing through pipes and electricity passing through wires. You might hear your house groaning as it expands and contracts with changes in temperature. And because of all this, you might have trouble sleeping, studying, and maintaining your sanity.

3. Tastes would be too strong, and the bad taste in your mouth in the morning would be extremely unpleasant. You might taste stray molecules floating around in the air. You might smell the residue of food that rotted in your refrigerator a year ago. You would smell the scents left by animals almost everywhere, and you wouldn't dare go near a pig pen or a fish cannery. You could smell other people's soap, shaving cream, toothpaste, and natural odors from across the room. You might find yourself somewhat disgusting.

4. Our senses have evolved in the way they have in order to maximize our chances for survival. For example, because we are diurnal (awake in light) we have many cones on the retina; nocturnal animals need mainly rods. Because we evolved as carnivores (hunting and eating meat), our eyes are close together so the overlapping visual fields can provide good depth perception. There is only so much room inside the human skull, which means that for any additional sensory capacity, something else must be sacrificed. For human beings, language is more important to survival than smell.

5. Over several million years we might lose some abilities and gain others. For example, because the range of sounds is somewhat different in the urban jungle than in a real jungle, we might become more sensitive to certain sound wave frequencies and less sensitive to others. We might lose our aversion to bitter tastes because we no longer forage for berries and don't often have to discriminate instantly between poisonous and nonpoisonous foods. If pollution resulted in everyone living under large domes with temperature control, cutaneous sensitivity to atmospheric conditions might become necessary. However, changes in sensory systems will occur only if certain genes give the individuals who carry them an advantage over others in living to maturity and reproducing. It would probably take a major environmental change to produce this kind of advantage.

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Activity 3.2 - Variability in the Absolute Threshold

Students can experience the concepts of threshold and variability in the absolute threshold at home. Ask students to place a watch or clock with a subtle ticking sound on a table in a quiet room. They should move away from the clock, then move closer to it until they just hear the ticking. If they stand there for a while, they will notice that they won't be able to hear the ticking on occasion, and they will need to step forward to hear the ticking. At other times, the ticking may seem "too loud" and they might have to step back until they hear the ticking of the clock only 50% of the time.

You may try this in class with a few student volunteers who position themselves around the room, and very quiet classmates. You will need a clock with a ticking second hand.

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Activity 3.3 - Sensory Adaptation

Our senses automatically adjust to the level of stimulation they are receiving so that they can be as sensitive as possible without getting overloaded. As a result, our senses become less sensitive when the overall level of stimulation is high, but more sensitive when the overall level of stimulation is low. This explains, for example, why the tick of a watch is more annoying in a quiet room than on a busy street. This phenomenon of sensory adaptation can be readily illustrated in class with a variety of senses, including touch, taste, and vision. Depending on your class size (e.g., if you have fewer than 30 or 35 students), you could allow all students to participate in the first two exercises or for larger classes you might prefer to select a subset of volunteers.

Touch. Fred Whitford suggests a simple exercise for demonstrating sensory adaptation with touch. Bring to class a number of samples of very coarse sandpaper and distribute them to students. After rubbing their index fingers gently over the paper a few times, they should rate its coarseness on a scale from 1 (*very soft*) to 7 (*very coarse*). After a minute or two, have them rub the same finger over the paper and again rate its coarseness. Their senses should have adapted to the coarseness and thus the ratings for the second time should be lower.

Taste. A different exercise (suggested by John Fisher) can be used to demonstrate sensory adaptation with taste. You'll need to bring to class (a) a pitcher containing a strong solution of water and sugar, (b) a pitcher containing fresh water, and (c) several Dixie cups. Distribute two Dixie cups to each student and fill one with sugar water and one with fresh water. Instruct students to take a sip of the sugar water and to swish it around in their mouths for several seconds without swallowing it; gradually it should taste less sweet. After swallowing it (or spitting it back into the cup), students should then taste from the cup containing fresh water. Students will be shocked at how incredibly salty the water tastes and will wonder if you didn't spike it with salt when they weren't looking! Explain that when the overstimulated taste buds responsible for sweetness became temporarily less sensitive, the taste buds responsible for salt became more prominent as a result.

Vision. A final exercise requires a little more effort but powerfully illustrates sensory adaptation in vision. Davis and Grover (1987) first described this activity, a modified version of a procedure developed by Hochberg et al. (1951), that uses a *Ganzfeld* (a homogenous visual field) to demonstrate that the visual system requires varied stimulation to prevent sensory receptor adaptation. To conduct this demonstration you will need to make a Ganzfeld and have a red light source, such as that on a stereo or coffee maker. The Ganzfeld is constructed using a ping pong ball. Cut the ping pong ball in half and discard the side with the writing on it. Then attach cotton around the rim of the remaining half in order to protect the student's eye. Instruct a student volunteer to place the Ganzfeld on one eye, touch the Ganzfeld on the red light, close their other eye, and continue to stare at the red light, reporting any experience that occurs. After a minute or so, although the light is still on, the student will state that you have turned the red light off. Explain to your students that this effect is the result of receptor adaptation because of the Ganzfeld.

Davis, S. F., & Grover, C. A. (1987). And then the lights went out: Constructing a simple Ganzfeld. In V. P. Makosky, L. G. Whittemore, & A. M. Rogers (Eds.), *Activities handbook for the teaching of psychology: Vol. 2* (pp. 49-50). Washington, DC: American Psychological Association.

Fisher, J. (1979). *Body magic*. Briarcliff Manor, NY: Stein and Day.

Hochberg, J. E., Triebel, W., & Seaman, G. (1951). Color adaptation under conditions of homogeneous visual stimulation (Ganzfeld). *Journal of Experimental Psychology, 41*, 153-159.

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Activity 3.4 - Sensation

In this exercise, students apply various phenomena associated with sensation to everyday examples. The student handout for this exercise is included as **Handout Master 3.2**.

Answers:

1. Distribution of receptors: Sensitivity is associated with the number and concentration of receptors. The fingertips and lips have many densely packed touch receptors. The lower back has relatively few, and the brain has none.

2. Difference threshold: The smallest difference in stimulation that can be reliably detected by an observer when two stimuli are compared is called the difference threshold. Apparently, the difference in sweetness among the three cups allows one to be perceived as distinct but is insufficient for discriminating between the other two.

3. Signal detection theory: Signal detection theory indicates that active decision-making behavior is involved in the absolute threshold. The tiredness, as well as attention, of subjects may be affecting such behavior.

4. Sensory adaptation: A reduction in sensitivity results from unchanging, repetitious stimulation. John may be having trouble feeling the glasses on his head because they've been there for awhile.

5. Optimal levels of stimulation: The human brain requires a certain level of stimulation to work most effectively. Stimulation is a matter of change and variety in the environment. Bill's work may be so repetitious that it fails to stimulate him.

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Activity 3.5 - Pressure Phosphene

Sometimes students have difficulty distinguishing, in a real sense, sensation from perception. Partly it is because of semantics—often people will use the term *sensation* when they mean *perception*. For example, people will refer to a "tingly sensation," or "warm sensation" when in fact the basic conscious realization that something (feeling, seeing, hearing, etc.) is occurring is perception. Sensation is the front-end of the process: the conversion of energy or substances into patterns of neural discharges. Perception occurs when the brain makes sense of these patterns of neural discharges.

