

# 5 :

## Sensation

### CHAPTER OVERVIEW

Sensation refers to the process by which we detect physical energy from the environment and encode it as neural signals. This chapter describes the senses of vision, hearing, taste, touch, smell, kinesthesia, and the vestibular sense. It also presents research findings from studies of subliminal stimulation.

In this chapter there are many terms to learn and several theories you must understand. Many of the terms are related to the structure of the eye, ear, and other sensory receptors. Doing the chapter review several times, labeling the diagrams, and rehearsing the material frequently will help you to memorize these structures and their functions. The theories discussed include the signal detection, Young-Helmholtz three-color and opponent-process theories of color vision, and the frequency and place theories of pitch. As you study these theories, concentrate on understanding the strengths and weaknesses (if any) of each.

NOTE: Answer guidelines for all Chapter 5 questions begin on page 145.

### CHAPTER REVIEW

First, skim each section, noting headings and boldface items. After you have read the section, review each objective by answering the fill-in and essay-type questions that follow it. As you proceed, evaluate your performance by consulting the answers beginning on page 145. Do not continue with the next section until you understand each answer. If you need to, review or reread the section in the textbook before continuing.

### Introduction (pp. 197–198)

David Myers at times uses idioms that are unfamiliar to some readers. If you do not know the meaning of the following expression in the context in which it appears in the text, refer to page 154 for an explanation: . . . *in a mirror she is again stumped*.

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

1. The process by which we detect physical energy from the environment and encode it as neural signals is \_\_\_\_\_. The process by which sensations are selected, organized, and interpreted is \_\_\_\_\_.
2. Sensory analysis, which starts at the entry level and works up, is called \_\_\_\_\_.  
Perceptual analysis, which works from our experience and expectations, is called \_\_\_\_\_.
3. The perceptual disorder in which a person has lost the ability to recognize familiar faces is \_\_\_\_\_.

### Sensing the World: Some Basic Principles

(pp. 198–203)

If you do not know the meaning of any of the following words, phrases, or expressions in the context in which they appear in the text, refer to page 154 for an explanation: *A frog could starve to death knee-deep in motionless flies; The shades on our senses are open just a crack; the faintest whimper from the cradle; "satanic messages"; hucksters; price hike . . . to raise the eyebrows; So everywhere that Mary looks, the scene is sure to go.*

**Objective 2:** Distinguish between absolute and difference thresholds, and discuss whether we can sense stimuli below our absolute threshold and be influenced by them.

1. The study of relationships between the physical characteristics of stimuli and our psychological experience of them is \_\_\_\_\_.
2. The \_\_\_\_\_ refers to the minimum stimulation necessary for a stimulus to be detected \_\_\_\_\_ percent of the time.
3. The theory of \_\_\_\_\_ led to the concept that absolute thresholds depend not only on the strength of the signal but also on a person's \_\_\_\_\_ state.
4. Some entrepreneurs claim that exposure to "below threshold," or \_\_\_\_\_, stimuli can be persuasive, but their claims are probably unwarranted.
5. Some weak stimuli may trigger in our sensory receptors a response that is processed by the brain, even though the response doesn't cross the threshold into \_\_\_\_\_ awareness.
6. Under certain conditions, an invisible image or word can \_\_\_\_\_ a person's response to a later question. The \_\_\_\_\_ illustrates that much of our information processing occurs \_\_\_\_\_.
7. The minimum difference required to distinguish two stimuli 50 percent of the time is called the \_\_\_\_\_. Another term for this value is the \_\_\_\_\_.

8. The principle that the difference threshold is not a constant amount, but a constant proportion, is known as \_\_\_\_\_. The proportion depends on the \_\_\_\_\_.

**Objective 3:** Describe sensory adaptation, and explain how we benefit from being unaware of changing stimuli.

9. After constant exposure to an unchanging stimulus, the receptor cells of our senses begin to fire less vigorously; this phenomenon is called \_\_\_\_\_.
10. This phenomenon illustrates that sensation is designed to focus on \_\_\_\_\_ changes in the environment.

