

Sensation & Perception

Sensation & Perception

- Sensation: stimulation of sense organs
- Perception: selection, organization, and interpretation of sensory input

Sensation & Perception

- Bottom-Up Processing: analysis that begins with the sensory receptors and works up to the brain's integration of sensory information
- Top-Down Processing: information processing guided by higher-level mental processes, as when we construct perceptions drawing on our experiences and expectations

Sensation

- Transduction & Psychophysics
- Vision
- Audition
- Chemical Senses: Olfaction & Gustation
- Somatosensation
- Body Senses: Equilibrioception, Proprioception
- Other Aspects of Sensation

Transduction

- Transformation of stimulus energies to electrochemical energy of neural impulses
- Sensory receptors are responsible for transduction
 - Rods and cones in the eye
 - Tastebuds in the mouth
 - Hair cells in the ear
 - Olfactory receptors in the nose
 - Receptors in the skin

Psychophysics

- Absolute Threshold: minimum level of stimulation that can be correctly detected at least 50% of the time
- Subliminal Stimulation: stimulation not detected on a conscious level; below absolute threshold

Psychophysics

- Difference Threshold: minimum difference between any 2 stimuli that a person can detect at least 50% of the time
 - Aka “Just Noticeable Difference”
 - Weber-Fechner Law: difference thresholds increase in proportion to the size of the original stimulus

Psychophysics

- **Signal Detection Theory**

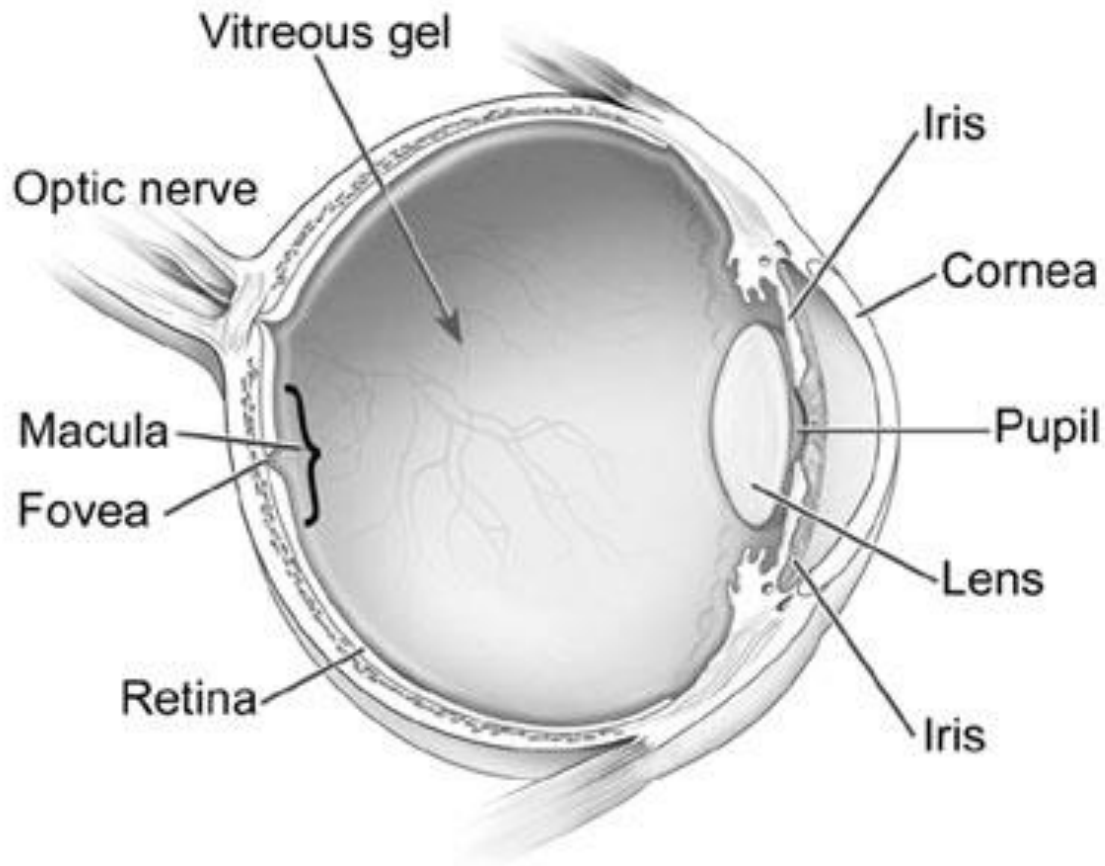
- proposes that there is no absolute threshold because the threshold changes with a variety of factors

- Factors involving the person detecting
- Factors involving the signal itself
- Factors involving the background

		<i>Event</i>	
		<i>Signal</i>	<i>Noise</i>
<i>Respond</i>	<i>"Yes"</i>	Hit	False Alarm
	<i>"No"</i>	Miss	Correct Rejection

Vision

- **Structures of the Eye & Brain**



Vision

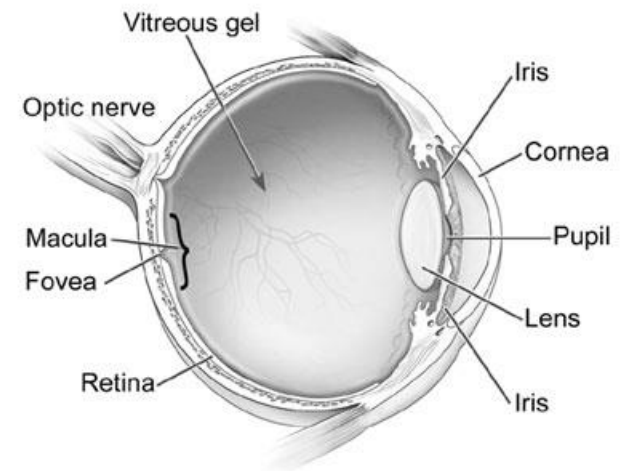
- **Structures of the Eye**

- Cornea

- transparent tissue in front of the eye which protects it

- Iris

- colored portion of eye which regulates the amount of light entering the eye



Vision

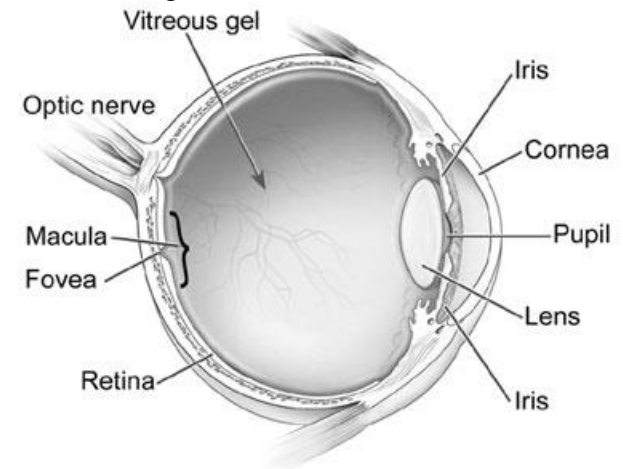
- **Structures of the Eye**

- Pupil

- opening in eye through which light enters

- Lens

- focuses incoming light onto the retina
 - Accommodation: curvature of lens adjusts to alter visual focus

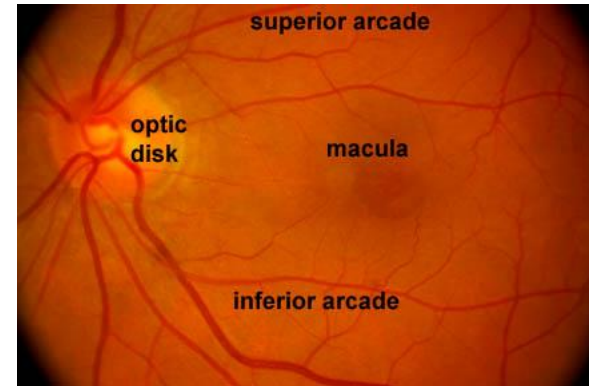


Vision

- **Structures of the Eye**

- Retina

- neural tissue lining back surface of the eye
 - Macula
 - center of retina responsible for detailed central vision
 - Fovea
 - part of the macula; contains cones only; where visual acuity is greatest