A nice way to demonstrate the distinction between sensation and perception is to have students produce their own pressure phosphenes. Pressure phosphenes illustrate Johannes Muller's doctrine of specific nerve energies. Briefly, the doctrine states that if you stimulate (say with electrical current) a taste receptor that normally responds to sweet, you will perceive a sweet taste. For vision, if you stimulate a photoreceptor with a slight amount of pressure (as opposed to light, its natural stimulus) you will perceive light! This is called a "pressure phosphene." The easiest way to produce a pressure phosphene is to have students close their left eye, and look at their nose with their right eye. Then, using the index finger of the right hand, have students repeatedly press gently the outside corner of their right eye (they should press on the outside corner of the eye lids, not directly on the eyeball). This doesn't require much pressure at all. One should observe a round patch of light that appears to the left of the tip of the nose. Remember to remind students to repeatedly (lightly) press or tap.

The first reaction to this demonstration is usually "wow," or "cool." From a pedagogical standpoint, the fascinating aspect of this demo is the fact that we are able to produce a sensation of light when no light exists! Because the sensory receptors responsible for vision have been activated, they carry out their "duty -- sensation -- and the brain assumes that the series of neural impulses it receives is light (perception).

Another critical point to note is the fact that the light appears on the opposite side of where the pressure is applied…why is this? – (this is a good question to ask students). Of course, the reason is that images are focused onto the retina in such a way that they are reversed and inverted (relative to the outside world). So, those light rays that normally reach the photoreceptors corresponding to the pressure stimulated ones in the demo, come from the left visual field. Hence, we perceive the light as coming from the left!

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Activity 3.6 - Peripheral Vision

The distribution of photoreceptors across the retina is not uniform. For example, the highest density of receptors is located around the fovea, which is responsible for seeing objects in the center of the visual field. In addition, the majority of the retina's cone receptors are located in this same region. Because a high density of receptors is necessary for good visual acuity, and because cone receptors are responsible for color vision, this should mean that only the objects near the center of our visual field should be perceived clearly and in color. In reality, however, most people perceive their entire visual field to be sharp and colorful. This is an illusion created by the saccadic movements of the eye, which collect color and fine detail information from all around, which the brain then combines into a seamless, uniform visual experience.

Begin by reviewing the distribution of photoreceptors on the retina and how this should affect our visual experience. Explain to students that you will demonstrate that the human eye is incapable of detecting details and color from objects in our peripheral vision. Select a volunteer from the class and ask him or her to sit in a chair facing the class. Instruct the volunteer to pick a point in front of them and to foveate (i.e., stare directly at) that point for the duration of the demonstration. Then, take a playing card and hold it about 2 feet from the side of the volunteer's head, just out of their peripheral vision. Tell the volunteer to inform the class when they can determine any of the playing card's features (color, suit, or value). Then, slowly bring the card into the volunteer's visual field, while maintaining the same distance between the card and their head. Remind your volunteer that they should continue to look straight ahead, and not to look at the card directly. If done correctly, students will be amazed by how close to the center of the volunteer's visual field the card must be before he or she can identify the cards color, suit, and value correctly. Students who wish to replicate the demonstration themselves can do so by selecting a random card without looking at it, holding the card at arm's length from their ear, and then slowly rotating their arm to the front while maintaining the arm's length distance between the card and their head. Again, it is critical that the student look straight ahead while performing the experiment.

Adapted from Dennet, D. (1991) *Consciousness explained.* Boston: Little, Brown and Company.

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Activity 3.7 - The Diagonal Line Effect

Use **Handout Master 3.3** to create the stimuli for this exercise. Make three copies of this handout and cut out the circle stimulus on each one. Arrange the circles so that the lines are vertical within one circle, horizontal in another, and diagonal in the third. Have students stand close to the circles and then back away. As they move away from the circles, the circles with the diagonal lines will appear to be a uniform field of gray whereas the vertical and horizontal lines will remain clearly visible. This demonstration illustrates that our visual system is geared to perceive vertical and horizontal lines more readily than diagonal lines.

If you want to be more quantitative with this exercise, you could measure and record the distances at which each student in your class can just distinguish the horizontal, vertical, and diagonal lines, then calculate the class average for each line orientation, and possibly perform a statistical analysis.

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Activity 3.8 - Field Demonstrations

As a simple but involving assignment, ask students to experience instances of perceptual phenomenon that are too difficult to demonstrate in class. Students could, for example, choose 2 demonstrations from among the following and write a short paper describing their experiences and relating them to theory and research presented in the text.

Dark Adaptation. For this demonstration, students should take about 15 index cards and a flashlight that is opaque on all sides (so that light shines only through the front) into a very dark room. After placing all 15 cards over the beam of light, students should slowly remove the cards one at a time until they can barely detect the light. Have them count the number of cards that remain over the light. After a few minutes, the light should begin to look brighter. When this is the case, have students try to add a card and see if they can still see the light. They should repeat this process of gradually adding cards over a 15-minute period. Consistent with dark adaptation, students should be able to detect an increasingly dim light the longer they spend in the dark.

Night Vision and the Fovea. Because rods rather than cones are active in dim light, it is easier to see objects that fall in areas rich with rods (i.e., outside the fovea) than in areas packed with cones (i.e., the fovea). To experience this, students should choose a relatively clear night (with few surrounding bright lights) to observe stars. Specifically, they should locate a relatively dim star so that it is slightly to the right or left of the focal point of their gaze. When students suddenly shift their gaze to look directly at the star, however, it should disappear.

The Autokinetic Illusion. Students can experience the autokinetic illusion (i.e., the apparent motion created by a single stationary object) for themselves by doing the following: Students should first create a very small point of light, either by using a thin, sharp flashlight or by covering a larger flashlight with a piece of cardboard containing a small hole. They should then go into a very dark room and shine the light on the wall about 10 feet in front of them. After a few moments, the light should appear to drift and move around slightly. In a dark room, there are no cues to tell you that the light is stationary. Therefore, the involuntary eye movements that typically go unnoticed in a changing environment cause the stationary object to appear to move.

Temperature Adaptation. Students can easily explore temperature adaptation by locating 3 medium size bowls and filling them with (a) very hot (but not painfully so) tap water, (b) very cold tap water, and (c) a mixture of the very hot and very cold water. Students should arrange them so that their right hand is in front of the cold water, their left hand is in front of the hot water, and the lukewarm water is in the middle. Students should them submerse their hands into the water (right into cold, left into hot) for about 3 minutes. After 3 minutes, they should quickly transfer both hands to the lukewarm (middle) bowl, and they will undoubtedly experience adaptation "first-hand."

Foley, H. J., & Matlin, M. W (2009). *Sensation and perception* (5th ed.). Upper Saddle River, NJ: Pearson.

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Activity 3.9 - In Search of Perceptual Illusions

Although the text provides several examples of the most common perceptual illusions, students often can gain a better understanding of them by actively finding their own examples. Possible ways to document examples include taking photos, cutting clippings out of magazines or newspapers, or by describing the illusion in detail if it is not possible to obtain a sample (e.g., if it was seen in a movie). Real world examples of afterimages, stroboscopic motion, perceptual contrast, Gestalt principles, and monocular cues abound, and students will likely enjoy their quest for the ultimate illusion. An added benefit is that students can share their examples with the rest of the class, who can try to identify the illusion portrayed. This way, all students will have had access to numerous examples outside of the text.

