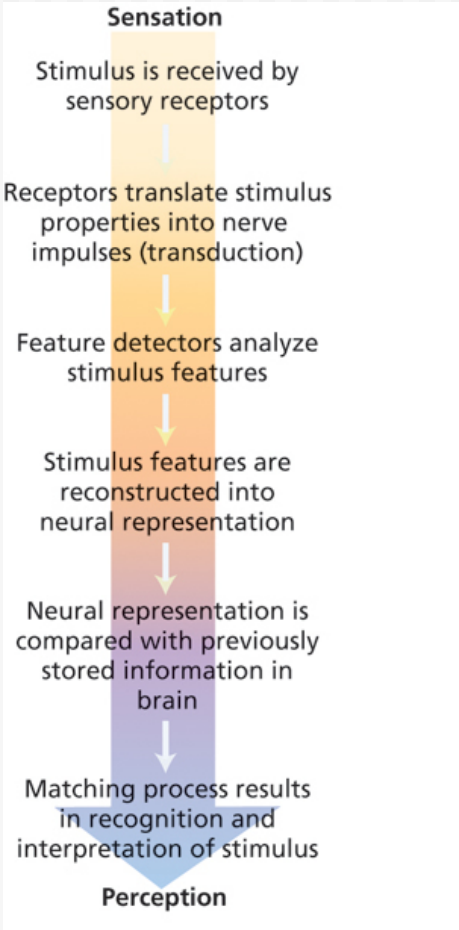
Chapter Four

Sensation and Perception

Sensation and Perception

- Sensation: the stimulus-detection process by which our sense organs respond to and translate environmental stimuli into nerve impulses that are sent to the brain
- Perception: making "sense" of what our senses tell us
  - This is the active process of organizing the stimulus output and giving it meaning

Sensation and Perception



Sensory Processes

- Sensory systems are designed to extract from the environment the information that we need to function and survive
- Psychophysics: the scientific area that studies relations between the physical characteristics of stimuli and sensory capabilities
  - Absolute limits of sensitivity
  - Differences between stimuli

Stimulus Detection

- Absolute Threshold: the lowest intensity at which a stimulus can be detected 50% of the time

TABLE 5.1 Some Approximate Absolute Thresholds for Humans

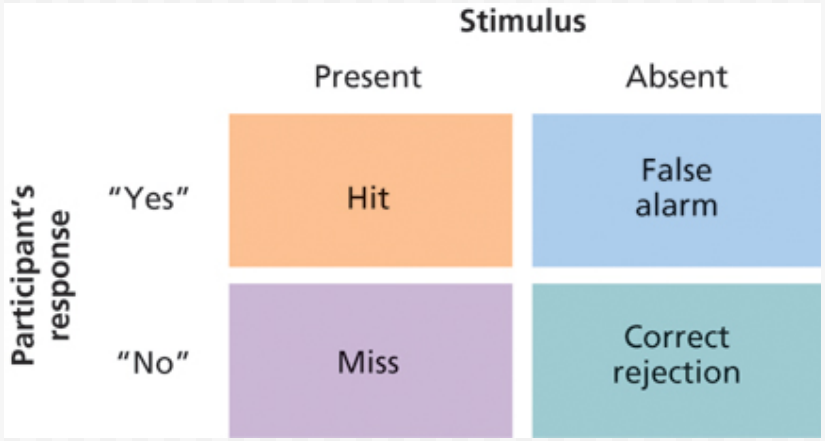
Sensory Modality	Absolute Threshold
Vision	Candle flame seen at 30 miles on a clear, dark night
Hearing	Tick of a watch under quiet conditions at 20 feet
Taste	1 teaspoon of sugar in 2 gallons of water
Smell	1 drop of perfume diffused into the entire volume of a large apartment
Touch	Wing of a fly or bee falling on a person's cheek from a distance of 1 centimeter

SOURCE: Based on Galanter, 1962.

Stimulus Detection

- An individual's sensitivity can fluxuate
- Decision Criterion: a standard of how certain they must be that a stimulus is present before they will say they detect it
- Signal Detection Theory: concerned with the factors that influence sensory judgments
  - Depends on factors such as fatigue, expectation, and significance of the stimulus

Stimulus Detection



Stimulus Detection

- At low stimulus intensities, both the participant's and the situation's characteristics influence the decision criterion
  - Increasing rewards for hits or costs for misses results in lower detection thresholds
  - Increasing costs for false alarms results in higher detection thresholds

Subliminal Stimuli

- Subliminal Stimulus: one that is so weak or brief that although it is received by the senses, it cannot be perceived consciously
  - Can have subtle effect on perceptions and attitudes
  - Persuasive stimuli above the perceptual threshold are far more influential

The Difference Threshold

- Difference Threshold: smallest difference between two stimuli that people can perceive 50% of the time
  - Just Noticeable Difference
- Weber's Law: the difference threshold is directly proportional to the magnitude of the stimulus with which the comparison is being made

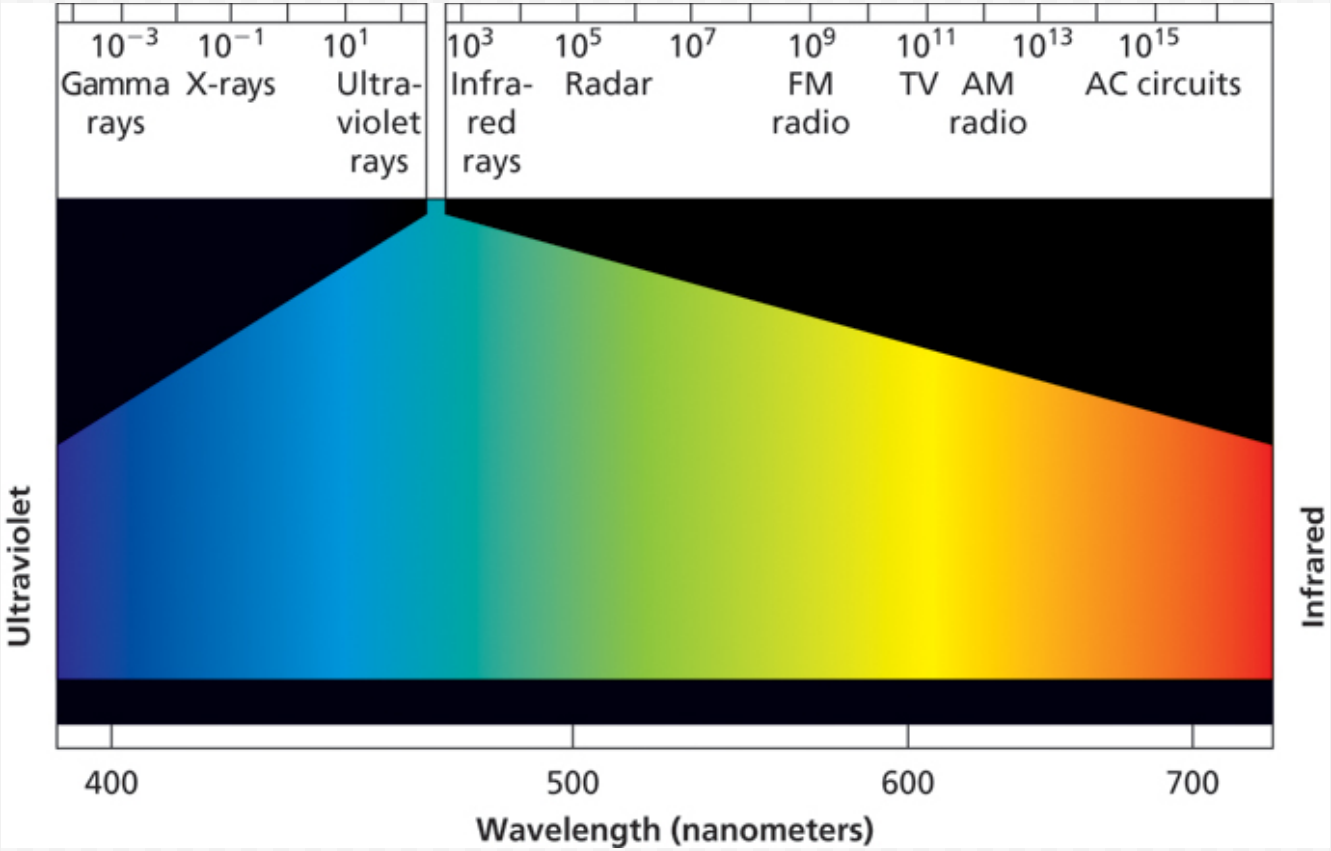
Sensory Adaptation

- Sensory Adaptation: the diminishing sensitivity to an unchanging stimulus
  - Occurs in all senses
  - Adaptive - allows our senses to pick up informative changes in the environment that could be important to our survival

The Sensory Systems

- Transduction: the process whereby the characteristics of a stimulus are converted into nerve impulses
- Vision:
  - Stimulus is electromagnetic energy (light waves)
  - Sensitive to wavelengths from about 400 to 700 nanometers

The Sensory Systems



Vision

- Light waves enter the eye through the *cornea*
- Pupil: an adjustable opening behind the cornea that controls the amount of light that enters the eye
  - Dilates or constricts using muscles in the *iris*, the colored part that surrounds the pupil

Vision

- Lens: an elastic structure that becomes thinner to focus on distant objects and thicker to focus on nearby objects
  - Lens focuses the visual image on the retina
- Retina: a multilayered light-sensitive tissue at the rear of the fluid-filled eyeball
  - Contains two types of light-sensitive receptor cells - *rods* and *cones*