Vision

- **Structures of the Eye**

- Retina

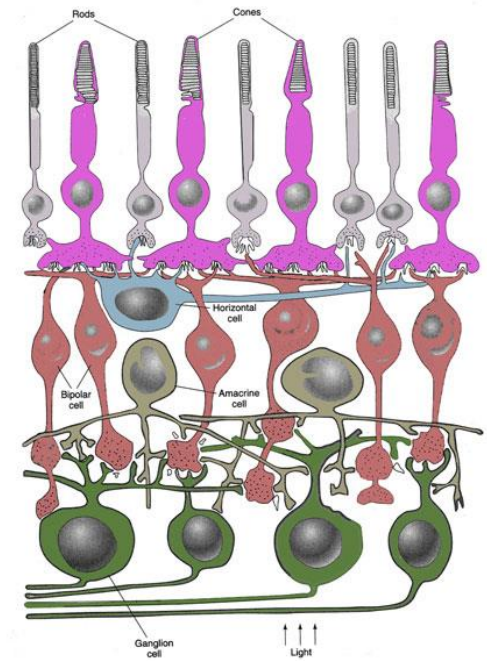
- Photoreceptors

- Rods

- » night vision; better motion sensation; peripheral vision; not color sensitive; more numerous

- Cones

- » color; detail; daytime vision; central vision; not sensitive in the dark, fewer



Vision

- **Structures of the Eye**

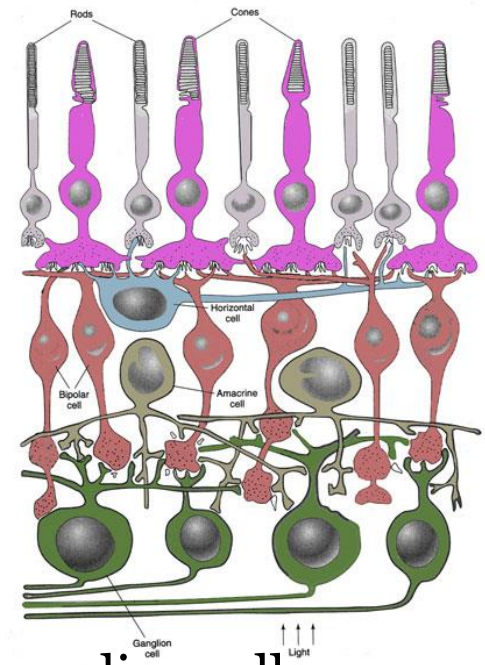
- Retina

- Bipolar Cells

- take impulses from photoreceptors to ganglion cells

- Ganglion Cells

- take impulses from bipolar cells to optic nerve; make up optic nerve



Vision

- **Structures of the Eye**

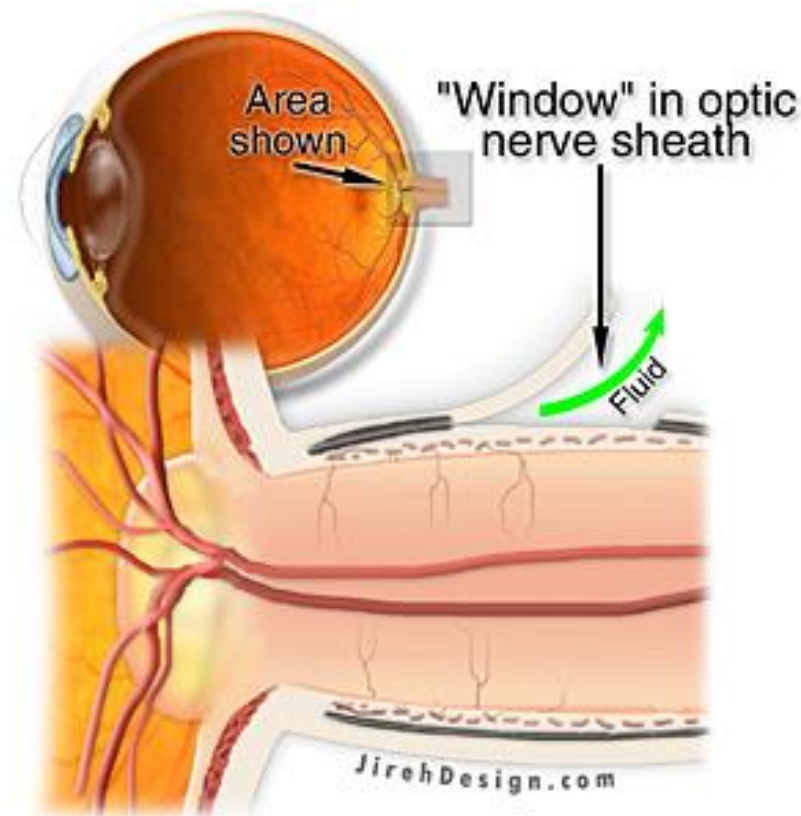
- Optic Nerve

- Optic Disk

- hole in retina where optic nerve fibers exit the eye

- Blind Spot

- no rods and cones located at this point of the retina, so any image that falls on this part of retina cannot be detected

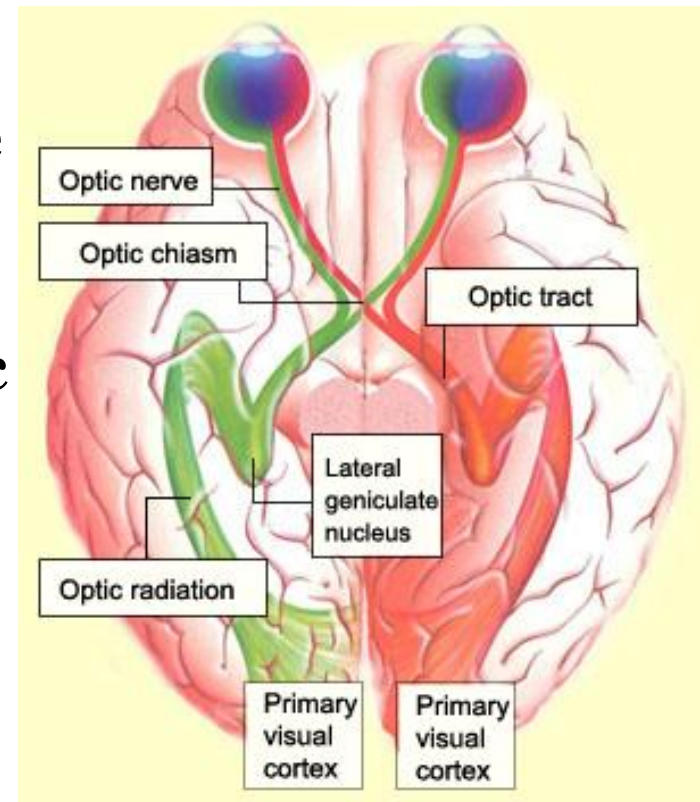


Vision

- **Structures of the Brain**

- Optic Chiasm

- point at which images on the nasal sides of each retina cross over to the opposite side of the brain via the optic nerve



Vision

- **Structures of the Brain**
 - Occipital Lobe
 - Visual Cortex
 - Feature Detectors
 - respond only to specific features of visual stimuli
 - Torsten Wiesel, David Hubel (1981) Nobel Prize

Vision

- **Parallel Processing**

- processing of various aspects of a visual stimulus is simultaneous

- Color, Form, Depth, Movement

- Stroop Effect

- Saying color of words with corresponding semantics is easier and quicker than saying color of words NOT with corresponding semantics

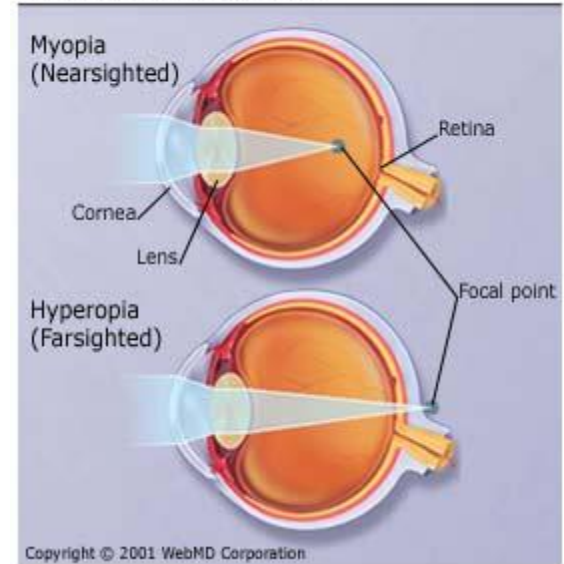
- Becomes difficult after people learn how to read

RED BLUE GREEN vs. **RED BLUE GREEN**

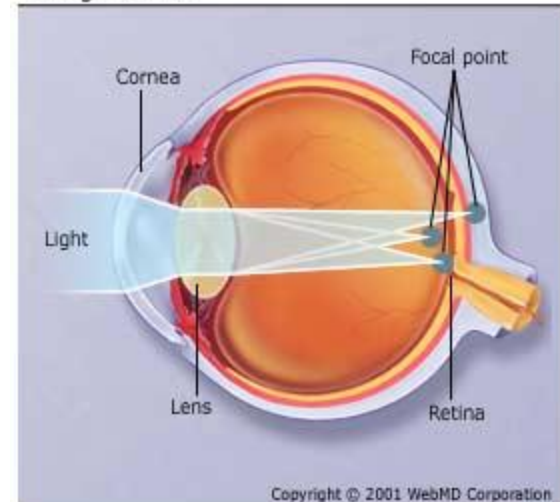
Vision

- **Visual Acuity**
 - sharpness & detail of image
 - Myopia
 - nearsightedness; light focused before it gets to the retina for far objects
 - Hyperopia
 - farsightedness; light focused after it gets to the retina for near objects
 - Astigmatism
 - irregularity in the shape of the cornea or the lens causes image at retina to become blurred & distorted