As an alternative assignment, ask students to create or develop their own illusion (i.e., by drawing or painting a two-dimensional picture or by assembling a three-dimensional object). Although the illusion should be unique, it should of course be based on principles from one of the major illusions discussed in the text. As an example, students could create their own reversible figure, illustrate one or more monocular cues (e.g., linear perspective, shadowing) in a drawing or painting, or create new examples of Gestalt principles of perceptual organization such as closure or proximity.

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Activity 3.10 - Explaining the Moon Illusion

Each of us has succumbed to the moon illusion; that is, the feeling that the moon at the horizon is larger than the moon at its zenith (or highest point). According to Margaret Matlin and Hugh Foley, this paradox has been the source of speculation by scientists and philosophers for thousands of years. Although early research has ruled out physical explanations (e.g., light refraction, angle of head or eye elevation), the precise psychological mechanism responsible is still in debate, and at least 8 competing explanations have been offered in the last 20 years. Ask your students to explore these explanations in more detail and to write a 2 to 4-page paper summarizing two or three different perspectives on this illusion. Ask them to identify which of the theories they believe provides the best explanation and why.

Foley, H. J., & Matlin, M. W (2009). *Sensation and perception* (5th ed.). Upper Saddle River, NJ: Pearson.

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Activity 3.11 - Using Escher to Illustrate Perceptual Principles

Debra Stein (1995) suggests a group exercise that both stimulates critical thinking and increases student interest in the discussion of perceptual processes. Divide your students into groups of 5 and give each group copies of two different M. C. Escher prints. You might want to purchase a book or calendar so that you'll have a enough prints to go around. Instruct your groups to choose a recorder and a spokesperson, and then give them 20-30 minutes to identify any and all examples of the following perceptual principles from the textbook: (a) figure-ground, (b) closure, (c) similarity, (d) continuity, (e) proximity, (f) monocular cues, (g) binocular disparity, (h) superposition, (i) elevation, (j) aerial perspective, (k) linear perspective, (l) texture gradient, (m) convergence, and (n) shadowing. When groups are finished, the spokesperson from each group should briefly present the group's finding to the class. Stein reports several positive benefits of this exercise, including: an increased amount of focused discussion about perceptual processes (due to the group discussions as well as the presentations), an increase in students' understanding of perceptual processes as revealed in test scores, and a tendency for greater application of the material (e.g., her students brought other examples from advertisements and art to class; others created illusions on their own).

Adapted from Stein, D. K. (1995). The use of M. C. Escher and N. E. Thing Enterprises prints to illustrate perceptual principles. Paper presented at the 17th National Institute on the Teaching of Psychology, St. Petersburg Beach.

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Activity 3.12 - Rods and Cones

Cones are sensitive to color but not as sensitive to light. By contrast, rods are sensitive to light, but do not register color information. Thus, in dim light, when the rods are doing most of the work, it is difficult to see colors. To demonstrate this phenomenon, bring in several pieces of construction paper of different colors. Ten minutes before you want to demonstrate this concept, dim the lights until you can just barely see. Then, hold up the pieces of paper and ask the students to write down what color they think that paper is. After you turn on the lights, review the correct colors with your students. How accurate were they?

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Activity 3.13 - Auditory Localization

The benefit of having two good ears, separated by our beefy head, is largely a benefit in locating sounds in space. Our determination of the direction of a sound source is made primarily by comparing the quality of sound that arrives at each ear. Basically two judgments are made: relative loudness and relative timing. After a distinct sound is produced, if the sound seems louder to the left ear than to the right ear and is heard at the left ear before it gets around to the right ear, then the person will decide that the sound came from the left.

To demonstrate this, ask a student to sit in front of you, facing the class. Blindfold the student and move around her or him, making a distinct sound. Snapping fingers works, but a sharper sound, such as clicking together two spoons, works even better. Your student’s job is to locate the source of your sound in space. The student can either point in the direction of the sound or try to describe its location verbally.

The subject will have little trouble if the sound is produced off to either side, either directly or at an angle. The trouble begins when the sound is equidistant from both ears, such as when the sound is made directly in front of, behind, or above the student. Although the student may realize that the sound is not coming from one side or another, there is little basis for deciding whether the sound is in front, above, or behind when the sound is equidistant from both ears.

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Activity 3.14 - Odor Identification Test

Although people can discriminate among a large number of odors, they have a surprisingly difficult time identifying the source of even the most familiar odors. You can illustrate this fact to your students (many of whom will be skeptical) by conducting a large-scale "smell test." First, gather several (approximately 8-15) dark or opaque containers with lids (empty black film canisters are ideal; as those are getting difficult to come by, make a trip to Target or The Container Store and see what you can scrounge up). Assign a different number to each canister (be sure to make a coding sheet with the correct sources) and place cotton balls in the bottom of each to absorb the smell. Good substances to test include baby powder, coffee, peanut butter, pencil shavings, ammonia, lemon extract, peppermint extract, vinegar, chocolate, coconut, Crayola crayons, Play-doh, soap, bubble gum, and spices (e.g., cloves, pepper, garlic, cinnamon). Instruct the students to lift the lid but to keep their eyes closed when smelling the canisters. Then pass the canisters around the room and have students mark their responses on a sheet of paper. Your confounded students will have a sense of familiarity ("Oh, I definitely know this one...what is it?") more often than they will have an exact identification. [Note that having students match the smells with a list of possible sources would greatly increase their chances of being successful.] If you have time, tally the number of correct guesses by a show of hands. Do good or poor smellers have any hypotheses about the cause of their abilities (or lack thereof)? Do the results replicate the finding that women generally have a better sense of smell than do men?

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Activity 3.15 - Phenylthiocarbamide

Phenaylthiocarbamide (PTC) is a chemical that, to most people, has an unpleasant and bitter taste. In 1931, a DuPont chemist accidentally created a cloud of PTC dust in the laboratory, and was surprised when he was the only one in the lab who did not notice the powder's bitter taste. Further research revealed that only about 70% of people can taste PTC, although this number varies in different populations. Although PTC does not occur naturally in food, the ability to taste PTC does correlate with sensitivity to other bitter foods. In 2003, the single gene responsible for differences in PTC tasting was identified. This gene, called TAS2R38, is responsible for a protein that is part of the bitter taste receptor. Although some controversy exists, the ability to taste PTC is generally considered a dominant trait. This means that non-tasters must be homozygous for the non-tasting version of the gene.

Purchase some PTC strips (these are inexpensive and, like everything else on the planet, are available through Amazon.com and other Internet retailers). If the PTC test kit comes with control strips, distribute these to students first. Have students label these strips '1.' Then distribute the PTC test strips and have students label the strips '2.' Next, tell students to place test strip 1 on their tongues and record their descriptions of the taste. You may also want to have students rank the bitterness on a scale from 1–10. Then have students repeat this process with test strip 2. Record on the board the number of students for whom test strip 2 tasted bitter and the number of students for whom the two strips tasted similar. Then have students calculate the percentage of the class that could and could not taste the PTC. You may also want to explore whether the PTC taste appeared to be more intense for some students than others. The results can be used to facilitate a discussion on individual differences in sensory ability and/or the inheritance of genetic differences.