Explain why sensory adaptation is beneficial.

### Vision (pp. 204–215)

If you do not know the meaning of any of the following words, phrases, or expressions in the context in which they appear in the text, refer to pages 154–155 for an explanation: *blind spot; Rods have no such hotline; Holy Grail; blindsight; Color, like all aspects of vision, . . . the theater of our brains.*

**Objective 4:** Define *transduction*, and specify the form of energy our visual system converts into the neural messages our brain can interpret.

1. Stimulus energy is converted into \_\_\_\_\_ messages through the process of sensory \_\_\_\_\_.
2. The visible spectrum of light is a small portion of the larger spectrum of \_\_\_\_\_ radiation.
3. The distance from one light wave peak to the next is called \_\_\_\_\_. This value \_\_\_\_\_.

determines the wave's color, or \_\_\_\_\_.

- The amount of energy in light waves, or \_\_\_\_\_, determined by a wave's \_\_\_\_\_, or height, influences the \_\_\_\_\_ of a light.

**Objective 5:** Describe the major structures of the eye, and explain how they guide an incoming ray of light toward the eye's receptor cells.

- Light enters the eye through the \_\_\_\_\_, then passes through a small opening called the \_\_\_\_\_; the size of this opening is controlled by the colored \_\_\_\_\_.
- By changing its curvature, the \_\_\_\_\_ can focus the image of an object onto the \_\_\_\_\_, the light-sensitive inner surface of the eye.
- The process by which the lens changes shape to focus images is called \_\_\_\_\_. Clarity, or sharpness, of vision is called \_\_\_\_\_.
- In nearsightedness, light rays from \_\_\_\_\_ (nearby/distant) objects converge \_\_\_\_\_ (in front of/in back of) the retina, rather than on it, and \_\_\_\_\_ (nearby/distant) objects are seen more clearly than \_\_\_\_\_ (nearby/distant) objects. In farsightedness, light rays from \_\_\_\_\_ (nearby/distant) objects converge \_\_\_\_\_ (in front of/in back of) the retina, and \_\_\_\_\_ (nearby/distant) objects are seen more clearly than \_\_\_\_\_ (nearby/distant) objects.

**Objective 6:** Contrast the two types of receptor cells in the retina, and describe the retina's reaction to light.

- The retina's receptor cells are the \_\_\_\_\_ and \_\_\_\_\_.
- The neural signals produced in the rods and cones activate the neighboring \_\_\_\_\_ cells, which then activate a

network of \_\_\_\_\_ cells. The axons of ganglion cells converge to form the \_\_\_\_\_, which carries the visual information to the \_\_\_\_\_.

- Where this nerve leaves the eye, there are no receptors; thus the area is called the \_\_\_\_\_.
- Most cones are clustered around the retina's point of central focus, called the \_\_\_\_\_, whereas the rods are concentrated in more \_\_\_\_\_ regions of the retina. Many cones have their own \_\_\_\_\_ cells to communicate with the visual cortex.
- It is the \_\_\_\_\_ (rods/cones) of the eye that permit the perception of color, whereas \_\_\_\_\_ (rods/cones) enable black-and-white vision.
- Unlike cones, in dim light the rods are \_\_\_\_\_ (sensitive/insensitive). Adapting to a darkened room will take **the retina** approximately \_\_\_\_\_ minutes.

**Objective 7:** Discuss the different levels of processing that occur as information travels from the retina to the brain's cortex.

- Visual information percolates through progressively more \_\_\_\_\_ levels. In the brain, it is routed by the \_\_\_\_\_ to higher-level brain areas. Hubel and Wiesel discovered that certain neurons in the \_\_\_\_\_ of the brain respond only to specific features of what is viewed. They called these neurons \_\_\_\_\_.
- Feature detectors pass their information to higher-level brain cells in the brain, including an area in the \_\_\_\_\_ cortex, which responds to specific visual scenes. Research has shown that in monkey brains such cells specialize in responding to a specific \_\_\_\_\_, \_\_\_\_\_, or \_\_\_\_\_.