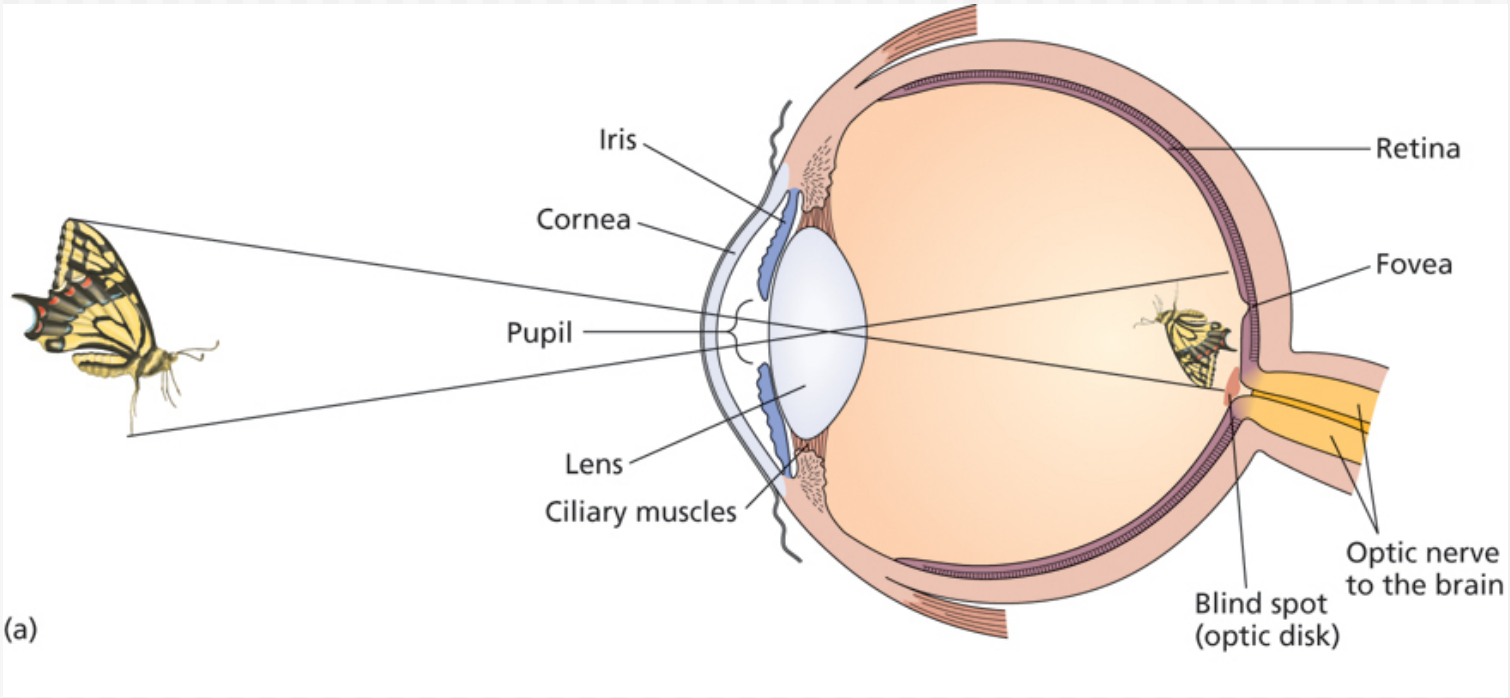
Vision

- Rods: primarily black-and-white brightness receptors
  - Function best in dim light
- Cones: color receptors
  - Function best in bright illumination
- Fovea: a small area in the center of the retina that contains no rods but many densely packed cones
  - Cones decrease in concentration the farther they are from the center of the retina

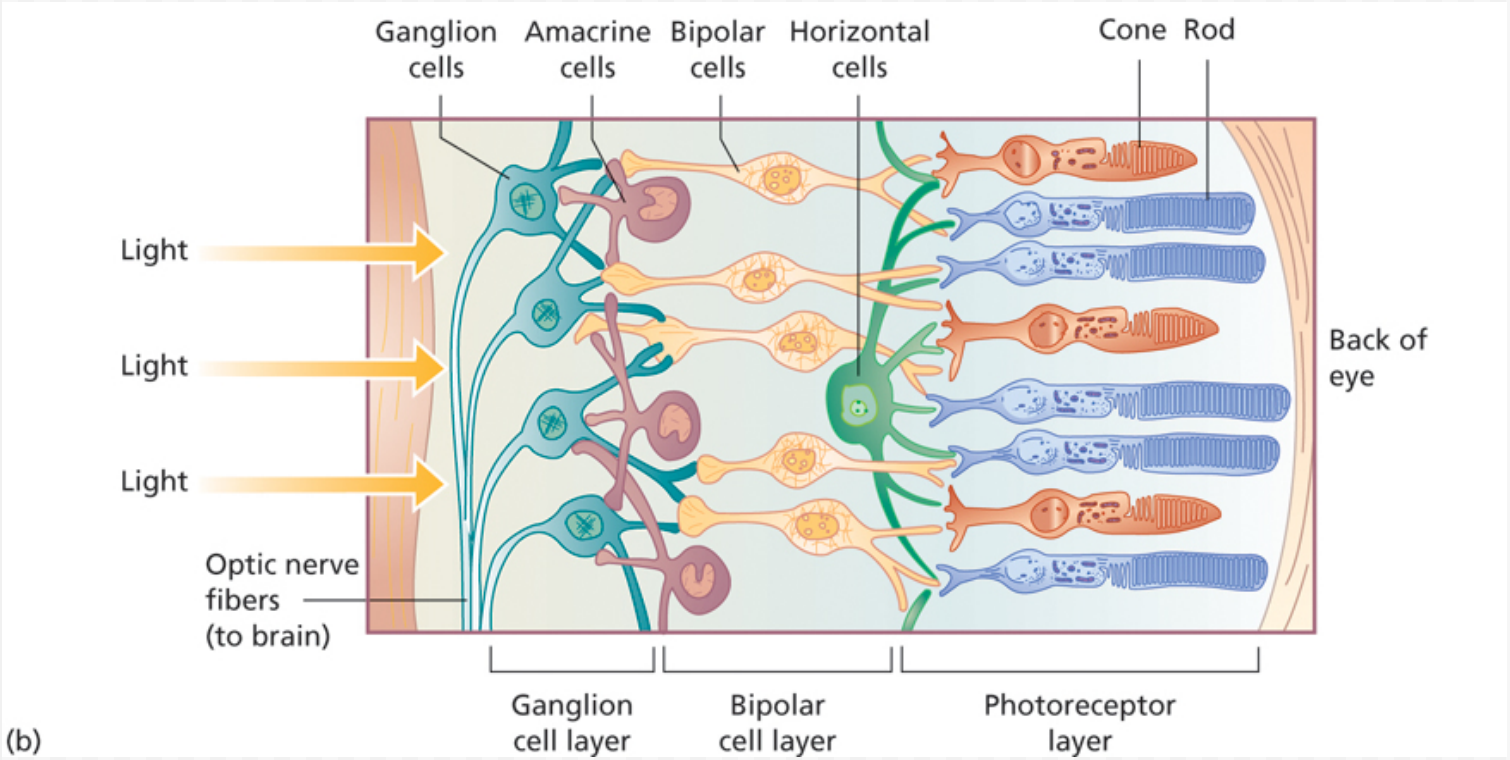
Vision

- Rods and cones have synaptic connections with *bipolar cells*
  - Bipolar cells are connected to *ganglion cells*
  - Axons of ganglion cells are collected into a bundle, which forms the optic nerve
- An absence of photoreceptors where the optic nerve exits the eye creates a *blind spot*

Vision



Vision



Vision

- The Visual Process:
  - Lens reverses image from right to left, top to bottom on retina
  - Activity of photoreceptors and associated neurons sends input into the brain
  - Brain reconstructs visual input in the correct direction

Vision

- Myopia (nearsightedness)
  - Visual image is focused in front of retina (or too near lens)
  - Occurs because the eyeball is longer than normal
- Hyperopia (farsightedness)
  - Image is focused behind retina (or too far from lens)

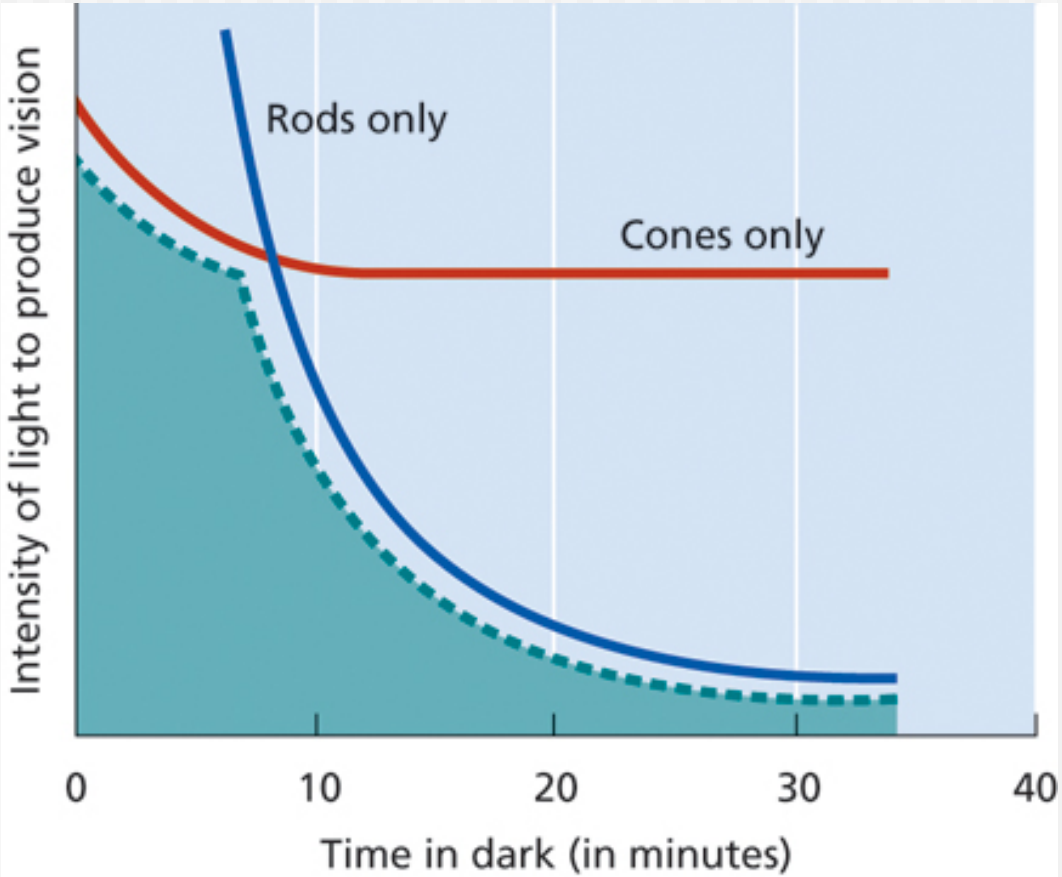
Vision

- Photopigments: protein molecules that allow rods and cones to translate light waves into nerve impulses
  - Produces a chemical reaction that changes the rate of neurotransmitter release

Vision

- Dark Adaptation: the progressive improvement in brightness sensitivity that occurs over time under conditions of low illumination
  - Regeneration of photopigment molecules