Wooding, S. (2006). Phenylthiocarbamide: A 75-year adventure in genetics and natural selection. *Genetics 172* (4), 2015-2023.

http://www.genome.gov/Pages/Education/Modules/PTCTasteTestActivity.pdf
http://www.amazon.com/TEST-PAPER-STRIPS-CONTROL-VIAL/dp/B001D7FF5O

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Activity 3.16 - The Role of Smell in Determining Flavor

The rich flavor that we sense from our favorite (and not-so-favorite) foods is derived from a combination of taste and smell. According to the text, without smell we can sense the basic tastes (e.g., bitterness, saltiness, sourness, sweetness) but do not experience flavor and thus we cannot identify many popular foods. You can easily replicate an experiment conducted by Mozel et al. (1969) by doing the following: Ask for a volunteer (ideally one with no food allergies) who isn't squeamish about tasting a variety of foods while blindfolded (and with a plugged nose). Implore your class to be quiet (you can show them cue cards with the correct answer during each guess), and then present the subject with a variety of foods that he or she should try to correctly identify without the sense of smell. For best results, food should be cut into small, uniform bite-size pieces and placed on toothpicks (you might need to help guide the food into subjects' hands). Without smell, subjects will have a surprisingly hard time identifying (or distinguishing between) foods with similar textures such as carrots, onions, pears, apples, squash, and potatoes.

Adapted from Fantino, B. F. (1981). Taste preferences: Influence of smell and sight. In L. T. Benjamin & K. D. Lowman (Eds.), *Activities handbook for the teaching of psychology* (pp. 29-30). Washington, DC: American Psychological Association.
Mozell M. M, Smith B. P., Smith P. E., Sullivan, R. L., Jr., & Swender, P. (Eds.)(1969). Nasal chemoreception in flavor identification. *Archives of Otolaryngology, 90*, 367-373.

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Activity 3.17 - The Effect of Visual Cues on Taste

Our sense of taste depends not only on olfactory cues but also on visual cues. To illustrate this fact, have a volunteer wait in the hall while you prepare (in full view of your class) a "typical American meal." Start by placing a bagel (or piece of bread) on a plate and by pouring a glass of orange juice and a glass of milk. Prepare the meal by using food coloring to distort its appearance. For example, you might make the milk a vibrant green, the orange juice look like motor oil (by mixing red, green, blue, and yellow), and the bread look moldy (with blue or green spots). Instruct your class to be a quiet audience and not to giggle or to give anything away. Bring the volunteer, blindfolded, back into the class and ask him or her to comment on the meal (e.g., "Does it taste good?" "Do you know what it is?") while eating it. The volunteer will no doubt correctly identify the foods and confirm that they taste good. After a few minutes, remove the blindfold and observe the volunteer's reaction. Asking the volunteer to continue eating will likely result in an emphatic, "No Thanks!" This should spark a lively discussion of the role of vision in taste and students are usually happy to share their personal experiences.

Adapted from Fantino, B. F. (1981). Taste preferences: Influence of smell and sight. In L. T. Benjamin & K. D. Lowman (Eds.), *Activities handbook for the teaching of psychology* (pp. 29-30). Washington, DC: American Psychological Association.

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Activity 3.18 - Saliva and Taste

Students may be surprised to learn that food must be dissolved in water in order to be tasted. That is, some kind of liquid must be available to bind solid food to the appropriate taste receptor (e.g., sweet, sour, bitter or salty). John Fisher suggests a simple exercise that demonstrates the crucial role of saliva in taste. First, have students wipe their tongue dry (the drier, the better) with the back of their hand. Then, walk around the room with a bowl of sugar and have students take a small pinch and place it on the tip of their tongue. They should not be able to taste anything until their mouth gradually moistens—with renewed saliva, the familiar sweet taste should come flooding back.

Fisher, J. (1979). *Body Magic*. Briarcliff Manor, NY: Stein and Day.

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Activity 3.19 - Let Them Eat Jellybeans!

Students usually aren't aware that the sense of taste determines only roughly half of what we consider to be flavor. Flavor is, in fact, a combination of taste and smell. The demonstration outlined here, adapted from The University of Chicago's "Brain Benders," provides an excellent illustration of this. The direct link to Brain Benders is: http://mps.uchicago.edu/docs/reports07/BrainBenders.pdf

Give each of your students a jellybean (or two, or three). Ask the students to pinch their nose closed when they first place the jelly bean in their mouth. After they have chewed the jellybean with their nose plugged, ask them to unplug their noses and notice the difference. They will then be able to perceive much more of the flavor of the jellybean and be much more likely to be able to identify the flavor.

At first (when the nose is plugged), students may be able to tell that the jellybean is sweet or sour, but upon unplugging the nose the full flavor of the jelly bean emerges -- the brain is now receiving signals from both the tongue and nose. It combines the two and BOOM -- you get full *flavor*. In the brain, nerve signals from the tongue and nose are combined to produce the flavor of the jellybean. When the nose is pinched, the strict taste properties (i.e., sweet, salty, sour, or bitter) of the jellybean are apparent. But you couldn't tell the full flavor until the receptors in the nose could send nerve signals to the brain.

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Activity 3.20 - The Body's Sensitivity to Touch

Although generally the sensation receptors in skin are remarkably sensitive, various parts of the body differ greatly in their sensitivity to pressure. This is because larger portions of the cerebral cortex are devoted to body areas that, for adaptive reasons, show greater sensitivity. (For example, crucial human features such as the mouth, face, and fingers are much more sensitive than are important, but less central, features such as the legs, feet, and back.) Both John Fisher and James Motiff have suggested exercises to illustrate this phenomenon. For this demonstration, divide students into pairs and have them take turns experiencing the vast differences in touch sensitivity on different parts of their body.

In Motiff's version, one student in the pair should keep his or her eyes closed while the other person randomly presses from one to four fingers lightly on that person's back, neck, leg, shoulder, forearm, face, and hand. The person being touched should attempt to guess in each case the number of fingers being applied. Students will have a much easier time correctly identifying the number of fingers applied to especially sensitive areas (such as the face and hand) compared to the other, less sensitive areas, which will feel indistinguishably like one point of pressure (i.e., one finger).

In Fisher's version, distribute a single hairpin to each pair of students. One student should pry the hairpin apart (so that its prongs are roughly an inch apart) and press the hairpin against the back of their partner's forearm. The person being touched will report feeling only a single point of pressure. Next, the student should bend the prongs inward so that they are only about 1/16 of an inch apart and place it this time on their partner's index finger tip. This time (despite the smaller difference between the prongs), the partner will have no trouble differentiating the two points, as the fingertip is much more sensitive than the forearm. For an eerier demonstration, Fisher suggests dragging the hairpin (with prongs one inch apart) slowly from the crease of the elbow down to the finger tips. Although the spacing between the prongs remains constant, the person being touched will report that distance between the prongs increases the closer the hairpin gets to the fingertips.

Finally, a demonstration suggested by Douglas Chute and Philip Schatz nicely illustrates that not all body locations receive the same attention from the brain. For this demonstration you'll need a ballpoint pen and volunteers with bare feet. First, ask students to close their eyes and hold out one of their hands. Explain that you will touch the tip of the pen to each of the three middle fingers (i.e., ignoring the thumb and the pinkie), and after each touch the student should report which finger was touched. Do this about 7-10 times, varying which finger gets touched. To no one's astonishment, students should be spectacularly successful in knowing which finger received the stimulation on each trial. Next, ask students to doff their shoes and socks, and repeat the demonstration, this time touching the three middle toes (i.e., ignoring the big toe and the littlest toe). Have students "number" their toes (big=1, next=2, littlest=5, and so on), and again report which toe was touched by the pen tip on each trial. You should now find that students are spectacularly unsuccessful at indicating which toe received the stimulation on each trial. The explanation for these differences lies in neural organization. The sensorimotor strip is dedicated much more heavily to the fingers, which receive a lot more stimulation, do a lot more work, and are a lot more important to a variety of tasks than are the toes.