Myopia and Hyperopia



Astigmatism



Vision

- **Electromagnetic Spectrum**

- Wavelength

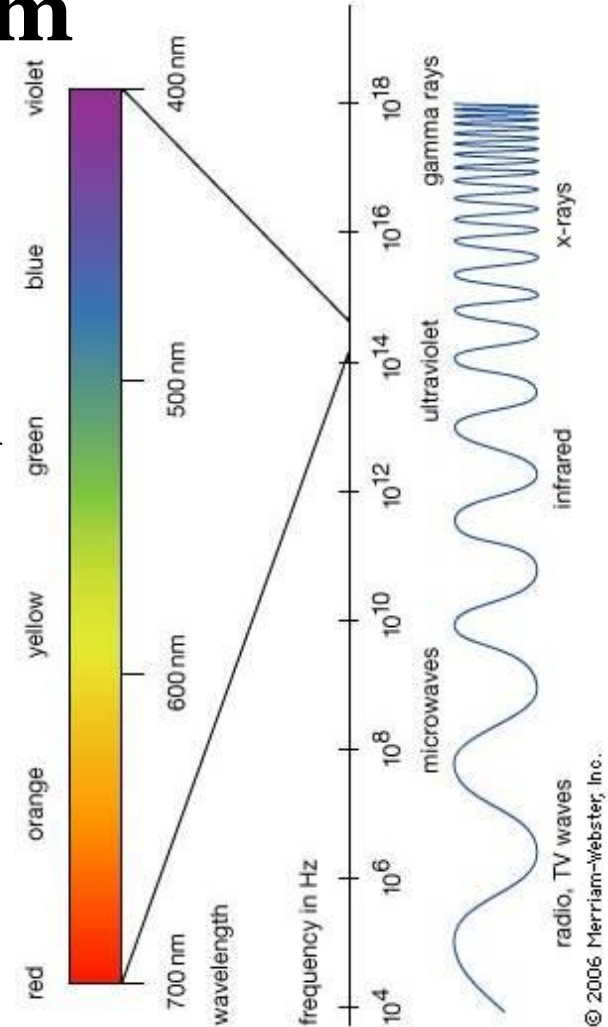
- distance between peaks

- Frequency

- number of wavelengths per given amount of time

- Amplitude

- height of wave



Vision

- **Perception of Light**

- Brightness

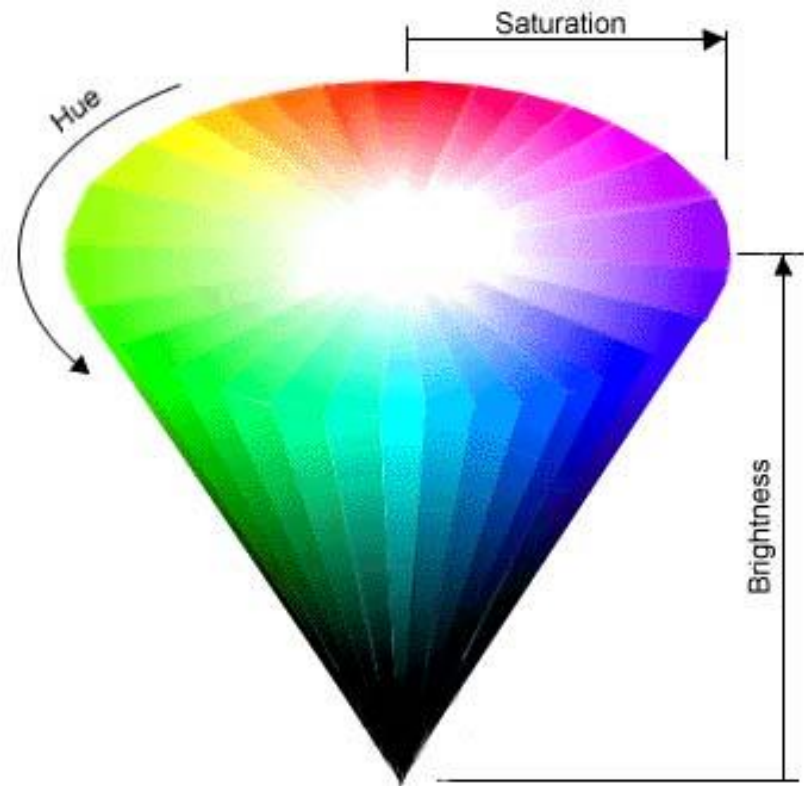
- determined by amplitude; how dark or light a color is

- Hue/Color

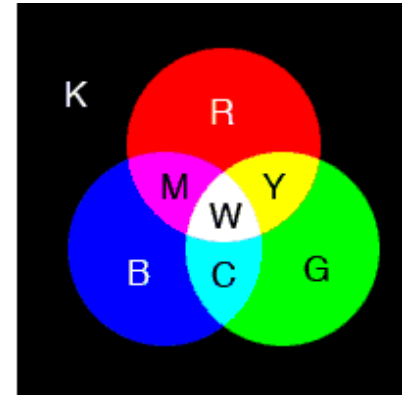
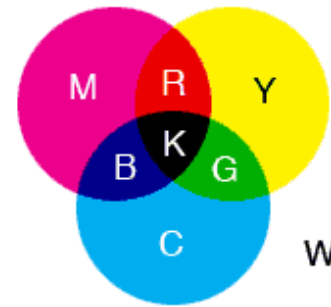
- determined by wavelength/frequency

- Saturation

- richness of color



Vision



- **Color Mixing**

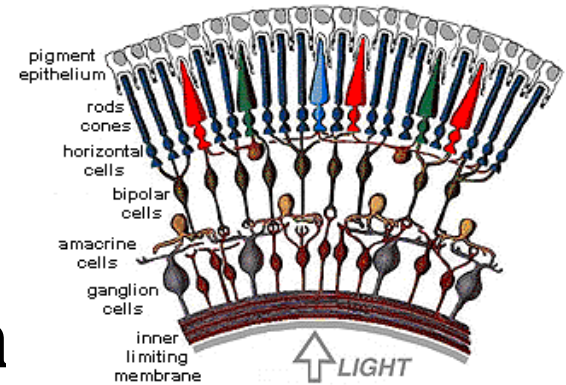
- Subtractive Color Mixing

- primary colors are magenta, cyan & yellow
 - mixing colors *subtracts* wavelengths and absorbs all but black

- Additive Color Mixing

- primary colors are red, blue, & green
 - mixing colors *adds* wavelengths and reflects white

Vision



- **Theories of Color Vision**

- Trichromatic Theory (Young-Helmholtz)

- Eyes have 3 different color photoreceptors (blue, green, red) sensitive to certain wavelengths of light
- All other colors are seen through firing of combination of cones
- Proposed by Hermann von Helmholtz & Thomas Young

- Color-blindness results from lack of chemicals being produced by one or more types of cones

- Monochromats or dichromats
- Red-green colorblindness most common

Vision



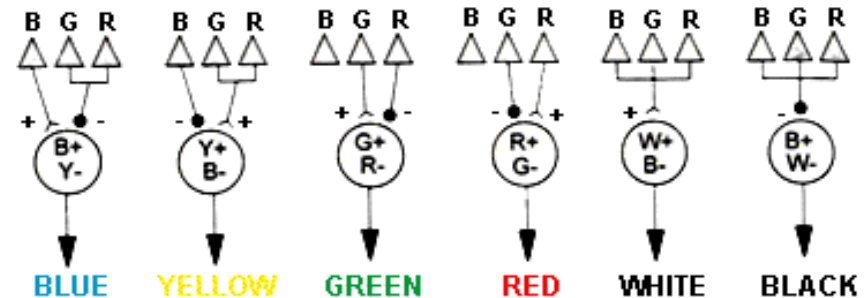
- **Theories of Color Vision**

- **Opponent-Process Theory**

- Receptors make antagonistic responses to three pairs of colors; certain neurons are excited or inhibited, depending on the wavelength of the light
- Proposed by Ewald Hering
- Afterimage: visual image which persists after stimulus is gone