Researchers have also identified nerve cells that may respond or not, depending on how a monkey \_\_\_\_\_ a given image.

**Objective 8:** Define *parallel processing*, and discuss its role in visual information processing.

17. The brain achieves its remarkable speed in visual perception by processing several subdivisions of a stimulus \_\_\_\_\_ (simultaneously/sequentially). This procedure, called \_\_\_\_\_, may explain why people who have suffered a stroke may lose just one aspect of vision. Other brain-damaged people may demonstrate \_\_\_\_\_ by responding to a stimulus that is not consciously perceived.
18. Once the distributed parts of the brain have processed sensory stimuli, EEG recordings reveal a moment of neural \_\_\_\_\_, lasting for about a fourth of a second and creating \_\_\_\_\_ waves. Other senses process information with \_\_\_\_\_ (similar/slower/faster) speed and intricacy.

**Objective 9:** Explain how the Young-Helmholtz and opponent-process theories help us understand color vision.

19. An object appears to be red in color because it \_\_\_\_\_ the long wavelengths of red and because of our mental \_\_\_\_\_ of the color.
20. One out of every 50 people is color deficient; this is usually a male because the defect is genetically \_\_\_\_\_.
21. According to the \_\_\_\_\_ theory, the eyes have three types of color receptors: one reacts most strongly to \_\_\_\_\_, one to \_\_\_\_\_, and one to \_\_\_\_\_. Mixing lights, as Young and von Helmholtz did, is \_\_\_\_\_ color mixing, unlike mixing paints, which is \_\_\_\_\_.
22. After staring at a green square for a while, you will see the color red, its \_\_\_\_\_ color, as an \_\_\_\_\_.

23. Hering's theory of color vision is called the \_\_\_\_\_ theory. According to this theory, after visual information leaves the receptors it is analyzed in terms of pairs of opposing colors: \_\_\_\_\_ versus \_\_\_\_\_, \_\_\_\_\_ versus \_\_\_\_\_, and also \_\_\_\_\_ versus \_\_\_\_\_.

Summarize the two stages of color processing.

**Objective 10:** Explain the importance of color constancy.

24. The experience of color depends on the \_\_\_\_\_ in which an object is seen.
25. In an unvarying context, a familiar object will be perceived as having consistent color, even as the light changes. This phenomenon is called \_\_\_\_\_.
26. We see color as a result of our brains' computations of the light \_\_\_\_\_ by any object relative to its \_\_\_\_\_.

**Hearing** (pp. 215–224)

If you do not know the meaning of any of the following words, phrases, or expressions in the context in which they appear in the text, refer to page 155 for an explanation: *sensitive to faint sounds, an obvious boon; A piccolo produces much shorter, faster sound waves than does a tuba; ear-lids; If a car to the right honks; cock your head; the culprits are . . . ear-splitting noise or music.*

**Objective 11:** Describe the pressure waves we experience as sound.

1. The stimulus for hearing, or \_\_\_\_\_, is sound waves, created by the compression and expansion of \_\_\_\_\_.
2. The amplitude of a sound wave determines the sound's \_\_\_\_\_.
3. The pitch of a sound is derived from the \_\_\_\_\_ of its wave.
4. Sound energy is measured in units called \_\_\_\_\_. The absolute threshold for hearing is arbitrarily defined as \_\_\_\_\_ such units.

**Objective 12:** Describe the three regions of the ear, and outline the series of events that triggers the electrical impulses sent to the brain.

5. The ear is divided into three main parts: the \_\_\_\_\_ ear, the \_\_\_\_\_ ear, and the \_\_\_\_\_ ear.
6. The outer ear channels sound waves toward the \_\_\_\_\_, a tight membrane that then vibrates.
7. The middle ear transmits the vibrations through a piston made of three small bones: the \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.
8. In the inner ear, a coiled tube called the \_\_\_\_\_ contains the receptor cells for hearing. The incoming vibrations cause the \_\_\_\_\_ to vibrate the fluid that fills the tube, which causes ripples in the \_\_\_\_\_. \_\_\_\_\_, which is lined with \_\_\_\_\_. This movement triggers impulses in adjacent nerve fibers that converge to form the auditory nerve, which carries the neural messages (via the \_\_\_\_\_) to the \_\_\_\_\_ lobe's auditory cortex. The brain interprets loudness from the \_\_\_\_\_ of hair cells a sound activates.