Chute, D. L., & Schatz, P. (1999). Observing neural networking *in vivo*. In L. T. Benjamin, B. F. Nodine, R. M. Ernst, and C. B. Broeker (Eds.), *Activities handbook for the teaching of psychology (Vol. 4*). Washington, DC: American Psychological Association.

Fisher, J. (1979). *Body Magic*. Briarcliff Manor, NY: Stein and Day.

Motiff, J. P. (1987). Physiological psychology: The sensory homunculus. In V. P. Makosky, L. G. Whittemore, & A. M. Rogers (Eds.), *Activities handbook for the teaching of psychology: Vol. 2* (pp. 49-50). Washington, DC: American Psychological Association.

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Activity 3.21 - The Size-Weight Illusion

Are large boxes heavier than small boxes? Use two boxes that differ considerably in size, like an earring box and a shoe box. Wrap 25 pennies in tissue paper or facial tissues to prevent rattling and put them in the small box. Tape enough pennies inside the larger box so that it weighs the same or slightly more than the smaller box. Now wrap both boxes in gift wrap or any kind of paper. Ask students to pick up the boxes and tell you which is heavier. The smaller box will seem to be much heavier even though it weighs the same or less than the larger box.

This is a demonstration of context effects in which heaviness is relative to the size of the stimulus. In vision, the illusion in which a circle of the same size is surrounded in one figure by smaller circles and in a second figure by larger circles illustrates context effects: the perceived size of the circle is affected by the context in which it appears.

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Activity 3.22 - Expectancy and Perception

Our expectations (i.e., preconceptions about what we are supposed to perceive) can influence perception. There are several simple, effective exercises to demonstrate this point in class.

· John Fisher suggests conducting a "spelling bee in reverse." Ask students to pronounce a word out loud after you write it on the board. Following MAC DONALD...MAC HENRY...MAC MAHON... with MAC HINERY will likely generate a chorus of Scottish-sounding surnames (e.g., "MacHinery!") rather than the correct pronunciation of *machinery*.

· For a similar exercise, Martin Bolt suggests adopting an old children's riddle. Ask students to shout out answers to the following questions: "What do these letters spell?" (Write FOLK on the board) "What do these letters spell?" (CROAK) "And these?" (SOAK). Then quickly ask, "What do you call the white of an egg?" Students will scream out "yolk" before they realize they've been had. (You can then inform them that the white of an egg is called the albumin.)

· J. R. Corey suggests an exercise that demonstrates the effect of expectancy on anagram solution. This exercise requires that you construct two different lists of anagrams and randomly distribute one to each student. Half of the students should receive anagrams that can be solved to form animals: LULB (bull), CALEM (camel), NUKKS (skunk), SEUMO (mouse), BAZER (zebra), and EAP (ape). The other half should receive anagrams that can be solved to form vegetables: NORC (corn), NOONI (onion), MATOOT (tomato), PREPPE (pepper), TEBE (beet), and EAP (pea). Note that the last anagram, EAP, can be solved in two ways (ape or pea) and thus provides the expectancy test. If students' expectancies are influential, then those who received the animal list should be more likely to solve EAP as ape, whereas those who received the vegetable list should be more likely to solve EAP as pea. According to Corey, the expectancy effect occurs for approximately 80-90% of the students.

· A powerful illusion based on expectancy is called the *size-weight illusion*. Use three food containers (metal or plastic), for example, three that hold 8 ounces, 16 ounces, and 32 ounces. Put dirt or pebbles into each container so that all three are exactly the same weight (use a kitchen scale). Cover them with tin foil so the material inside cannot be seen. Most people asked to judge the lightest or heaviest will be certain that the smallest container weighs the most, and the largest weighs the least. Even though you prepared them yourself, you may have difficulty accepting that they are all the same weight. This effect is explained by our expectations. When we see the large container, we prepare our muscles to lift something heavy. When it is only filled to a portion of its capacity, it is picked up easily.

· Ann Elliott suggests a demonstration of gustatory expectancy. Two hours before class time, pour milk into a cup and coffee into a cup and allow them to sit until they become room temperature. In class, poll students to make sure no one has a food allergy or religious reason that would prohibit them from drinking certain beverages (you might administer a quick survey, listing several beverages so that the importance of milk and coffee in this demonstration is not immediately apparent). Ask for volunteers to close their eyes and sip from each of the cups (you might have one student volunteer or have the entire class participate; you can counterbalance the order of sips, or do a quicker presentation). After each sip, ask the volunteers to rate the temperature of the beverage on a scale ranging from 1 (*cold*) to 4 (*hot*). You might also ask students to indicate in writing if they thought the beverages were the same temperature. You should find that, due to students' expectations, they rate the coffee as cool or cold, whereas they rate the milk as warm or hot. In reality, of course, both beverages are room temperature. The expectation of a hot beverage (coffee) that isn't leads to a cooler rating, just as the expectation of a cold beverage (milk) that isn't produces a warmer rating.

Block, J. R., & Yuker, H. E. (1989). *Can you believe your eyes?* New York: Gardner Press.
Bolt, M. (1992). Instructor's resources for use with D. G. Myer's, *Psychology* (3rd ed.). New York: Worth.
Corey, J. R. (1990). Psychological set and the solution of anagrams. In V. P. Makosky, C. C. Sileo, L. G. Whittemore, C. P. Landry, & M. L. Skutley (Eds.), *Activities handbook for the teaching of psychology.* Vol. 3 (pp. 90-91). Washington, DC: American Psychological Association.
Elliott, A. N. (1999). A classroom demonstration of Galileo's distinction between objective and subjective reality. In L. T. Benjamin, B. F. Nodine, R. M. Ernst, and C. B. Broeker (Eds.), *Activities handbook for the teaching of psychology (Vol. 4*). Washington, DC: American Psychological Association.
Fisher, J. (1979). *Body Magic*. Briarcliff Manor, NY: Stein and Day.

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Activity 3.23 - Stimuli and Their Context

This is a brief demonstration of the brain's activity in integrating stimuli into meaningful units based on context. Reproduce the **Handout Masters 3.4A** and **3.4B**. There are two sets of lists**, List A** and **List B**, one on each handout. Without calling attention to the different lists, distribute **List A** to one side of the class and **List B** to the other, face down. When you say "go," students are to read the entire list first (emphasize this) and then fill in as many of the incomplete words as they can in 20 seconds. Give the "go" signal and after 20 seconds ask them to stop. Then ask how many had "Duck" as their first answer (hands on one side will go up) and how many had "Dick" (hands on the other side will go up). Continue the questioning through the remaining word pairs: Fox-Box, Bet-Bat, Bad-Bed, Part-Port, Hat-Rat, Hunt-Hint, Paint-Point, Bold-Fold, Farm-Harm. Why did the two halves of the classroom consistently differ? Clearly the brain has reacted to the stimulus inputs within the context of surrounding and prior stimuli.

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Activity 3.24 - Crossword Puzzle

Copy and distribute **Handout Master 3.5** to students as a homework or in-class review assignment.