Vision

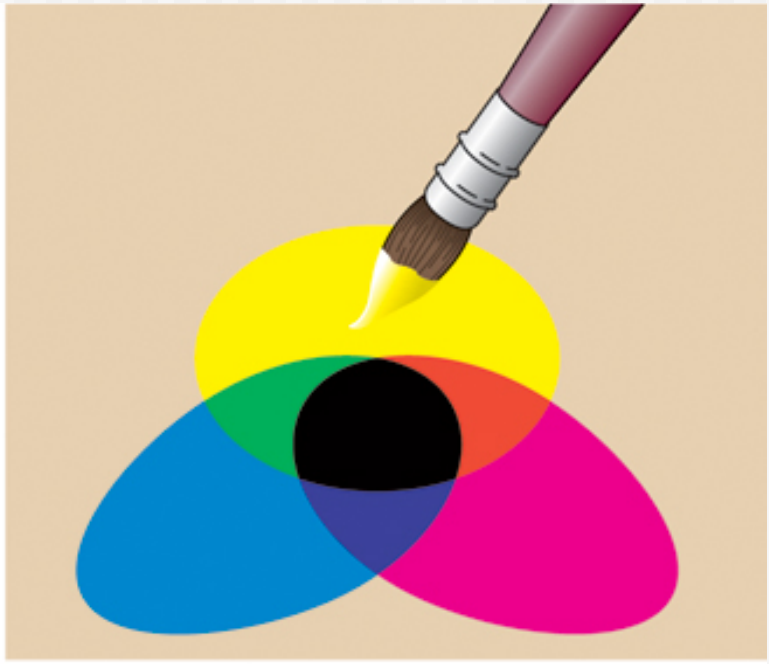


Vision

- Color mixture:
  - Additive: involves additive mixture of wavelengths in light focused on a white surface
    - Blue, green, and red
  - Subtractive: occurs by subtracting or absorbing particular wavelengths
    - Blue, yellow, and red

Vision

(a)

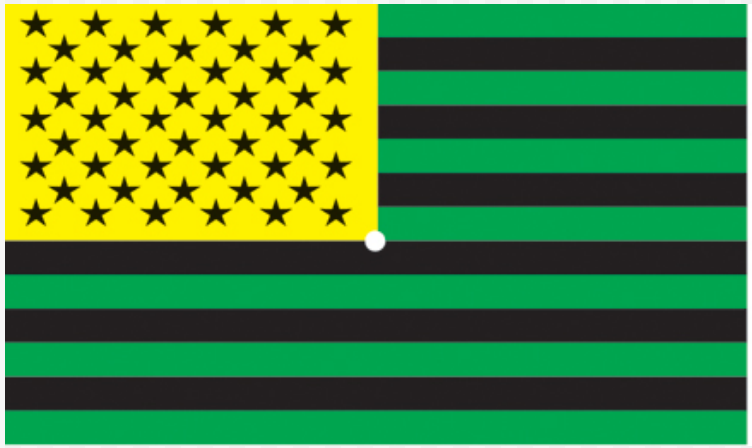


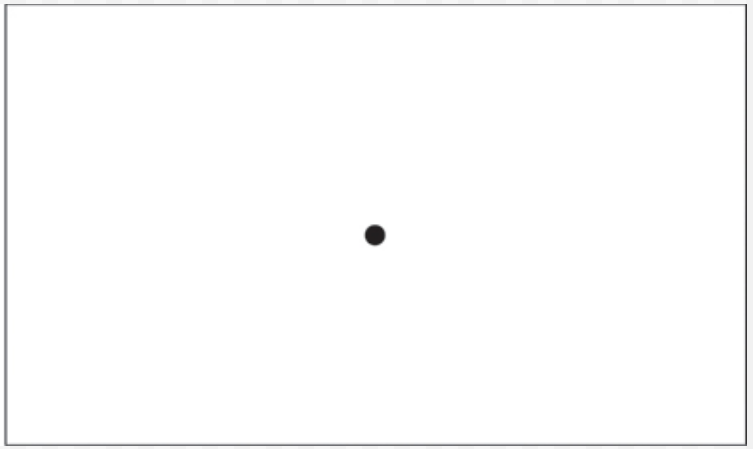
(b)

Vision

- Two theories of color vision:
  - Young-Helmholtz Trichromatic Theory: Cones are most sensitive to wavelengths corresponding to blue, green, and red
    - Problem with the perception of the color yellow
    - Problem with color afterimages

Vision

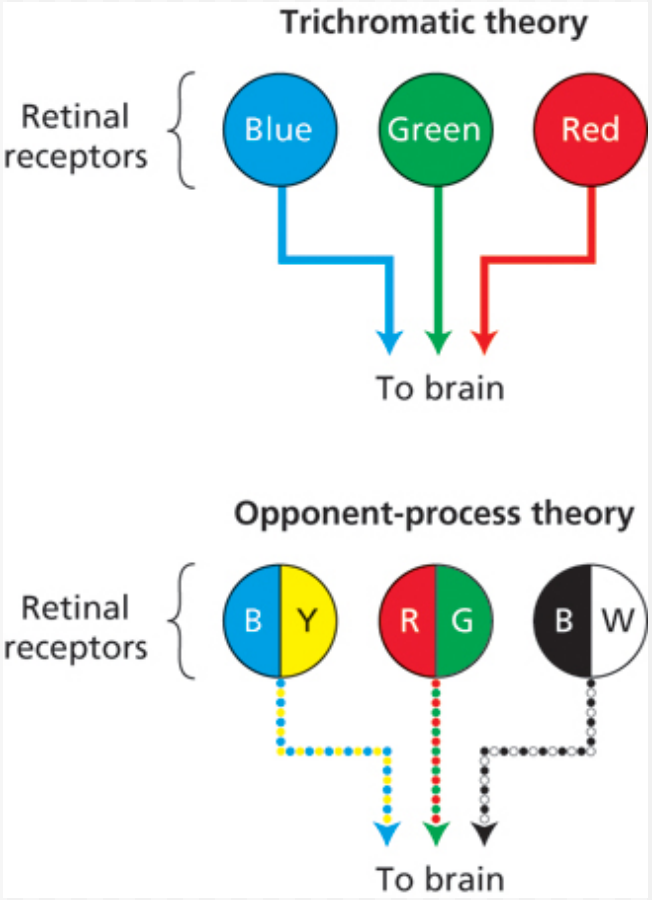




Vision

- Opponent-Process Theory: Three types of cones respond to two wavelengths
  - Red-green
  - Blue-yellow
  - Black-white

Vision



Vision

- Dual-Process Theory: combines trichromatic and opponent-process theories to account for the color transduction process
  - Trichromatic: cones are most sensitive to blue, green and red
  - Opponent processes begin in ganglion cells and beyond (not the cones)

Vision

- Color-Deficient Vision:
  - *Trichromats:* people with normal color vision
    - Sensitive to all three systems
  - *Dichromat:* people who are color-blind in one of the three systems
  - *Monochromat:* people who are completely color-blind
    - Sensitive only to the black-white system

Vision

Vision

- Analysis and reconstruction:
  - From the retina, the optic nerve sends messages to thalamus
  - Input is routed to the primary visual cortex in the occipital lobe
  - Feature Detectors: cells within the primary visual cortex that fire selectively in response to visual stimuli that have specific characteristics
  - Visual association cortex combines and interprets information

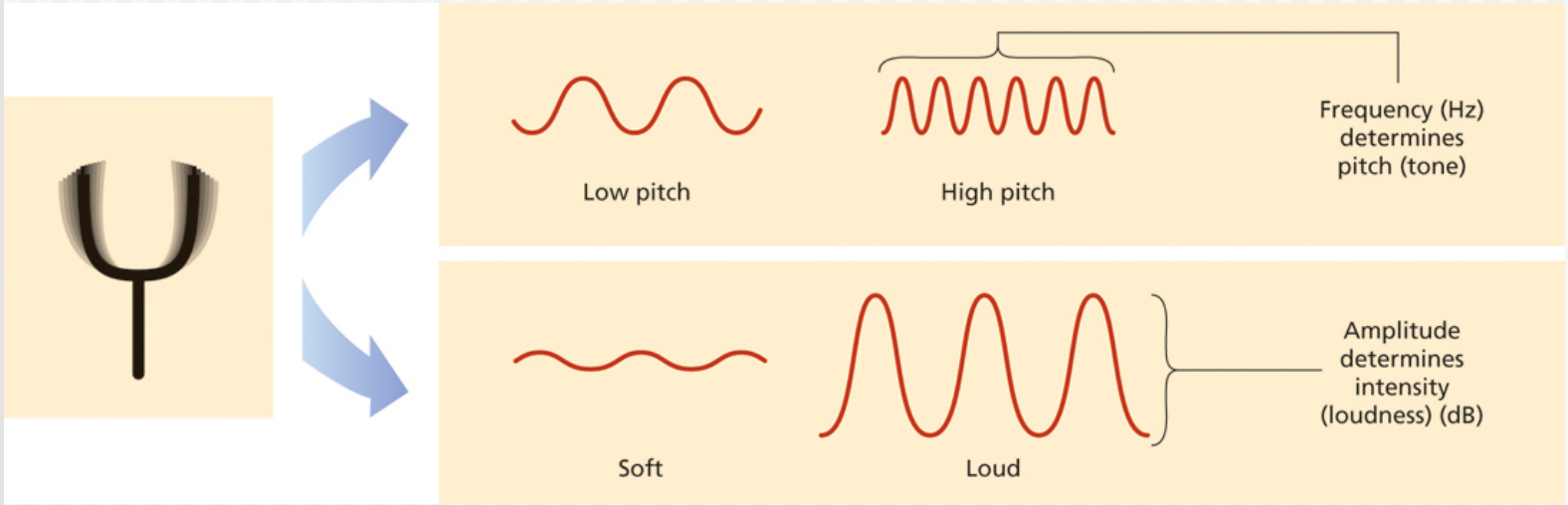
Audition

- Stimuli for hearing are sound waves
  - Two characteristics: frequency and amplitude
- Frequency: the number of sound waves, or cycles, per second
  - Hertz: the technical measure of cycles per second; 1 Hz = 1 cycle/second
  - Humans can detect sound frequencies from 20 to 20,000 Hz

Audition

- Amplitude: the vertical size of the sound waves (the amount of compression and expansion of the molecules in the conducting medium
  - Decibels (dB): a measure of the physical pressures that occur at the eardrum

Audition



Audition

- Auditory Transduction:
  - Sound waves travel to *eardrum*
    - Eardrum vibrates in response
  - *Middle ear* houses three bones: *hammer, anvil,* and *stirrup*
    - Vibrating activity of these bones amplifies sound waves
    - Stirrup is attached to the *oval window*, which is the boundary between the middle ear and the inner ear