- **Opponent Color Pairs**

- red-green
- yellow-blue
- white-black



Vision

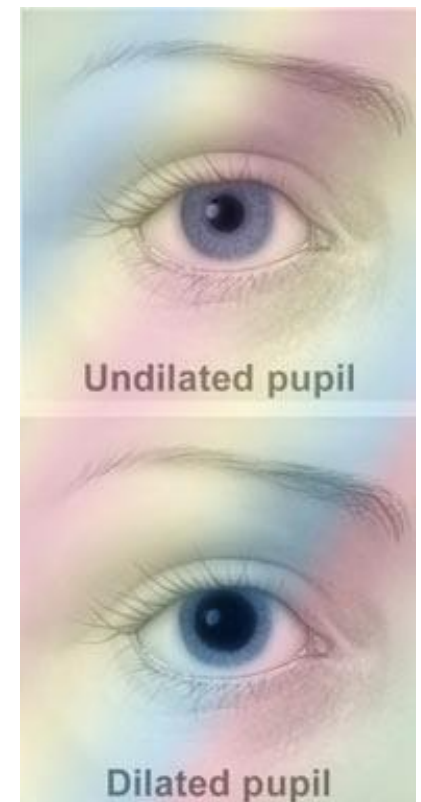
- **Adaptation**

- Light Adaptation

- Gradual decrease in sensitivity to high levels of light
 - Shift from using predominantly rods to using cones

- Dark Adaptation

- Gradual increase in sensitivity to low levels of light
 - Shift from using predominantly cones to using rods

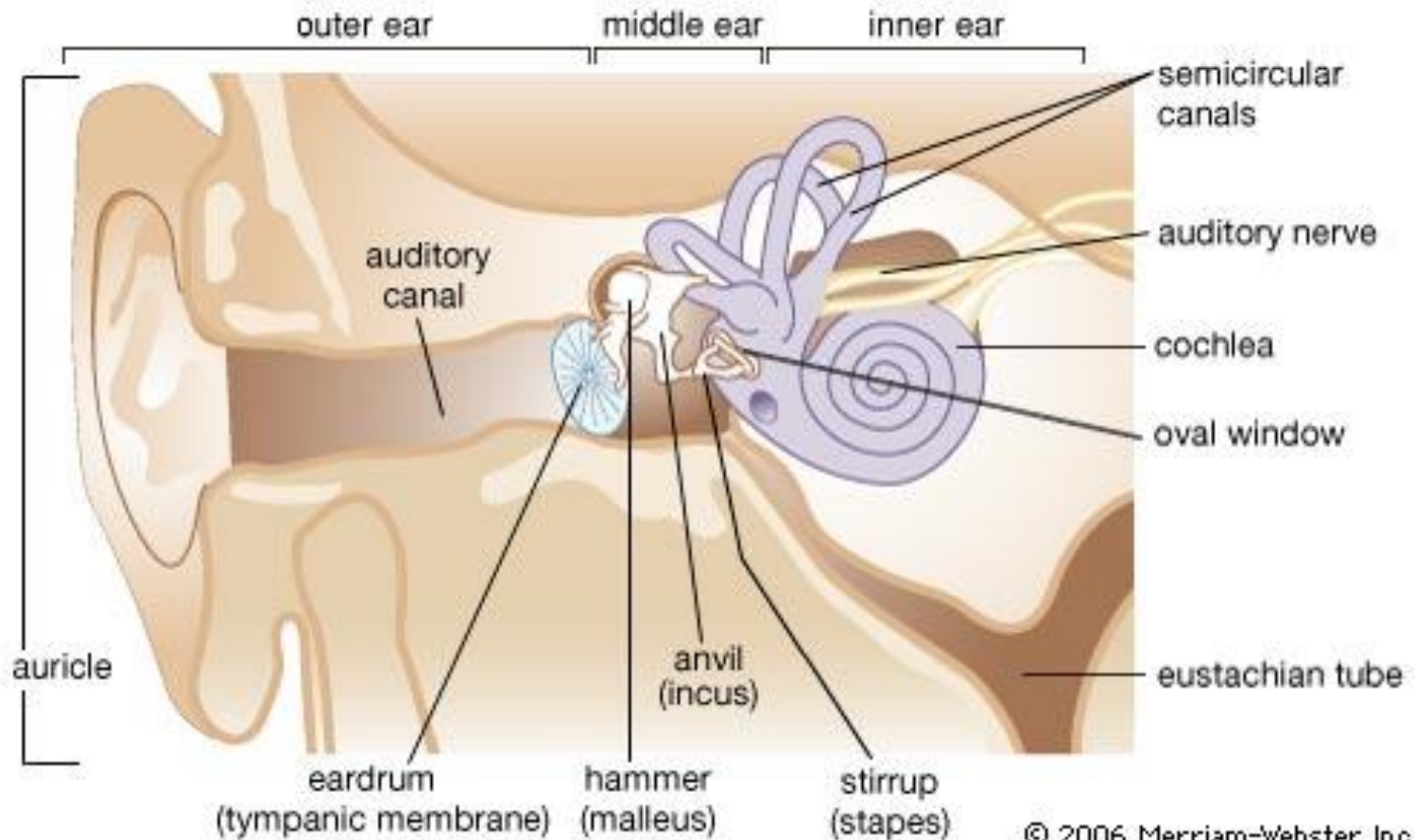


Vision

- Visual Dominance/Visual Capture: the dominance of vision over other sense modalities, such that what is felt or heard conforms to what is seen

Audition

- **Structures of the Ear**



Audition

- **Structures of the Ear**

- Outer Ear

- Pinna/Auricle

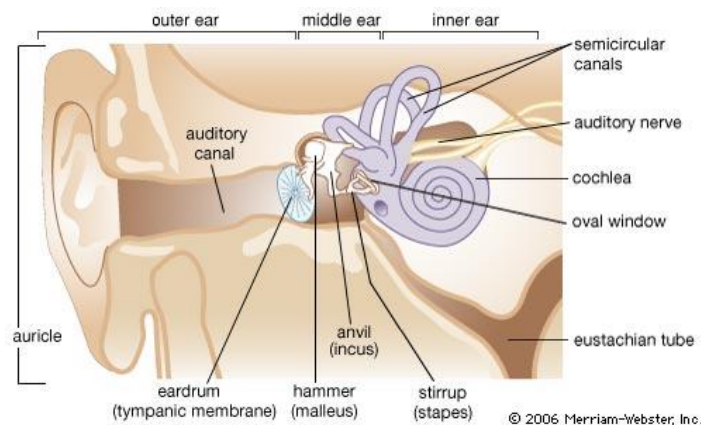
- funnels sound into ear

- Ear Canal/ Auditory Canal:

- channels sound waves to eardrum

- Eardrum/ Tympanic Membrane

- vibrates with sound waves, causing middle ear to vibrate



Audition

- **Structures of the Ear**

- Middle Ear

- Ossicles

- middle ear bones; smallest bones in the body; transfer and amplify sound

- Hammer (Malleus)

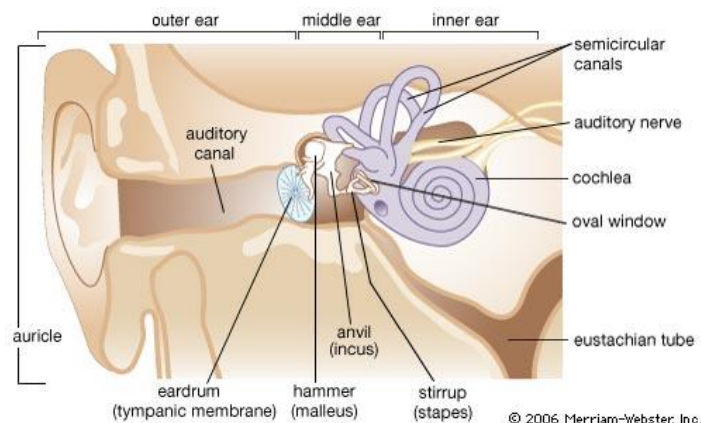
- » transfers vibration from eardrum to anvil

- Anvil (Incus)

- » transfers vibration from hammer to stirrup

- Stirrup (Stapes)

- » transfers vibration from anvil to cochlea, via the oval window



Audition

- **Structures of the Ear**

- Inner Ear

- Cochlea

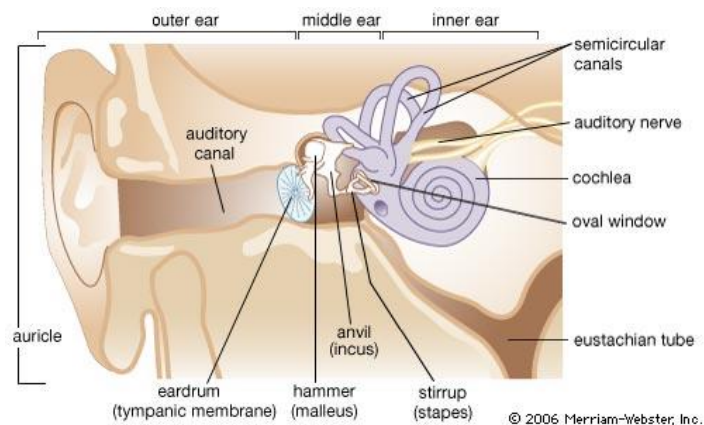
- coiled, fluid-filled tube which trigger nerve impulses as a result of vibrating sound waves