Answers for the Crossword puzzle:

Across
4. cues for perceiving depth based on both eyes. **Binocular**
7. area in the retina where the axons of the three layers of retinal cells exit the eye to form the optic nerve. **Blindspot**
10. the rotation of the two eyes in their sockets to focus on a single object. **Convergence**
11. the sensations of movement, balance, and body position. **Vestibular**
12. snail-like structure of the inner ear, filled with fluid. **Cochlea**
14. the activation of receptors in the various sense organs. **Sensation**
15. **perception**; the ability to perceive the world in three dimensions. **Depth**
17. the method by which the sensations experienced at any given moment are interpreted and organized in some meaningful fashion. **Perception**
Down
1. the sensation of taste. **Gustation**
2. cues for perceiving depth based on one eye only. **Monocular**
3. the tendency to complete figures that are incomplete. **Closure**
5. images that occur when a visual sensation persists for a brief time even after the original stimulus is removed. **Afterimages**
6. the sensation of smell. **Olfaction**
8. disorder in which the signals from the various sensory organs are processed in the wrong cortical areas. **Synesthesia**
9. the tendency to perceive objects that are close to each other as part of the same grouping. **Proximity**
12. visual sensory receptor found at the back of the retina, responsible for color vision and sharpness of vision. **Cones**
13. **nerve**; bundle of axons from the hair cells in the inner ear. **Auditory**
16. visual sensory receptor found at the back of the retina, responsible for non-color sensitivity to low levels of light. **Rods**

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Activity 3.25 - Fill-in-the-Blanks

Copy and distribute **Handout Master 3.6** to students as a homework or in-class review assignment.

Answers for Fill-in-the-Blanks—Chapter 3

sensation
just noticeable difference
absolute threshold
subliminal perception
habituation
sensory adaptation
saturation
cornea
lens
cones
light adaptation
afterimages
eardrum
auditory nerve

gustation
olfaction
olfactory bulbs
somesthetic senses
kinesthetic sense
perception
figure ground
proximity
closure
depth perception
monocular
binocular
perceptual set

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▼HANDOUT MASTERS

- Handout Master 3.1 - Beware of What You Wish For
- Handout Master 3.2 - Sensation
- Handout Master 3.3 - The Diagonal Line Effect
- Handout Master 3.4a - Stimuli and Their Context
- Handout Master 3.4b - Stimuli and Their Context
- Handout Master 3.5 - Crossword Puzzle
- Handout Master 3.6 - Fill-in-the-Blanks

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Handout Master 3.1

Beware of What You Wish For

Human beings do not have the most sensitive or acute sensory systems in the animal world. Some bats can hear frequencies that exceed 100,000 Hertz, dolphins receive auditory messages from great distances, and cats can probably localize sounds better than we do because they can rotate their ears. Rats see better at night than we can, eagles have more acute distance vision, and horses have a wider visual field. Rabbits have more taste buds than we do, and many animals have a keener sense of smell.

This exercise asks you to consider how you would perceive the world if your senses were more acute or sensitive than they actually are.

1. List a few things you would see, that you cannot see now, if your sense of vision were "better."

2. List a few things you would hear, that you cannot hear now, if you could hear "better."

3. If your chemical senses—taste and smell—were more sensitive, how might you be affected?

4. Why are our senses no more and no less acute or sensitive than they are?

5. If human beings continue to be urban creatures for the next few million years, in what ways might our sensory systems evolve or change?

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Handout Master 3.2
Sensation

Sensation is initiated by the physical stimuli that surround and inhabit the body. As stimuli impinge on receptors, neural impulses are initiated and speed along specific pathways toward destinations in the brain. During sensation assorted influences come into play; the intensity of stimulation, its repetitiousness, and the range and mixture of stimuli. Stimulation may be subliminal, may produce sensory adaptation, or may be less than optimal. Below, explain the phenomenon being described in terms of the concept listed after it.

1. Different portions of the body vary in their sensitivity to touch. The fingertips and lips are especially sensitive and the lower back is relatively insensitive. The brain itself is completely indifferent to touch.
   Distribution of receptors:

2. Janet has prepared three cups of coffee but can't recall how much sugar is in each. The cup with the smallest amount of sugar is easy to identify, but Janet can't taste any difference between the other two cups even though she knows one has more sugar.
   Difference threshold:

3. A nurse notices that patients perform more poorly on auditory tests—tests involving the threshold of hearing—when they are tired as a result of loss of sleep.
   Signal detection theory:

4. John is looking all over for his glasses when his wife points them out at the top of his head.
   Sensory adaptation:

5. Bill was initially delighted to land a job at the post office, but recently he has become worried. By the end of his shift, he almost always feels edgy, nervous, and confused. This is difficult for Bill to understand because his work makes few demands. He just sits there all day, alone in a room, putting thousands of letters into the numerous bins.
   Optimal levels of stimulation:

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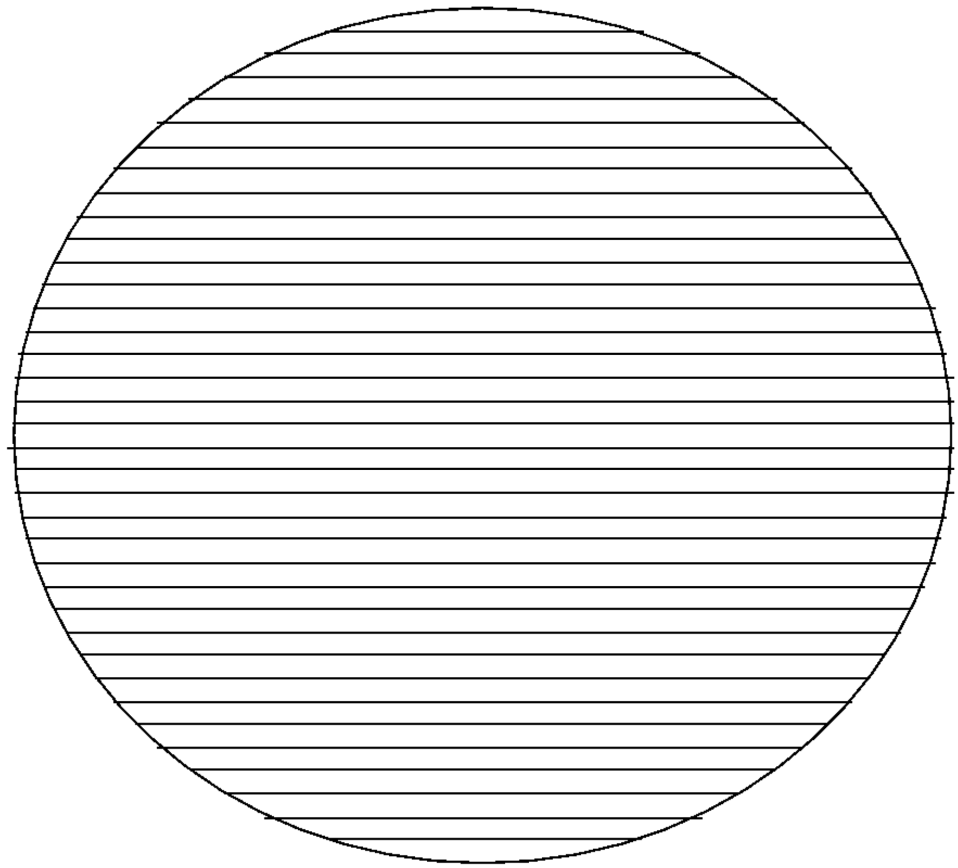
Handout Master 3.3

The Diagonal Line Effect



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Handout Master 3.4a

Stimuli and Their Context

List A

Goose Swan D__ck	Bonnet Derby __at
Bear Wolf __ox	Shoot Kill H__nt
Wager Gamble B__t	Artist Brush P__int
Sinful Evil B__d	Courage Brave __old
Portion Fraction P__rt	Tractor Crops __arm