9. (Close-Up) On tasks requiring alert performance, people in noisy environments work \_\_\_\_\_ (more/less) efficiently. People who live in noisy environments suffer elevated rates of \_\_\_\_\_-related disorders such as \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_. Noise is especially stressful when it is \_\_\_\_\_ or \_\_\_\_\_.

**Objective 13:** Contrast place and frequency theories, and explain how they help us to understand pitch perception.

10. One theory of pitch perception proposes that different pitches activate different places on the cochlea's basilar membrane; this is the \_\_\_\_\_ theory. This theory has difficulty accounting for how we hear \_\_\_\_\_-pitched sounds, which do not have such localized effects.
11. A second theory proposes that neural impulses, sent to the brain at the same frequency as the sound wave, allow the perception of different pitches. This is the \_\_\_\_\_ theory. This theory fails to account for the perception of \_\_\_\_\_-pitched sounds, because individual neurons cannot fire faster than \_\_\_\_\_ times per second.
12. For the higher pitches, cells may alternate their firing to match the sound's frequency, according to the \_\_\_\_\_ principle.

**Objective 14:** Describe how we pinpoint sounds.

13. We locate a sound by sensing differences in the \_\_\_\_\_ and \_\_\_\_\_ with which it reaches our ears.
14. A sound that comes from directly ahead will be \_\_\_\_\_ (easier/harder) to locate than a sound that comes from off to one side.
15. As with visual information, the brain uses \_\_\_\_\_ as specialized neural teams work on different auditory tasks simultaneously.

**Objective 15:** Contrast the two types of hearing loss, and describe some of their causes.

16. Problems in the mechanical conduction of sound waves through the outer or middle ear may cause \_\_\_\_\_.
17. Damage to the cochlea's hair cell receptors or their associated auditory nerves can cause \_\_\_\_\_ hearing loss. It may be caused by disease, but more often it results from the biological changes linked with \_\_\_\_\_ and prolonged exposure to ear-splitting noise or music.
18. Scientists have discovered ways to \_\_\_\_\_ hair cell regeneration.

**Objective 16:** Describe how cochlear implants function, and explain why Deaf culture advocates object to these devices.

19. An electronic device that restores hearing among nerve-deafened people is a \_\_\_\_\_.
20. Advocates of \_\_\_\_\_ object to the use of these implants on \_\_\_\_\_ before they have learned to \_\_\_\_\_. The basis for their argument is that deafness is not a \_\_\_\_\_.
21. Sign language \_\_\_\_\_ (is/is not) a complete language, \_\_\_\_\_ (with/without) its own grammar, syntax, and semantics. Those who learn only sign language during childhood \_\_\_\_\_ (have/do not have) difficulty later learning to read and write. People who lose one channel of sensation (such as hearing) \_\_\_\_\_ (seem to/do not seem to) compensate with a slight enhancement in their other sensory abilities.
22. People who become deaf, or who lose another channel of sensation, often experience \_\_\_\_\_ in another ability.
23. (Close-Up) Deaf children raised in a household where sign language is used express higher \_\_\_\_\_ and feel more \_\_\_\_\_.