- Oval Window

- » membrane of cochlea which transfers vibrations from middle ear to cochlea

- Round Window

- » when oval window membrane moves in, round window membrane moves out to relieve pressure



Audition

- **Structures of the Ear**

- Inner Ear

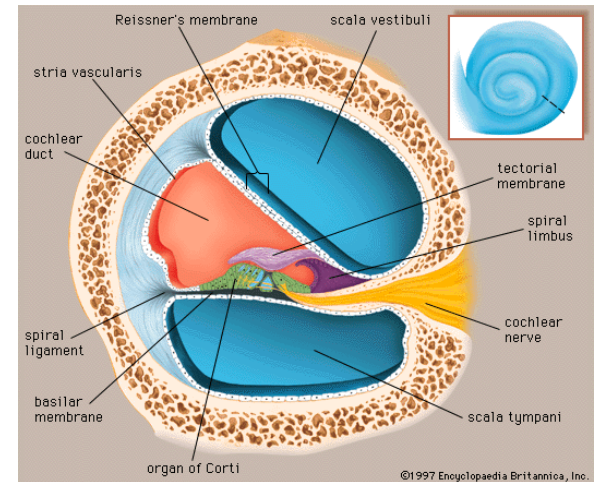
- Cochlea

- Basilar Membrane

- » lined with hair cells which move in response to the vibrations of sound

- Cilia & Hair Cells

- » Cilia vibrate, causing hair cells to send neural impulses to the auditory nerve (because of vibrations)



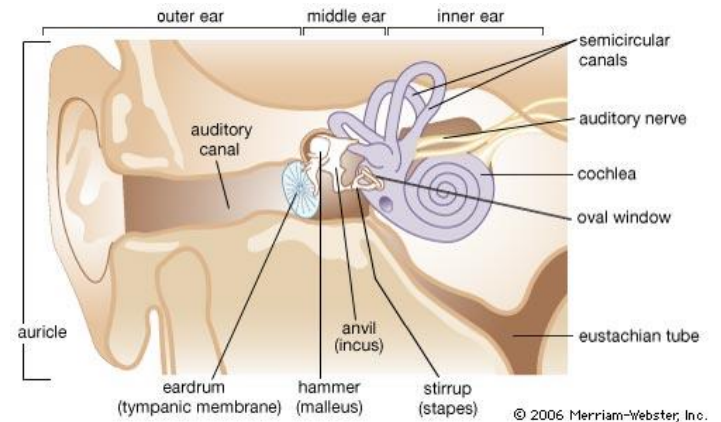
Audition

- **Structures of the Ear**

- Inner Ear

- Auditory Nerve

- takes impulses from ear to auditory cortex

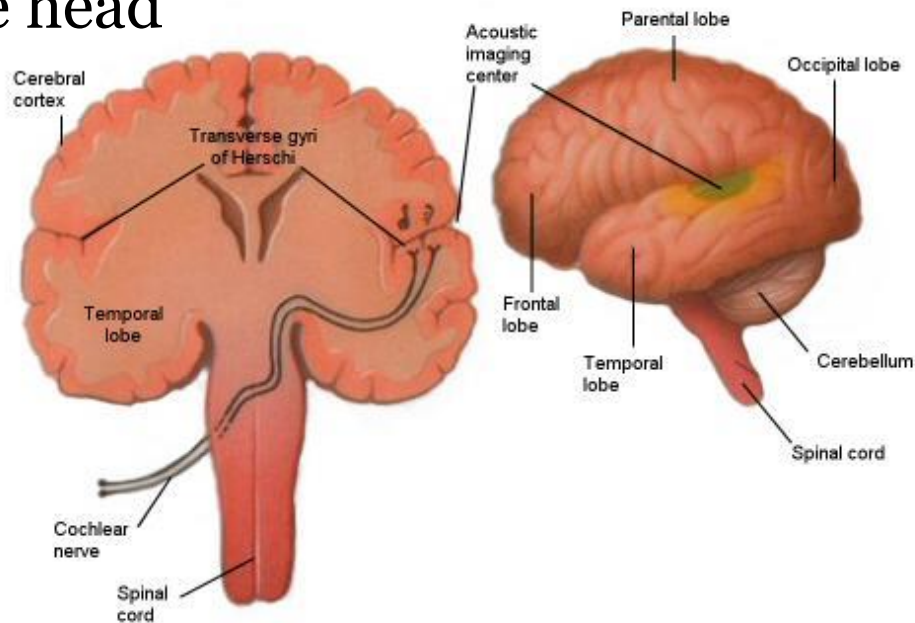


Audition

- **Structures of the Brain**

- Auditory Cortex

- within the temporal lobe; receives info from both ears, but mostly from the ear on the opposite side of the head



Audition

- **Sound Waves**

- Wavelength

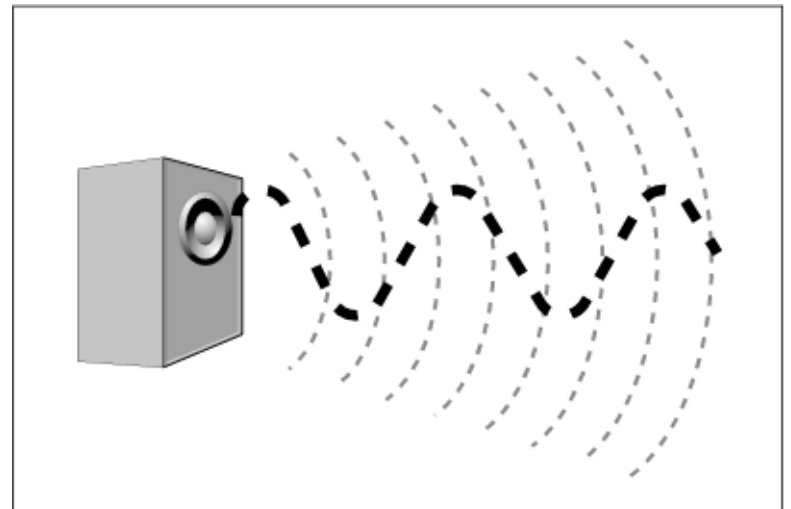
- distance between peaks

- Frequency

- number of wavelengths per given amount of time

- Amplitude

- height of wave



Audition

- **Perception of Sounds**

- Loudness/Volume

- determined by amplitude, perceived as loudness
 - Measure loudness in decibels (dB)

- Pitch

- how high or low a sound is; determined by frequency/wavelength
 - Measure pitch in Hertz (Hz), wavelengths/sec.

- Timbre

- purity of sound
 - why different instruments sound different

Audition

- **Theories of Hearing**

- Hearing Pitch

- Place Theory

- Location of stimulated hair cells determines pitch

- Stimulation of hair cells near oval window perceived as high pitched; far from oval window perceived as low pitched

- Frequency Theory

- Hair cells will send neural messages with a frequency that matches the original sound

- Volley Principle

- » hair cells alternate firing to enable perception of very high pitches

Audition

- **Theories of Hearing**

- Locating Sounds

- Sound Localization

- Process of locating sounds

- Sound wave will reach one ear faster than the other

- Ear that hears quicker is closer to sound

- Brain interprets the angle to locate the source of sound

Audition

- **Hearing Loss**

- Conduction/Conductive Hearing Loss

- hearing loss as a result of damage to the outer or middle ear

- Nerve Deafness/Sensorineural Hearing Loss

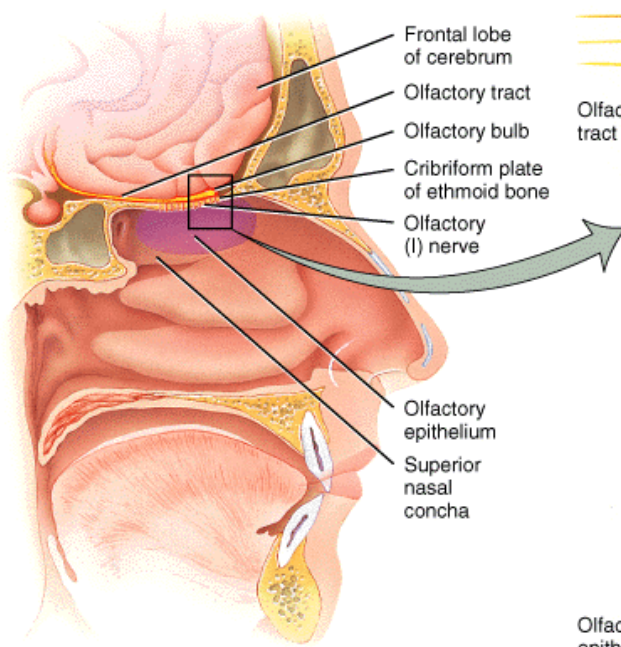
- hearing loss as a result of damage to the inner ear or auditory nerve