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Handout Master 3.4b
Stimuli and Their Context

List B

Sam Pete D__ck	Cat Mouse __at
Package Carton __ox	Help Suggest H__nt
Base Ball B__t	Needle Sharp P__int
Pillow Sheet B__d	Bend Crease __old
Ship Dock P__rt	Hurt Punish __arm

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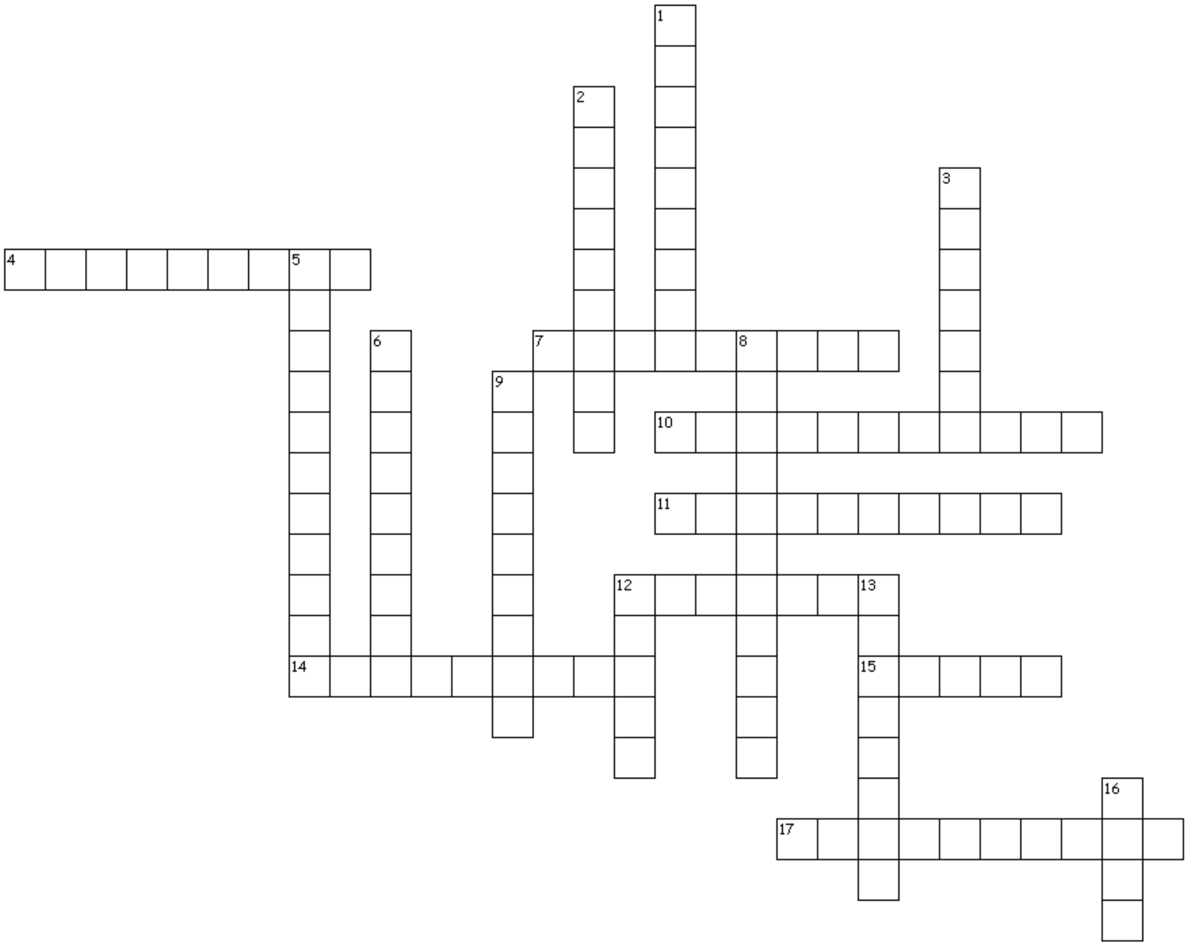
Handout Master 3.5

Crossword Puzzle



Across
4. cues for perceiving depth based on both eyes.
7. area in the retina where the axons of the three layers of retinal cells exit the eye to form the optic nerve.
10. the rotation of the two eyes in their sockets to focus on a single object.
11. the sensations of movement, balance, and body position.
12. snail-like structure of the inner ear, filled with fluid.
14. the activation of receptors in the various sense organs.
15. **perception**: the ability to perceive the world in three dimensions.
17. the method by which the sensations experienced at any given moment are interpreted and organized in some meaningful fashion.

Down
1. the sensation of taste.
2. cues for perceiving depth based on one eye only.
3. the tendency to complete figures that are incomplete.
5. images that occur when a visual sensation persists for a brief time even after the original stimulus is removed.
6. the sensation of smell.
8. disorder in which the signals from the various sensory organs are processed in the wrong cortical areas.
9. the tendency to perceive objects that are close to each other as part of the same grouping.
12. visual sensory receptor found at the back of the retina, responsible for color vision and sharpness of vision.
13. **nerve**; bundle of axons from the hair cells in the inner ear.
16. visual sensory receptor found at the back of the retina, responsible for non-color sensitivity to low levels of light.

► Return to Activity: Crossword Puzzle
◄ Return to complete list of Handout Masters for Chapter 3
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Handout Master 3.6
Fill-in-the-Blanks

1. ____________________ is the activation of receptors in the various sense organs.
2. ________________________ ________________ __________________ is the smallest difference between two stimuli that is detectable 50 percent of the time.
3. The smallest amount of energy needed for a person to consciously detect a stimulus 50 percent of the time it is present is called ____________________ ______________________.
4. The process by why subliminal stimuli act upon the unconscious mind, influencing behavior is called _________________ __________________.
5. ____________________________ is the tendency of the brain to stop attending to constant, unchanging information.
6. The tendency of sensory receptor cells to become less responsive to a stimulus that is unchanging _________________ _______________________.
7. This refers to the purity of the color people see and it is called _______________.
8. The ________________ is a clear membrane that covers the surface of the eye; protects the eye and is the structure that focuses most of the light coming into the eye.
9. The ____________________ is another clear structure behind the iris, suspended by muscles; finishes the focusing process begun by the cornea.
10. The visual sensory receptors found at the back of the retina, responsible for color vision and sharpness of vision are called the _____________.
11. The recovery of the eye's sensitivity to visual stimuli in light after exposure to darkness is called _______________ ______________.
12. The images that occur when a visual sensation persists for a brief time even after the original stimulus is removed are called _______________________.
13. The thin section of skin that tightly covers the opening into the middle part of the ear, just like a drum skin covers the opening in a drum is called the ___________ _____________________.
14. The bundle of axons from the hair cells in the inner ear; receives neural message from the organ of Corti in the _________________ ________________.
15. The term for the sensation of a taste is called _____________________.
16. The sense of smell is called _________________________.
17. The areas of the brain located just above the sinus cavity and just below the frontal lobes that receive information from the olfactory receptor cells are called ________________________ ____________________.
18. The body senses consisting of the skin senses, the kinesthetic sense, and the vestibular senses are called _________________ ______________________.
19. The sense of the location of body parts in relation to the ground and each other is called the ____________________ _____________.
20. ______________________________ is the method by which the sensations experienced at any given moment are interpreted and organized in some meaningful fashion.
21. A Gestalt principle known as __________________________ ____________ is the tendency to perceive objects, or figures, as existing on a background.
22. The Gestalt principle of ___________________ is the tendency to perceive objects that are close to each other as part of the same grouping.