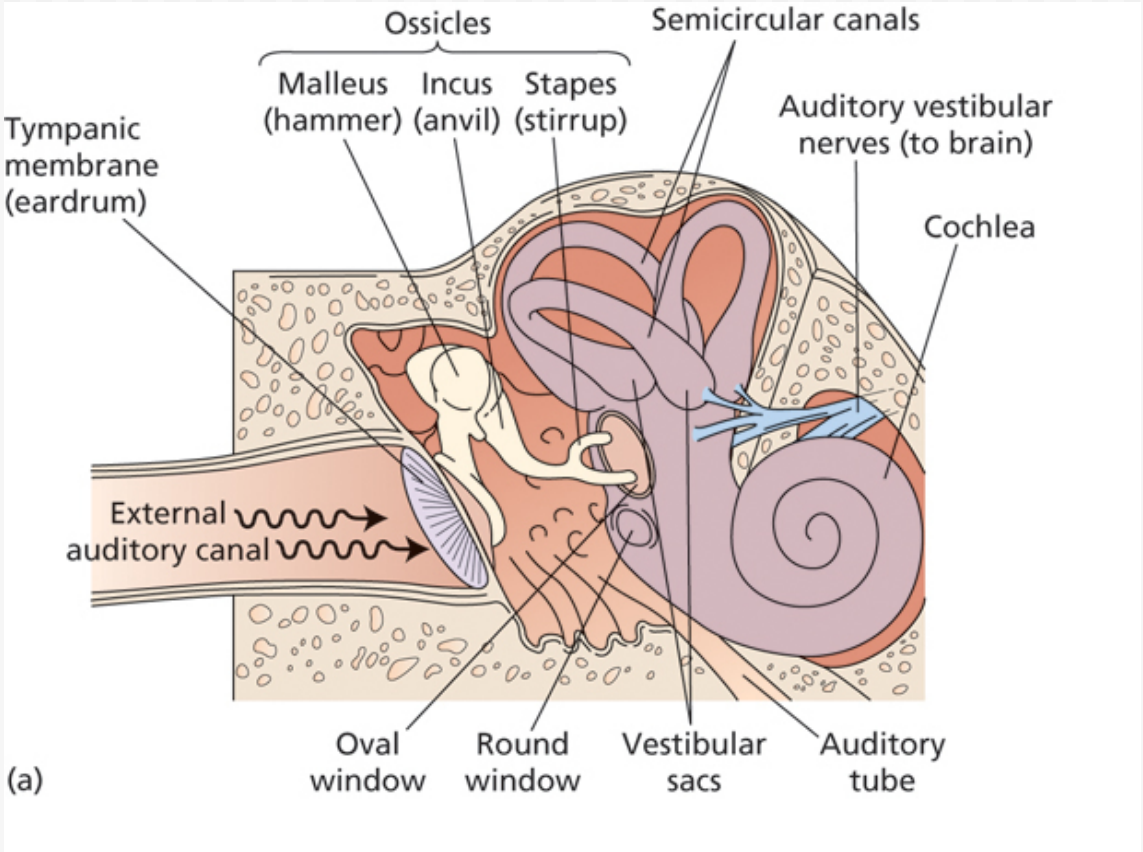
Audition

- Auditory Transduction (continued):
  - Inner ear contains the *cochlea*, which is a coiled, fluid-filled tube
    - *Basilar membrane:* a sheet of tissue that runs the length of the cochlea
    - *Organ of Corti* rests on the basilar membrane; contains thousands of tiny hair cells that are the actual sound receptors

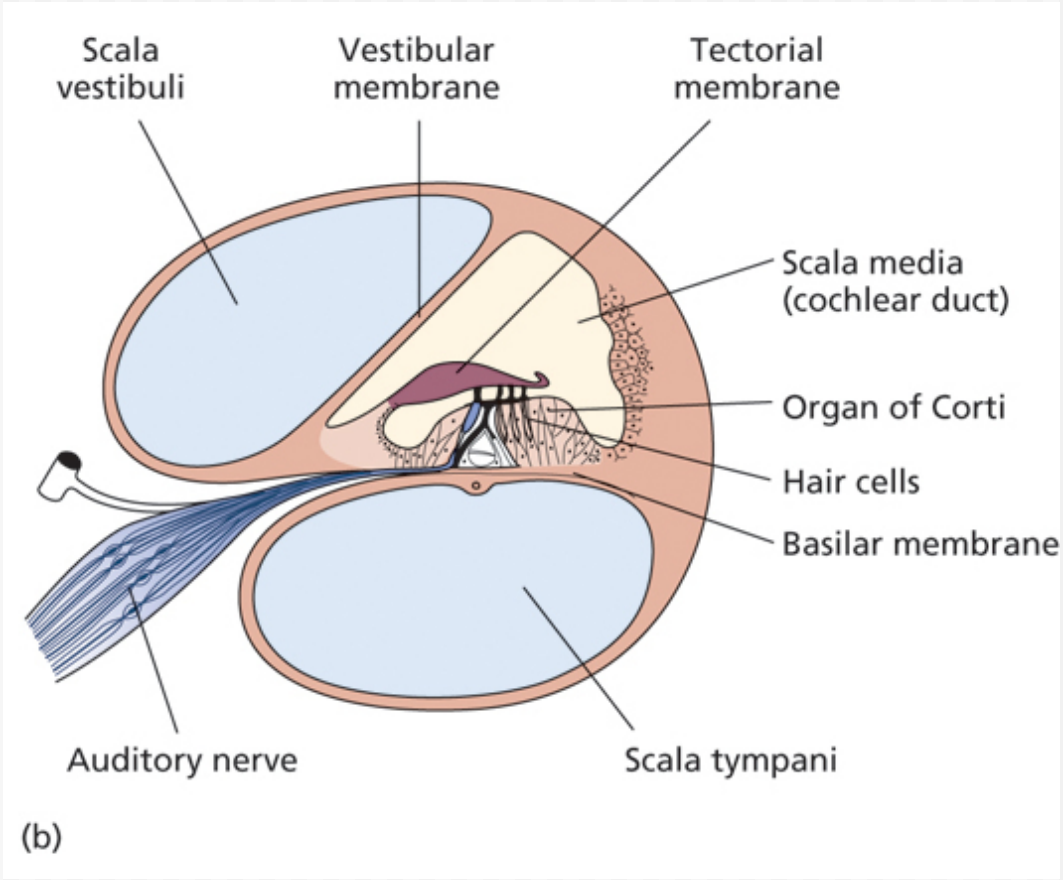
Audition

- Auditory Transduction (continued):
  - Pressure created at oval window by vibrating middle ear bones sets cochlea in motion
  - Fluid waves vibrate basilar membrane
  - Hair cells in organ of Corti bend; triggers the release of neurotransmitters
    - nerve impulses are sent to the brain
  - Detector neurons in the auditory cortex respond to specific auditory input

Audition



Audition



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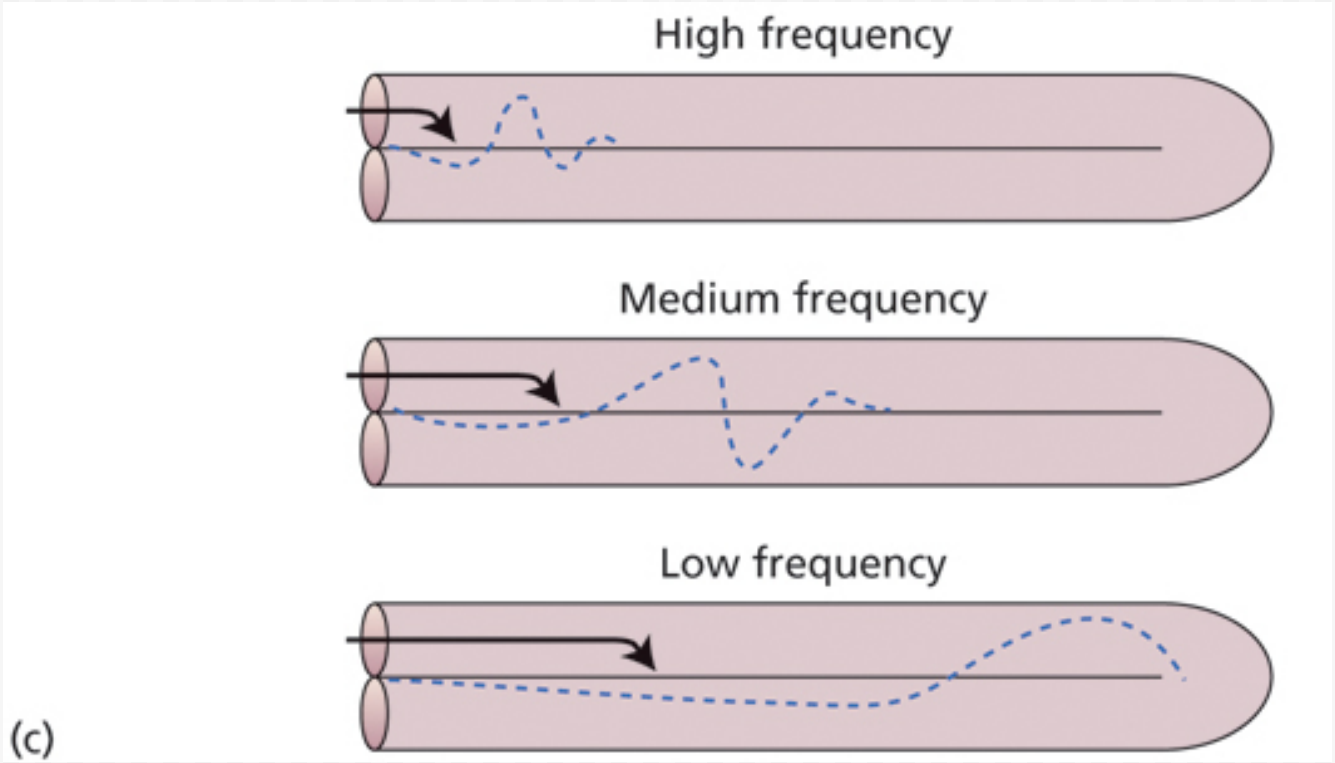