- Assistive Devices

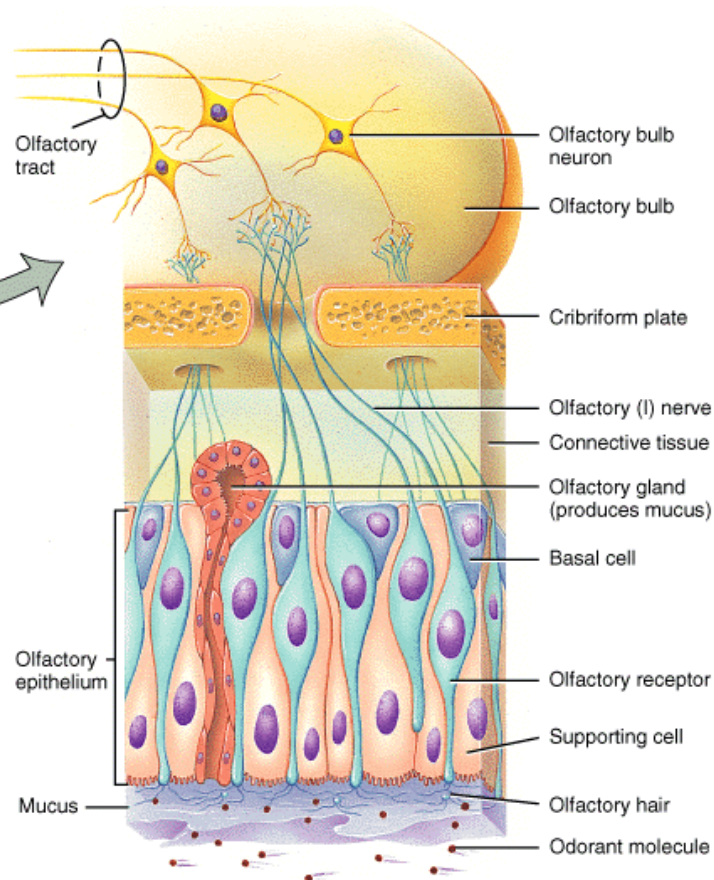
- Hearing aids amplify sounds
 - Cochlear implants communicate sound directly to the inner ear

Chemical Senses

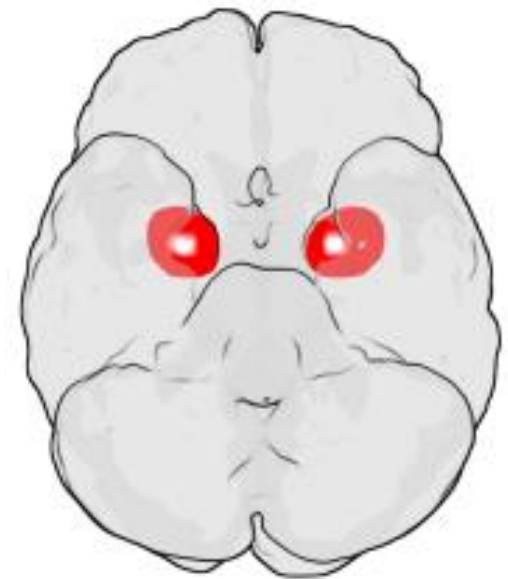
• Olfaction



(a) Sagittal view



(b) Enlarged view of olfactory receptors



Chemical Senses

- **Olfaction**

- Odor molecules are sensed in the olfactory epithelium at the top of the nasal cavity
- Dissolved odorants bind to receptor sites for olfactory receptors which triggers an action potential
- Axons pass impulses into the olfactory bulb which sends impulses to the olfactory cortex

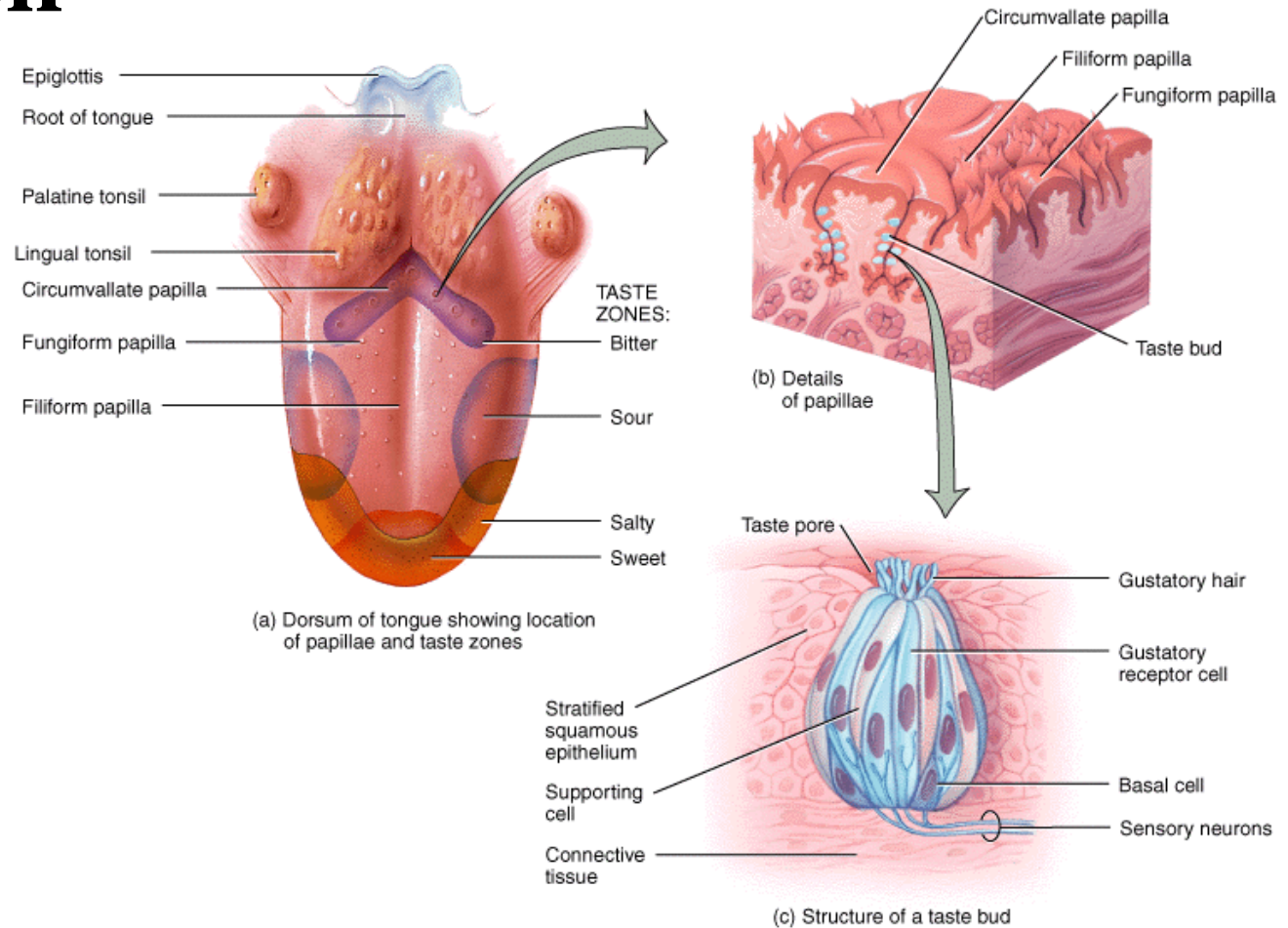
Chemical Senses

- **Olfaction**

- We have about 350 different olfactory receptors
- Can detect about 10,000 different odors
- Pheromones: chemicals which trigger physiological or behavioral response in another member of the same species but without an apparent odor