### Other Important Senses (pp. 224–235)

If you do not know the meaning of any of the following words, phrases, or expressions in the context in which they appear in the text, refer to pages 155–156 for an explanation: *we yearn to touch—to kiss, to stroke, to snuggle; Rubbing the area around your stubbed toe; Sometimes the pain in sprain is mainly in the brain; firewalking, . . . putting his feet where his mouth was; A well-trained nurse may distract needle-shy patients by chatting with them; there is more to taste than meets the tongue; bathing your nostrils in a stream of scent-laden molecules; Words more readily portray the sound of coffee brewing than its aroma; biological gyroscopes.*

**Objective 17:** Describe the sense of touch.

1. The sense of touch is a mixture of at least four senses: \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_. Other skin sensations, such as tickle, itch, hot, and wetness, are \_\_\_\_\_ of the basic ones.
2. The \_\_\_\_\_ influence on touch is illustrated by the fact that a self-produced tickle produces less activation in the \_\_\_\_\_ than someone else's tickle.

**Objective 18:** State the purpose of pain, and describe the biopsychosocial approach to pain.

3. People born without the ability to feel pain may be unaware of experiencing severe \_\_\_\_\_. People with illness-related \_\_\_\_\_ experience extreme sensitivity to things others find only mildly painful.
4. Pain is a property of the \_\_\_\_\_ as well as of the \_\_\_\_\_ and our \_\_\_\_\_.
5. A sensation of pain in an amputated leg is referred to as a \_\_\_\_\_ sensation. Another example is \_\_\_\_\_, experienced by people who have a ringing-in-the-ears sensation.

6. Pain-producing brain activity may be triggered with or without \_\_\_\_\_.
7. The pain system \_\_\_\_\_ (is/is not) triggered by one specific type of physical energy. The body \_\_\_\_\_ (does/does not) have specialized receptor cells for pain.
8. Melzack and Wall have proposed a theory of pain called the \_\_\_\_\_ theory, which proposes that there is a neurological \_\_\_\_\_ in the \_\_\_\_\_ that blocks pain signals or lets them through. It may be opened by activation of \_\_\_\_\_ (small/large) nerve fibers and closed by activation of \_\_\_\_\_ (small/large) fibers or by information from the \_\_\_\_\_.
9. Individual differences in perceiving pain are an example of \_\_\_\_\_ influences on pain. Such influences demonstrate that pain is not merely a \_\_\_\_\_ phenomenon, as proposed centuries ago by \_\_\_\_\_. Rather, pain is created by the \_\_\_\_\_.

List some pain control techniques used in the Lamaze method of prepared childbirth and in other health care situations.

**Objective 19:** Describe the sense of taste, and explain the principle of sensory interaction.

10. The basic taste sensations are \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, and a meaty taste called \_\_\_\_\_.
11. Taste, which is a \_\_\_\_\_ sense, is enabled by the 200 or more \_\_\_\_\_ on the top and sides of the tongue. Each contains a \_\_\_\_\_ that catches food chemicals.

12. Taste receptors reproduce themselves every \_\_\_\_\_ . As we age, the number of taste buds \_\_\_\_\_ (increases/decreases/remains unchanged) and our taste sensitivity \_\_\_\_\_ (increases/decreases/remains unchanged). Taste is also affected by \_\_\_\_\_ and by \_\_\_\_\_ use.
13. When the sense of smell is blocked, as when we have a cold, foods do not taste the same; this illustrates the principle of \_\_\_\_\_. The \_\_\_\_\_ effect occurs when we \_\_\_\_\_ a speaker saying one syllable while \_\_\_\_\_ another.

**Objective 20:** Describe the sense of smell, and explain why specific odors so easily trigger memories.

14. Like taste, smell, or \_\_\_\_\_, is a \_\_\_\_\_ sense. Unlike light, an odor \_\_\_\_\_ (can/cannot) be separated into more elemental odors.
15. The ability to identify scents peaks in \_\_\_\_\_ and declines thereafter.
16. The attractiveness of smells depends on \_\_\_\_\_ associations.
17. Odors are able to evoke memories and feelings because there is a direct link between the brain area that gets information from the nose and the ancient \_\_\_\_\_ centers associated with memory and emotion.

**Objective 21:** Distinguish between kinesthesia and the vestibular sense.

18. The system for sensing the position and movement of body parts is called \_\_\_\_\_. The receptors for this sense are located in the \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_ of the body.
19. The sense that monitors the position and movement of the head (and thus the body) is the \_\_\_\_\_.