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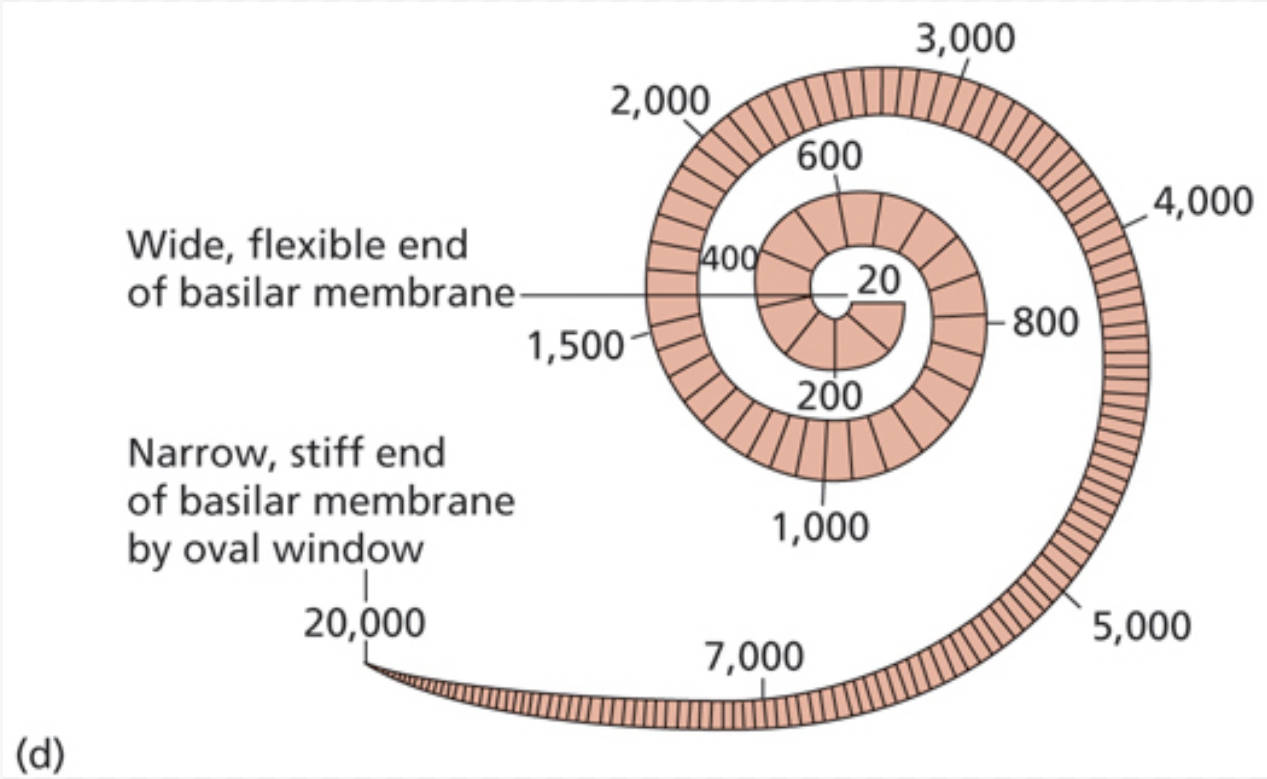


Audition

- Auditory system transforms wave amplitude and frequency into nerve impulses
- Intensity:
  - High-amplitude sound waves cause hair cells to bend more
    - Releases more neurotransmitters and causes the nerve to fire more frequently
  - Some receptor neurons have higher thresholds than others

Audition

- Pitch:
  - Frequency Theory of Pitch Perception: nerve impulses sent to the brain match the frequency of the sound wave
    - Only works up to 1,000 Hz
  - Place Theory of Pitch Perception: the specific point in the cochlea where the fluid wave peaks and most strongly bends the hair cells serves as a frequency coding cue
    - Allows us to hear pitches higher than 1,000 Hz

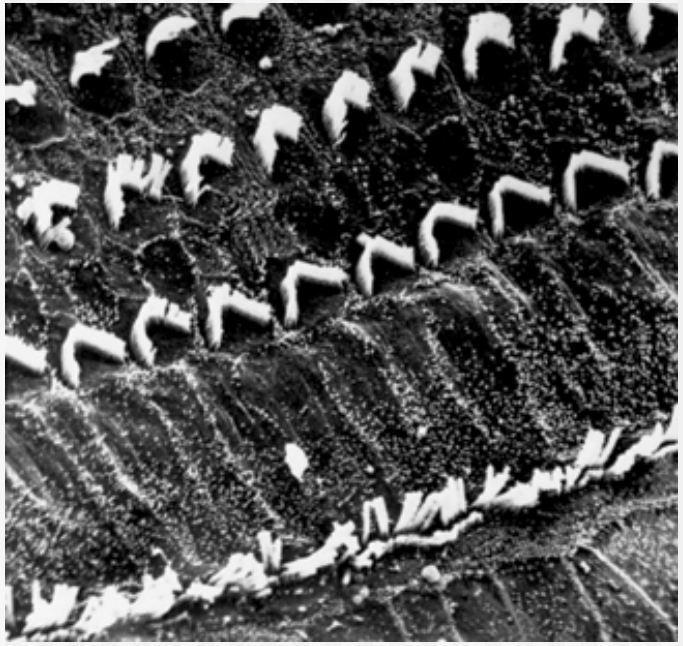
Audition

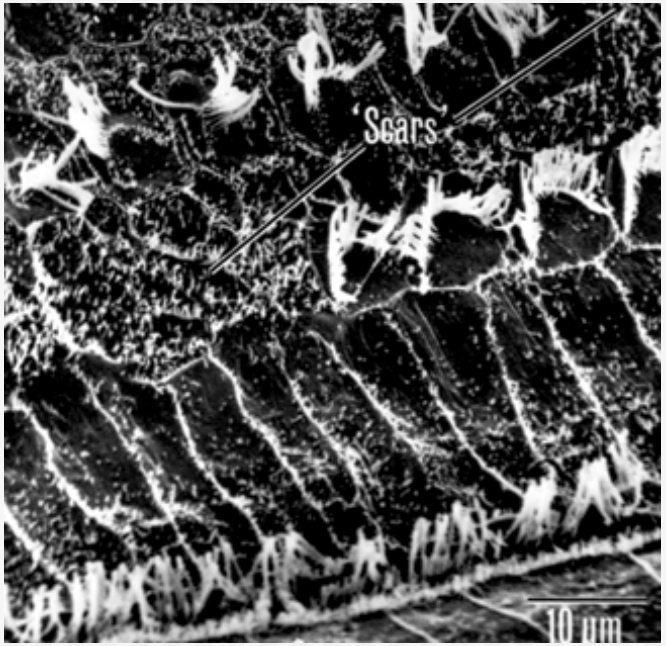
- Sound Localization:
  - Nervous system uses time and intensity differences of sounds arriving at the two ears to locate sounds
    - Sound will be perceived first and loudest by the closest ear
    - Our ability to localize sounds is very sensitive

Audition

- Two types of hearing loss:
  - Conduction Deafness: problems with the mechanical system that transmits sound waves to the cochlea
    - Can be helped with hearing aids
  - Nerve Deafness: caused by damaged receptors within the inner ear or damage to the auditory nerve itself
    - Does not respond to hearing aids
    - Caused by aging, disease, loud sounds

Audition

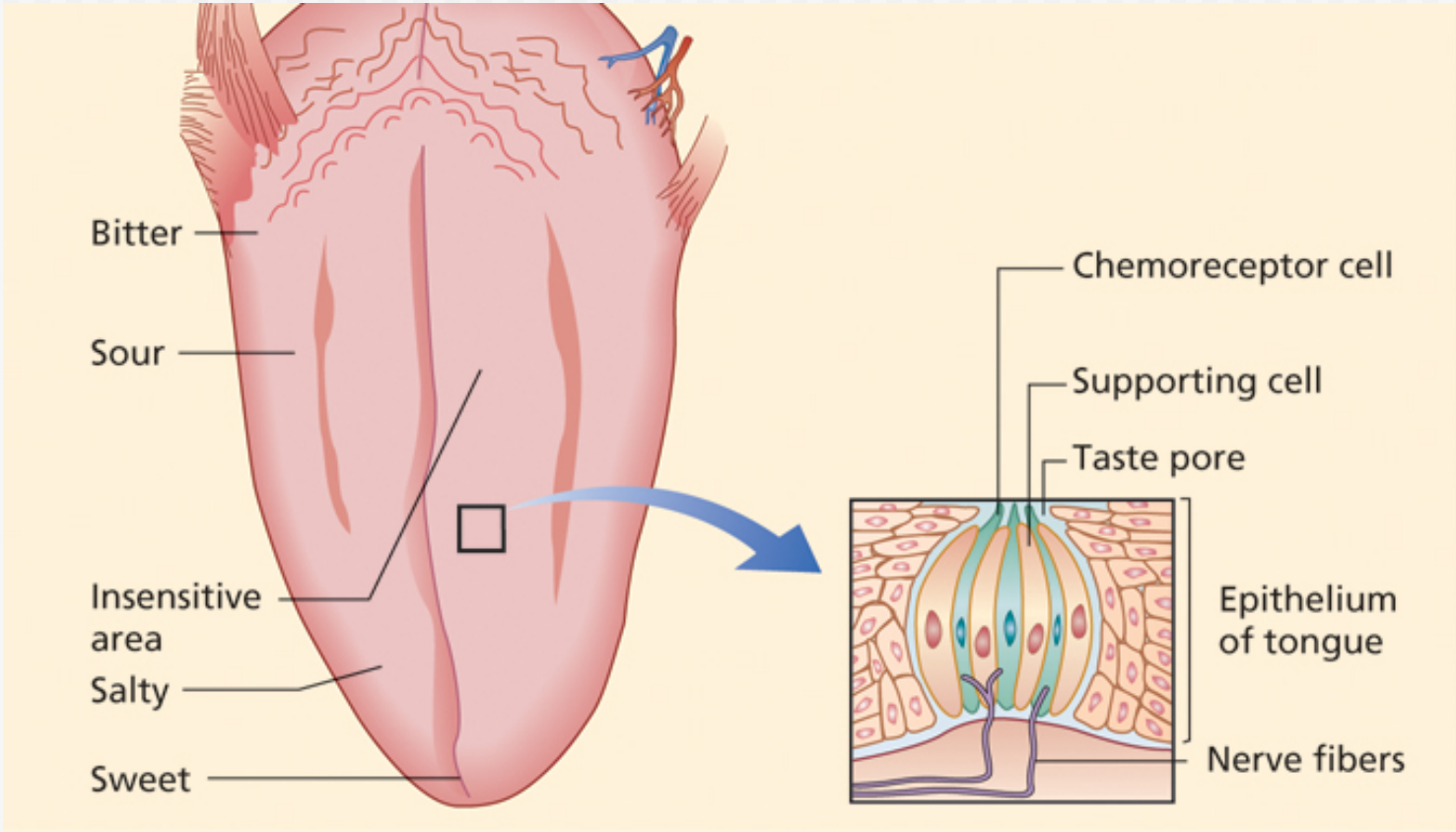




Taste and Smell

- Gustation: the sense of taste
  - Responds to only four qualities: sweet, sour, salty, and bitter
- Taste Buds: chemical receptors concentrated along the tip, edges, and back surface of the tongue
  - *Umani:* a taste sensation that increases the intensity of other taste qualities
  - Humans have about 9,000 taste buds

Taste and Smell



Taste and Smell

- "Taste" results from complex patterns of neural activity produced by taste buds
- Provides pleasure
- Has adaptive significance
  - Discrimination between nutrients and toxins
    - Poisons tend to have bitter tastes
    - High-calorie foods tend to have sweeter tastes