Chemical Senses

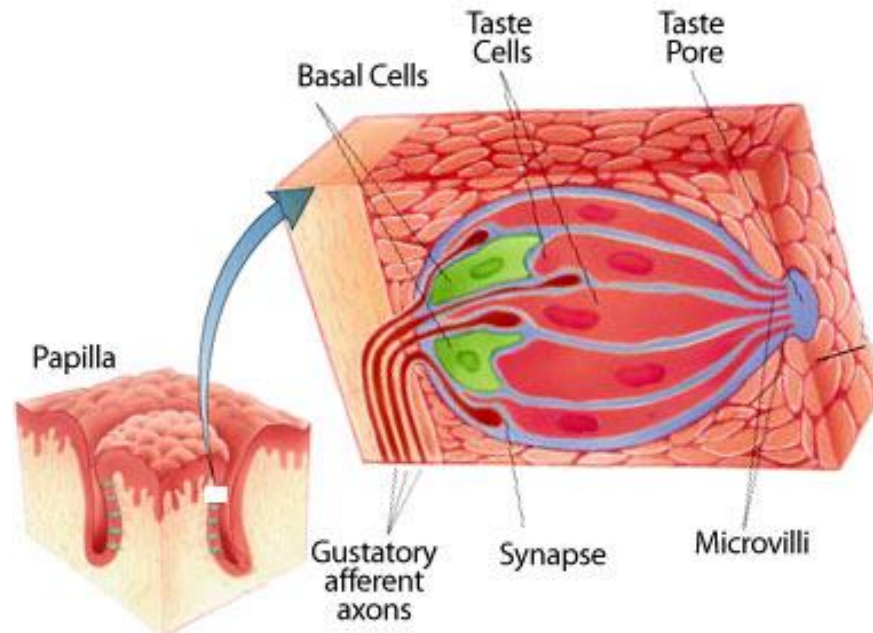
• Gustation



Chemical Senses

- **Gustation**

- Taste receptors are located on the walls of the mouth and tongue
- Receptors last around 1-2 weeks

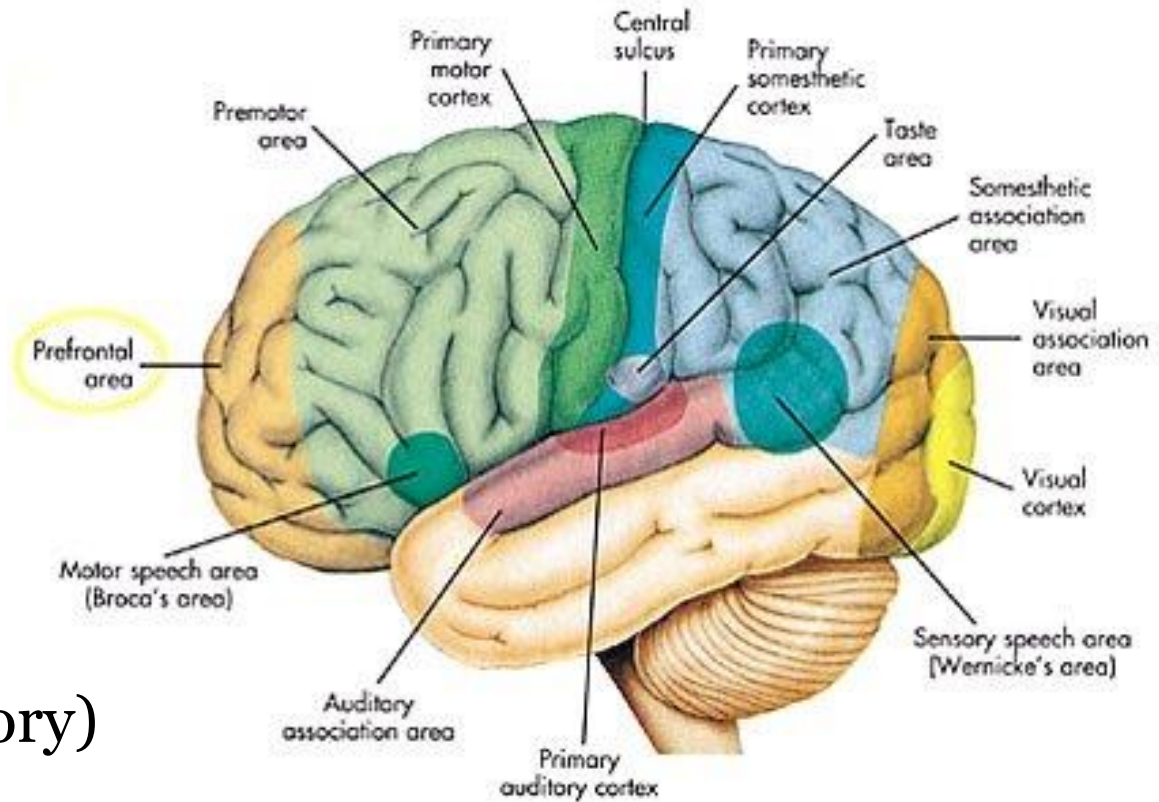


Chemical Senses

- **Gustation**

- 5 Basic Tastes

- Sweet
 - Salty
 - Bitter
 - Sour
 - *Umami* (Savory)



Somatosensation

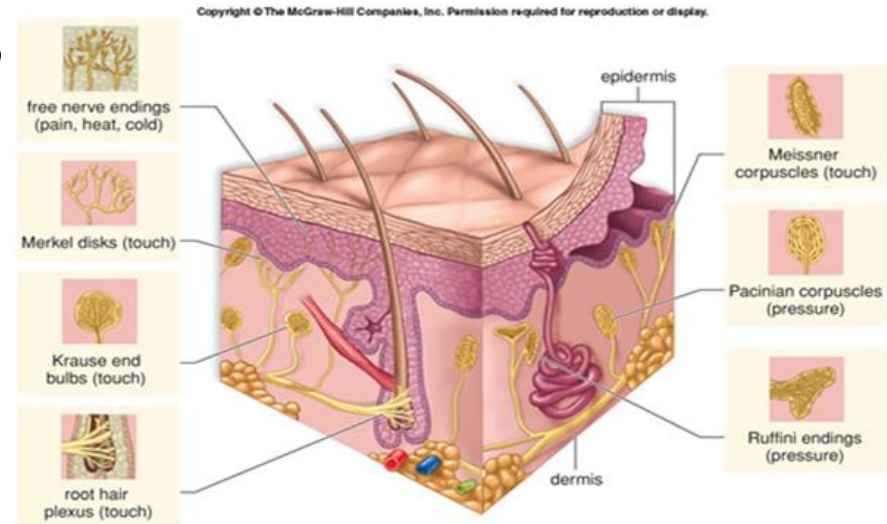
- **4 Basic Sensations**

- Somatoreceptors

- Warmth
- Cold
- Pressure
- Pain

- Often associated with secretion of Substance P
- Secretion of endorphins relieves pain

- Other touch sensations result from simultaneous stimulation of different receptors



Somatosensation

- **Pain Theories**

- Gate-Control Theory

- We experience pain only if pain messages can pass through a hypothetical gate in the spinal cord on the way to the brain
 - Competing messages can block off gate for pain

- Biopsychosocial Theory

- Biological, psychological, and social components interact to create our experience of pain

Somatosensation

- **Pain Disorders**

- Congenital Insensitivity to Pain with Anhidrosis (CIPA)

- inability to feel pain or differences in temperature
 - inability to sweat because of inability to detect body temperature

Body Senses

- **Equilibrioception**
 - Vestibular Sense
 - Balance or equilibrium
 - Semicircular Canals
 - contain fluid which moves in response to physical movement
 - Vestibular Sacs

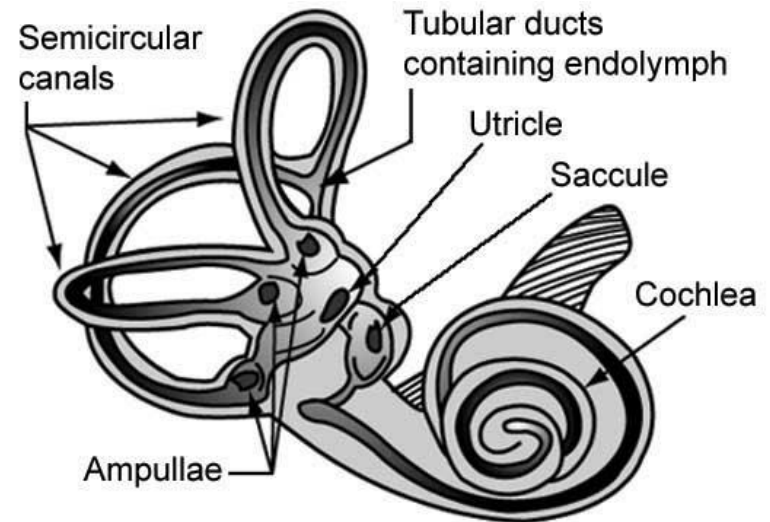


Figure 2: The Vestibular System - semicircular canals and otolith organs

Body Senses

- **Proprioception**

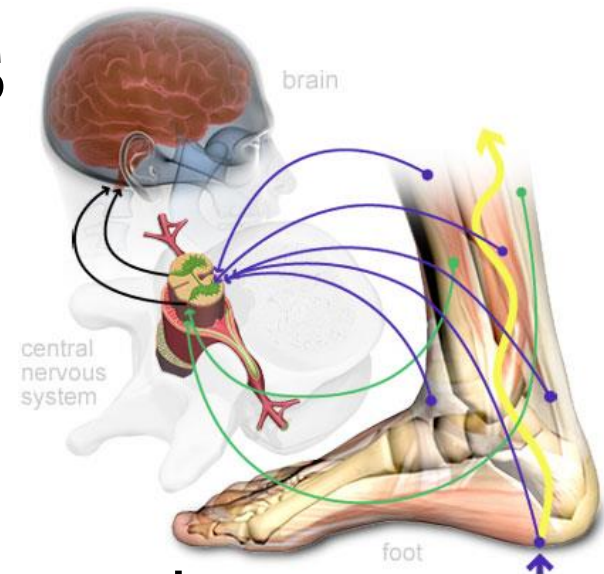
- Kinesthetic Sense

- Enables people to sense the position and movement of body parts

- Sensory receptors are located in muscles, tendons, & joints

- Phantom Limb Syndrome

- people who have lost limbs sometimes still feel pain in limbs that no longer exist because of random CNS activity (also related to kinesthetic sense)