23. The Gestalt principle of ____________________ is the tendency to complete figures that are incomplete.
24. The ability to perceive the world in three dimensions is known as ________________________ ______________________.
25. __________________________ cues for perceiving depth based on one eye only.
26. ______________________ cues for perceiving depth based on both eyes.
27. ___________________ _______________ is the tendency to perceive things a certain way because previous experiences or expectations influence those perceptions.

Words for Fill-in-the-Blanks

absolute threshold
afterimages
auditory nerve
binocular
closure
cones
cornea
depth perception
eardrum
figure ground
gustation
habituation
just noticeable difference
kinesthetic sense
lens
light adaptation
monocular
olfaction
olfactory bulbs
perception
perceptual set
proximity
saturation
sensation
sensory adaptation
somesthetic senses
subliminal perception

► Return to Activity: Fill-in-the-Blanks
◄ Return to complete list of Handout Masters for Chapter 3
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▼ VIDEO SERIES

The VIDEO SERIES features over 100 original videos covering the most recent research, science, and applications across the general psychology curriculum, and utilizing the latest in film and animation technology. Each 4-6 minute video clip has automatically graded assessment questions tied to it.

Access www.MyPsychLab.com, and select "Videos."

Chapter 3 Video Content available:

Video: The Basics: In Full Appreciation of the Cookie (4:34)
Watch how the simple act of eating a chocolate chip cookie involves all of our senses, and several parts of the brain are involved in forming our perception of that experience.

Video: The Big Picture: Taking in the World Around Us (3:50)
Learn about transduction, sense organs, and how our actions and high-level thinking begin with sensations and perceptions.

Video: In the Real World: Managing Pain (6:40)
See how injury is communicated to the brain, how pain signals can be intensified or blocked, and what the safest, most effective methods are for pain management.

Video: Special Topics: Recognizing Faces (4:33)
Find out which regions of the brain are involved in facial recognition and why some people have problems recognizing faces.

Video: Thinking Like a Psychologist: Can Smells Alter Mood and Behavior? (6:49)
Learn how smells can spark vivid memories and have a powerful effect on our mood, both good and bad.

Video: What's In It For Me? Perceptual Magic in Art and Movies (7:45)
Investigate the ways in which artists play on and exploit sensation and perception to create works of art and illusion.

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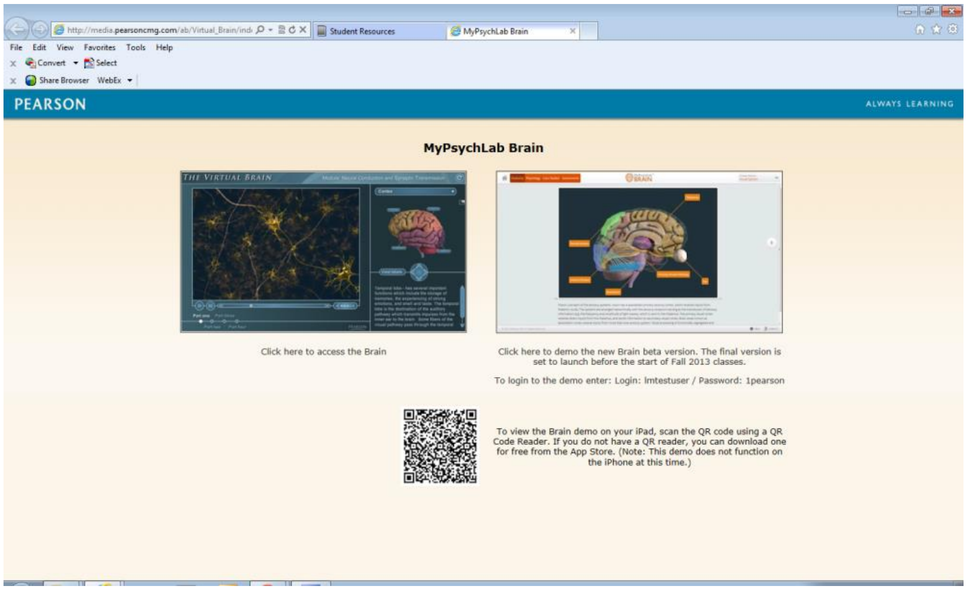
▼ VISUAL BRAIN

THE VISUAL BRAIN is an interactive virtual brain designed to help students better understand neuroanatomy, physiology, and human behavior. Thirteen virtual brain modules bring to life many of the most difficult topics typically covered in the introductory course. This hands-on experience engages students and helps make course content and terminology relevant. Modules relevant to the current chapter are highlighted in **bold** below.

Access www.MyPsychLab.com, and click on the Student Resources tab.



Select among these modules

- Brain Damage and Neuroplasticity
- **Control of Movement**
- Drug Addiction
- Hunger and Eating
- Lateralization and Language
- Learning and Memory
- Nervous System
- Neural Conduction
- **Perception**
- Psychiatric Disorders
- Sleep and Waking
- Stress and Health
- **Visual System**

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▼EXPERIMENT AND SURVEY SIMULATIONS

EXPERIMENT AND SURVEY SIMULATIONS allow students to participate in online simulations of virtual versions of classic psychology experiments, surveys, and research-based inventories, helping to reinforce what they are learning in class and from their textbook.

Access www.MyPsychLab.com, and select "Simulations."

Chapter 3 Simulations Content available:

Simulation: Ambiguous Figures
View ambiguous figures, and find out if what you "see" can be influenced by what you've viewed previously.

Simulation: Weber's Law
Experience the "just noticeable difference" phenomenon firsthand.

Simulation: Müller-Lyer Illusion
Test your perceptions of an optical illusions to learn about the difference between sensation and perception.

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▼WRITING SPACE *featuring* auto-feedback WRITING PRACTICE

WRITING SPACE helps students master concepts and develop critical thinking through writing. WRITING SPACE provides a single place within your MyLab to create and track your writing assignments, access writing resources, and exchange meaningful, personalized feedback quickly and easily. Plus, WRITING SPACE has integrated access to Turnitin, the global leader in plagiarism prevention.

Access www.MyPsychLab.com, and select "Writing Space" from the left-hand navigation bar.

Auto-feedback Writing Practice accessible from Writing Space

WRITING PRACTICE prompts within WRITING SPACE offer immediate automated feedback. Each student submission receives detailed feedback based on the following traits: Development of Ideas, Organization, Conventions, Voice, Focus and Coherence. Instructors can provide additional feedback and can adjust the auto-generated grade.

WRITING PRACTICE SAMPLE 3.1

> The Gestalt psychologists maintained that when people perceive sensory elements their tendency is to see things in terms of the entire form or pattern rather than as individual parts. Identify and describe these basic principles of perceptual organization from the Gestalt perspective: figure-ground, similarity, proximity, and closure.

Instructor-Created Writing Assignments accessible from Writing Space:

Instructors can create their own writing prompts and grading rubrics, or copy and paste from a library of sample prompts and rubrics available within this Instructor Manual. Instructors can provide personalized feedback and grades to students.

INSTRUCTOR-CREATED SAMPLE 3.1

> Investigate the claims that proponents of aromatherapy make about the health benefits of essential oils. What does scientific research tell us about these claims?

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