Taste and Smell

- Olfaction: sense of smell
  - Receptors are long cells that project through the nasal cavity and into the mucous membrane
    - Humans have about 40 million olfactory receptors
  - Olfactory Bulb: a forebrain structure immediately above the nasal cavity
    - Receptors send input to the olfactory bulb, which codes the various odors

Taste and Smell

- Influence of smell on behavior is stronger in animals than humans
- Pheromones: chemical signals found in natural body scents
  - May have a subtle influence on our behavior
- Menstrual Synchrony: the tendency of women who live together or are close friends to become more similar in their menstrual cycles

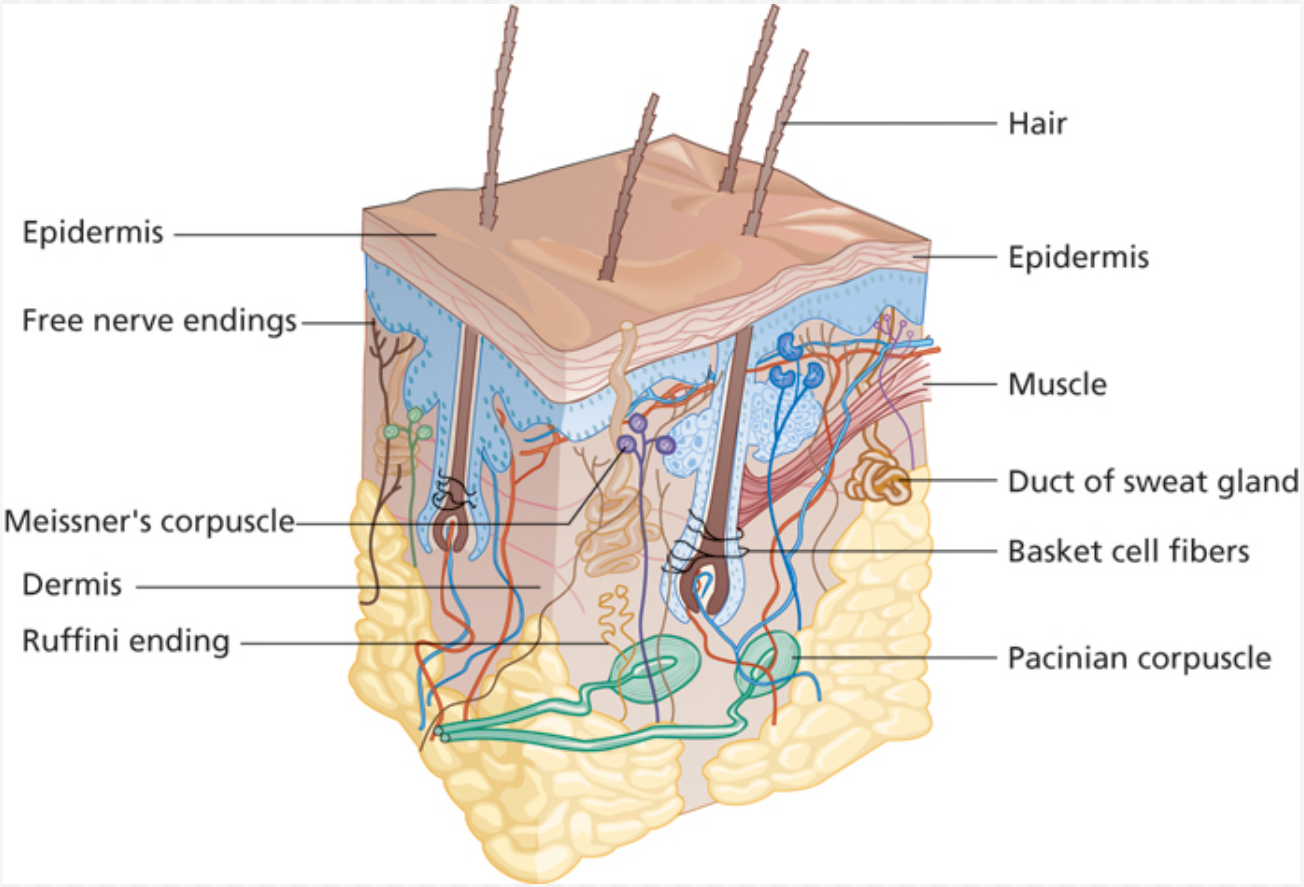
The Skin and Body Senses

- Importance of Touch:
  - Allows us to escape external danger
  - Alerts us to disorders within our body
  - Source of pleasure
- Humans are sensitive to four tactile sensations:
  - Pressure (touch), pain, warmth, cold
  - Conveyed by receptors in the skin and in our internal organs

The Skin and Body Senses

- The Skin:
  - Multilayered elastic structure
  - Contains a variety of receptor structures
    - *Free Nerve Endings:* primary receptors for pain and temperature
    - *Basket Cell Fibers:* receptors for touch and light pressure
  - Skin receptors send messages to the corresponding point in the somatosensory cortex

The Skin and Body Senses



The Skin and Body Senses

- *Phantom Limb:* amputees experience vivid sensations coming from the missing limb
  - Irritation of nerves fools the brain

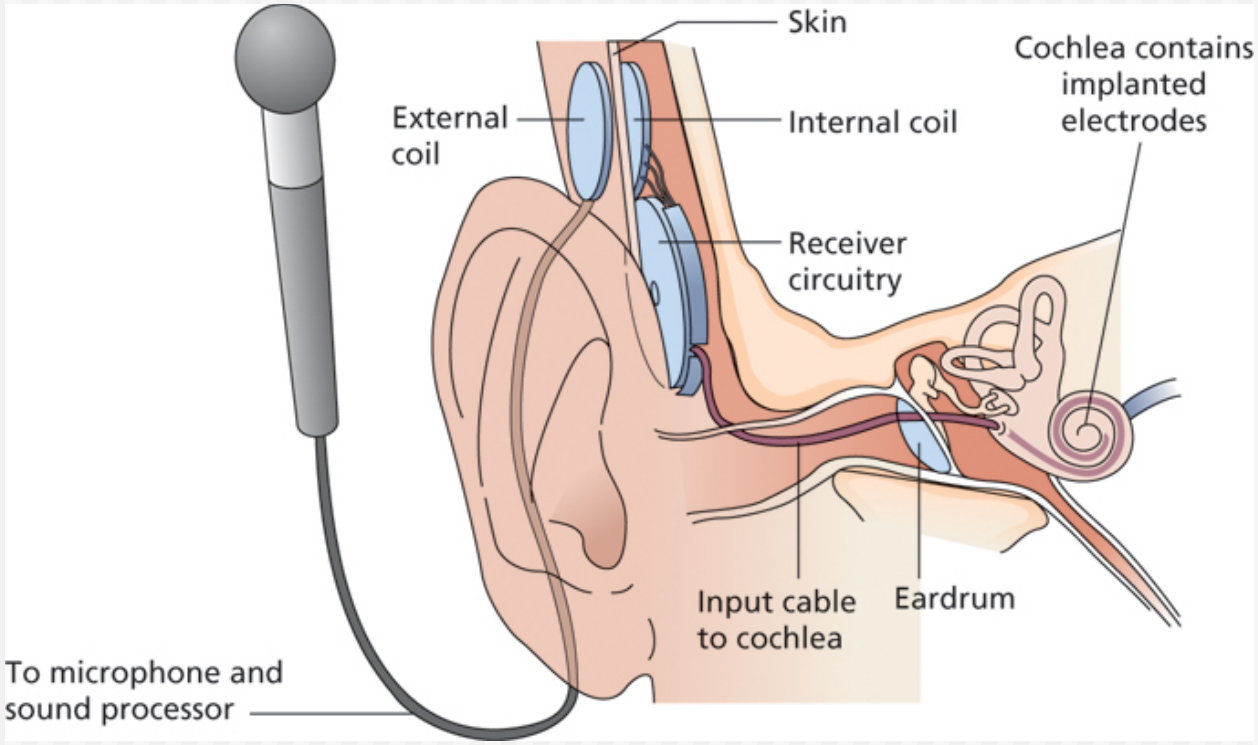
The Skin and Body Senses

- Kinesthesis: provides us with feedback about our muscles' and joints' positions and movements
  - Nerve endings in the muscles, tendons, and joints
- Vestibular Sense: the sense of body orientation, or equilibrium
  - Receptors are located in the inner ear

Sensory Prosthetics

- Sensory Prosthetic Devices: provide sensory input that can, to some extent, substitute for what cannot be supplied by the person's sensory receptors
  - seeing with ears and tongue, cortical and cochlear implants

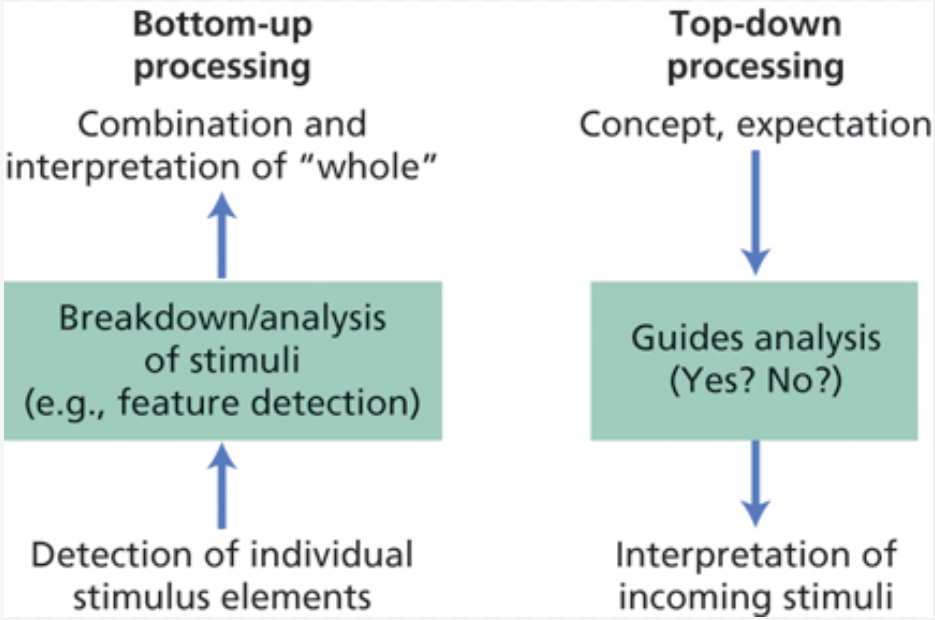
Sensory Prosthetics



Perception

- Perception is an active, creative process in which raw sensory data are organized and given meaning
- Bottom-up Processing: the system takes in individual elements of the stimulus and then combines them into a unified perception
- Top-down Processing: sensory information is interpreted in light of existing knowledge, concepts, ideas, and expectations

Perception



The Role of Attention

- Attention involves two processes:
  - Focusing on certain stimuli
  - Filtering out other incoming information
- Studied experimentally using *shadowing*
- Inattentional Blindness: the failure of unattended stimuli to register in consciousness

The Role of Attention

- Stimulus characteristics that affect attention:
  - Intensity
  - Novelty
  - Movement
  - Contrast
  - Repetition

The Role of Attention

- Personal factors that affect attention:
  - Motives
  - Interests
  - Threats to well-being
    - Participants are faster at finding a single angry face in a happy crowd than a single happy face in an angry crowd

Organization and Structure

- Gestalt Principles: argues that the whole is more than (and different from) the sum of its parts
- Figure-Ground Relations: our tendency to organize stimuli into a central or foreground figure and a background

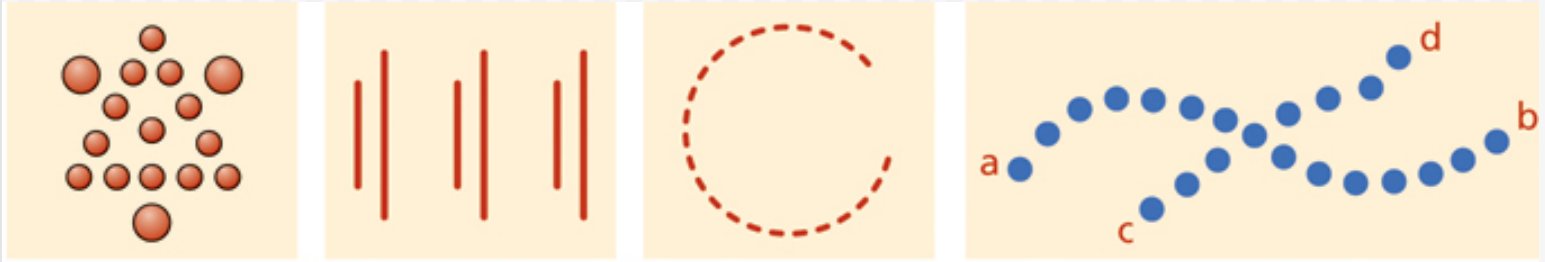
Organization and Structure

Organization and Structure

Organization and Structure

- Gestalt Laws of Perceptual Organization:
  - *Law of Similarity:* similar elements will be perceived as belonging together
  - *Law of Proximity:* elements that are near each other are likely to be perceived as part of the same configuration
  - *Law of Closure:* people tend to fill in gaps in incomplete figures
  - *Law of Continuity:* people link individual elements together to form a pattern that makes sense

Organization and Structure



(a) Similarity (b) Proximity (c) Closure (d) Continuity

Perception

- Perceptual Schema: a mental representation or image containing the critical and distinctive features of a person, object, event, or other perceptual phenomenon
  - Schemas provide mental templates that allow us to identify and classify sensory input
  - Each of our perceptions is essentially a hypothesis about the meaning of the sensory information

Perception

- Perceptual Set: a readiness to perceive stimuli in a particular way
- Perceptual Constancies: allow us to recognize familiar stimuli under varying conditions
  - *Shape Constancy:* allows us to recognize people and other objects from many different angles

Perception

- Perceptual Constancies (continued):
  - *Brightness Constancy:* relative brightness of objects remains the same under different conditions of illumination
  - *Size Constancy:* the size of objects remains relatively constant even though images on our retina change in size with variations in distance

Perception

Perception

- Monocular Depth Cues: cues which require only one eye
  - Patterns of light and shadow
  - *Linear perspective:* the perception that parallel lines converge in the distance
  - *Interposition:* objects closer to us may cut off part of our view of more distant objects
  - Height in the horizontal plane

Perception

- Monocular Depth Cues (continued):
  - Texture
  - *Clarity:* clear objects are judged to be closer
  - *Relative Size:* if two objects are of similar size, the one that looks smaller will be judged to be farther away
  - *Motion Parallax:* if we are moving, nearby objects appear to move faster than faraway ones

Perception

- Binocular Depth Cues: require the use of both eyes
  - *Binocular Disparity:* each eye sees a slightly different image
  - *Convergence:* produced by feedback from the muscles that turn your eyes inward to view a close object

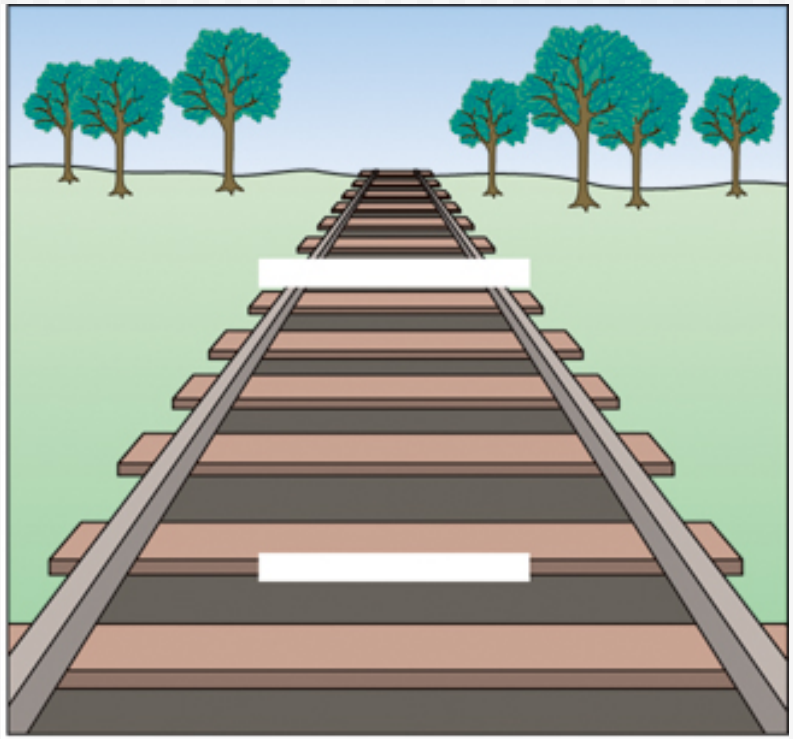
Perception

- Perception of Movement:
  - Primary cue for perceiving motion is the movement of the stimulus across the retina
  - Stroboscopic Movement: illusory movement produced when a light is briefly flashed in darkness and then, a few milliseconds later, another light is flashed nearby
    - Principle behind motion pictures

Perceptual Illusions

- Illusions: compelling but incorrect perceptions
  - Most can be attributed to perceptual constancies that ordinarily help us perceive more accurately

Perceptual Illusions



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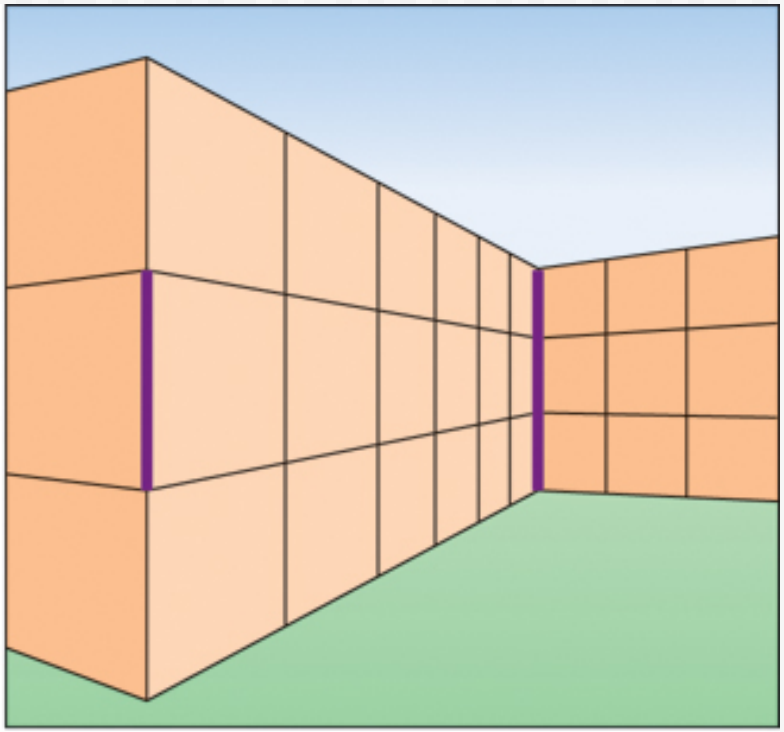
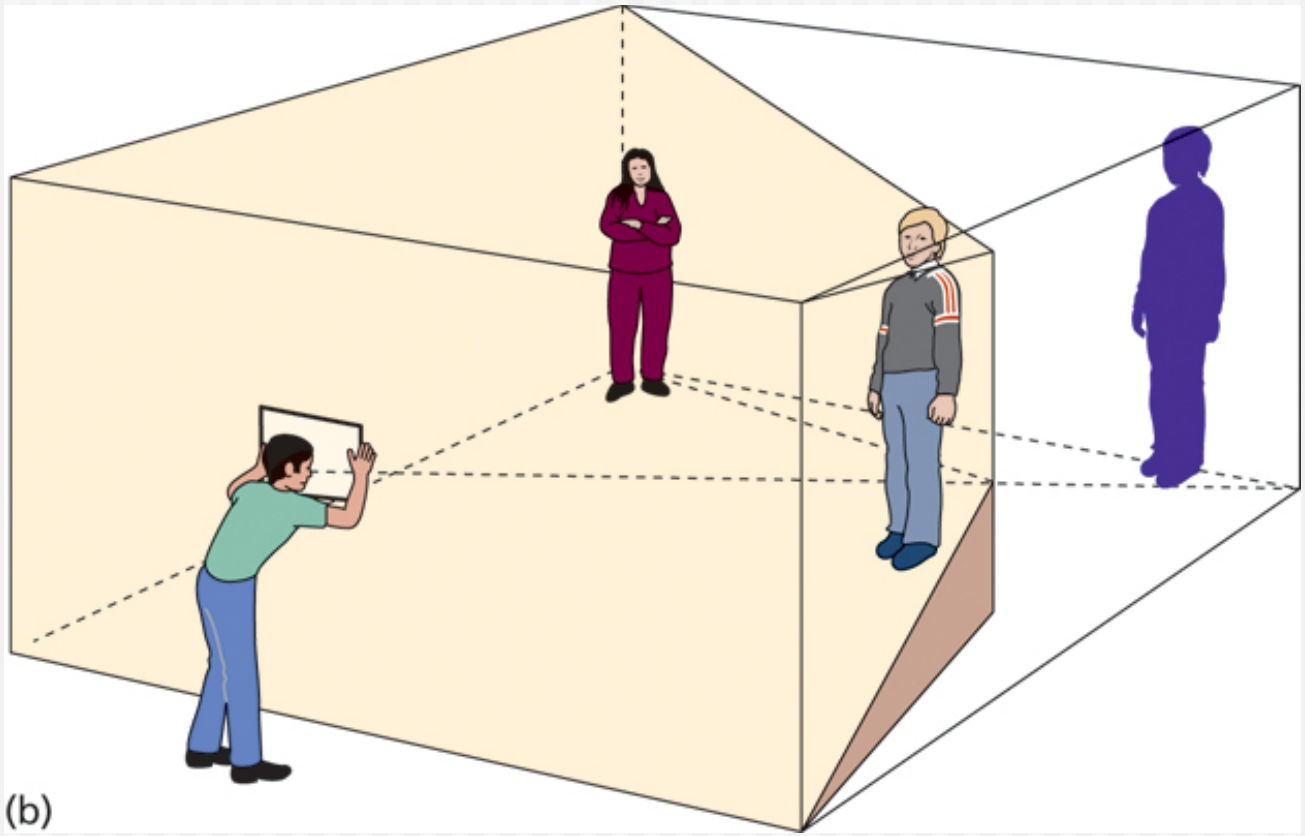


(b)

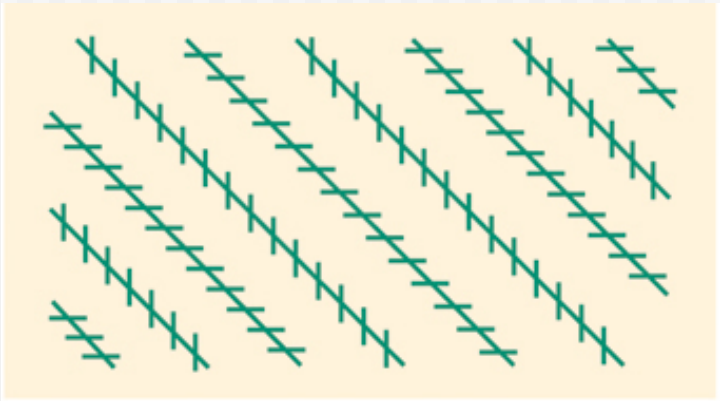
Perceptual Illusions

(a)

Perceptual Illusions

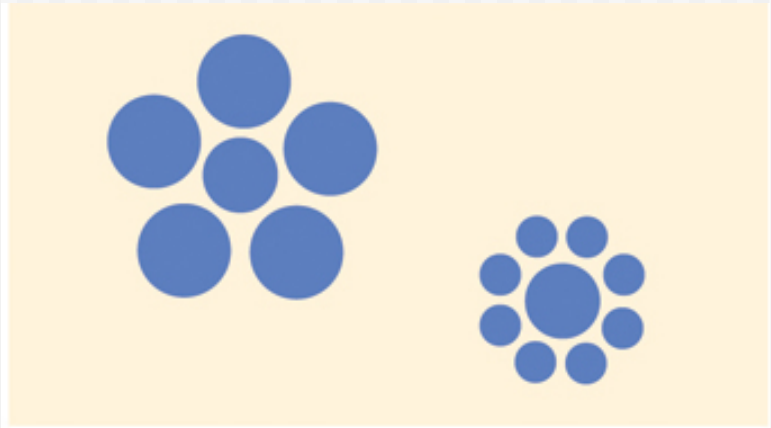


Perceptual Illusions



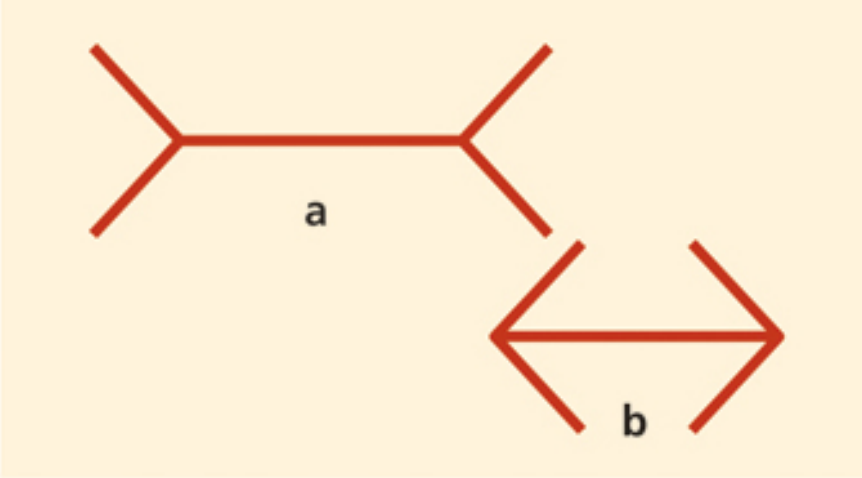
The long lines are actually parallel, but the small lines make them appear crooked.

Perceptual Illusions



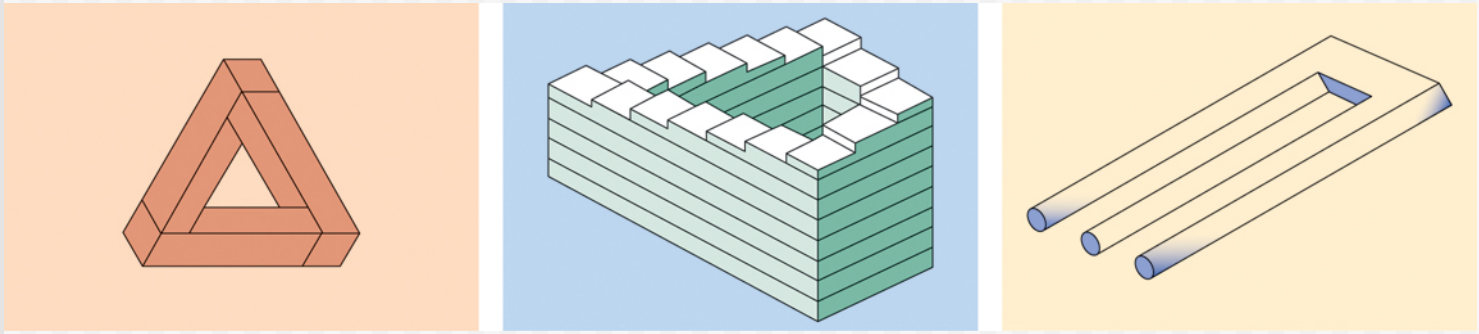
Which inner circle is larger?
Check and see.

Perceptual Illusions



The Müller-Lyer illusion. Which line, a or b, is longer? Compare them with a ruler.

Perceptual Illusions

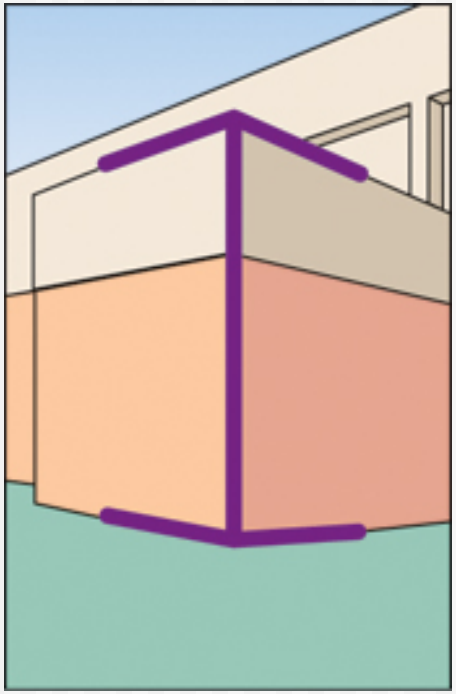


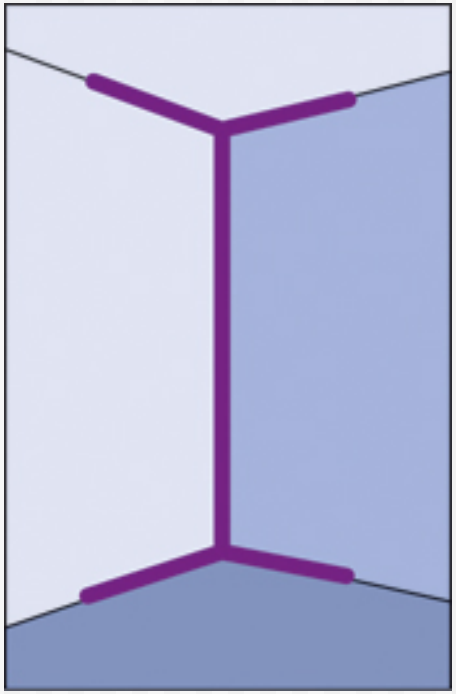
Perceptual Development

- Results from biological and environmental factors
- What is the object above the woman's head?
  - Different answers depending on culture

(a)

Perceptual Development



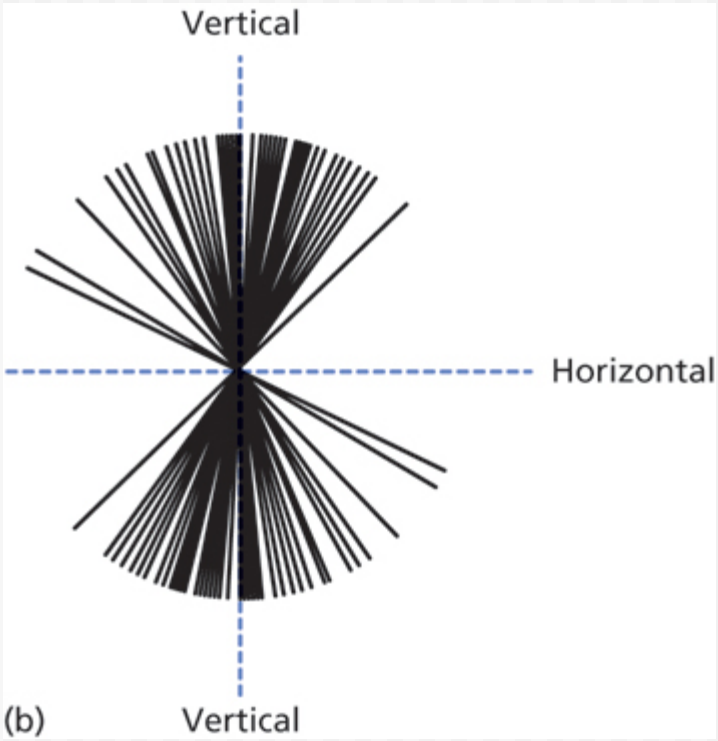


Critical Periods

- Critical Periods: certain kinds of experiences must occur if perceptual abilities and the brain mechanisms that underlie them are to develop normally
  - Kittens raised in completely vertical environments were unable to see horizontal objects, and vice-versa (Blakemore & Cooper, 1970)

Critical Periods

(a)



(b)

Levels of Analysis