Sensation

- **Sensory Interaction**

- Senses work together to influence the overall perception of the environment
 - Ex: flavor is determined by taste, smell, texture and temperature
- McGurk Effect: perceptual phenomenon which demonstrates an interaction between hearing and vision in speech perception

Sensation

- **Sensory Adaptation**
 - Gradual decline in sensitivity after prolonged stimulation
 - Keeps people responsive to changes rather than constants

Sensation

- **Selective Attention**

- Focusing of conscious awareness on a particular stimulus, to the exclusion of others
- Cocktail Party Effect: ability to attend to only one voice among many
- Inattentional Blindness: failing to see visible objects when our attention is directed or focused elsewhere

Sensation

- **Sensory Compensation**
 - People who lose one aspect of sensation seem to compensate with slight enhancement of other sensory abilities
 - Brain plasticity can account for some changes, like blind using occipital lobe to read Braille

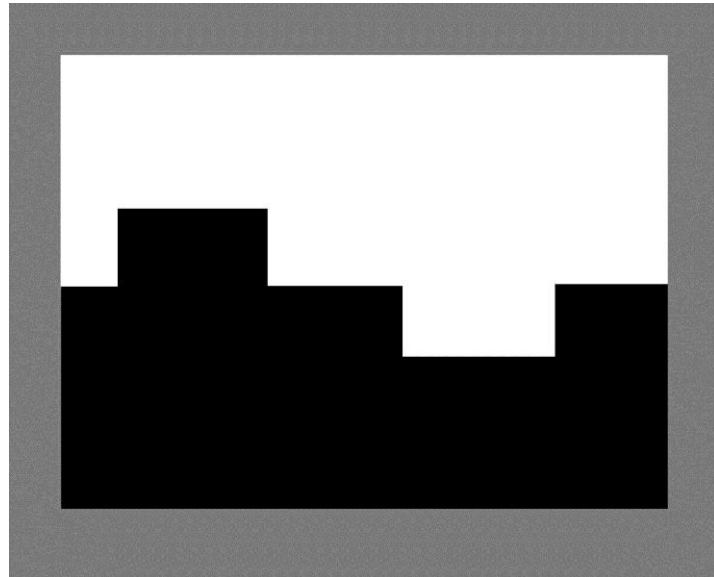
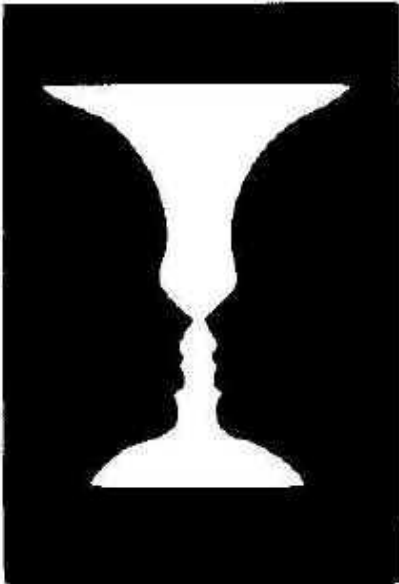
Perception

- Form Perception
- Depth Perception
- Motion Perception
- Perceptual Constancy
- Other Aspects of Perception
- Extra-Sensory Perception

Form Perception

- **Figure-Ground**

- organization of visual field into objects (figures) that stand out from their surroundings (ground)

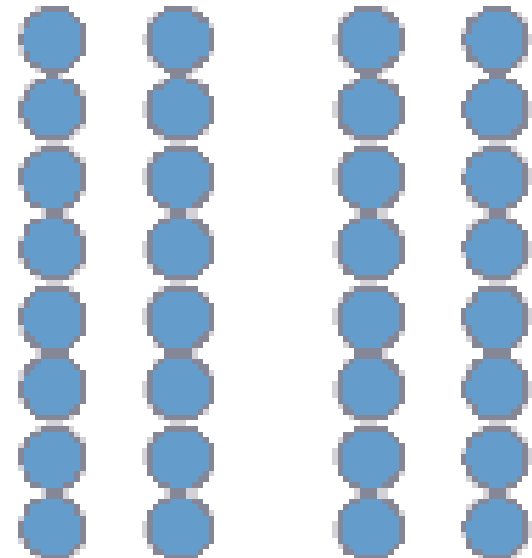
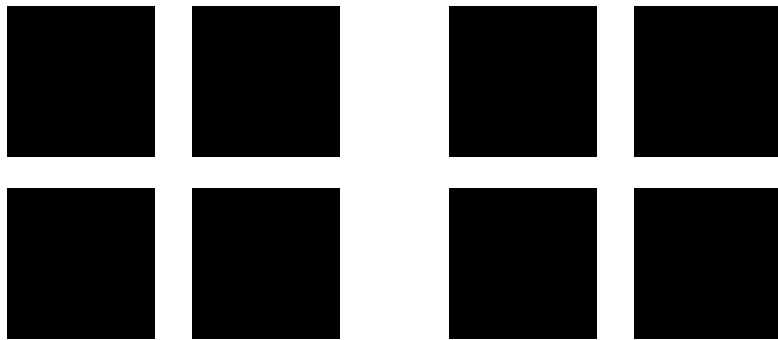


Form Perception

- **Gestalt Grouping Principles**

- Proximity

- group objects together based on proximity to other objects



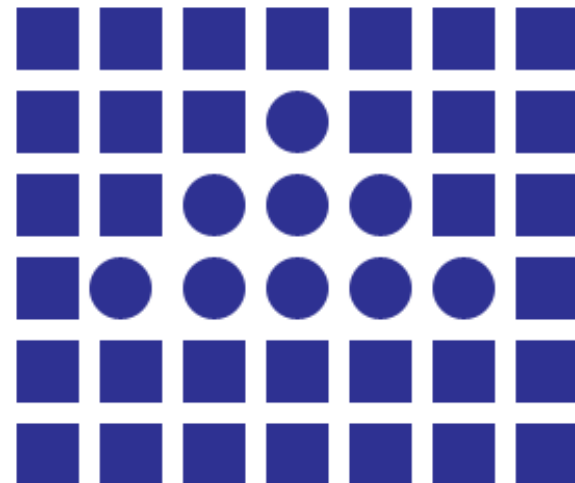
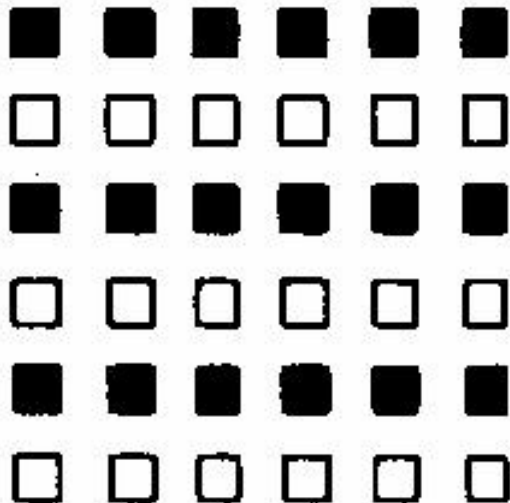
Proximity

Form Perception

- **Gestalt Grouping Principles**

- Similarity

- group objects together according to which objects are most similar to it

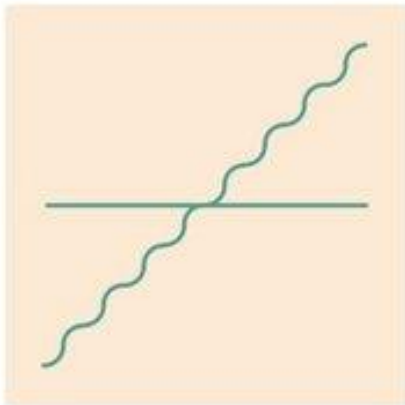


Form Perception

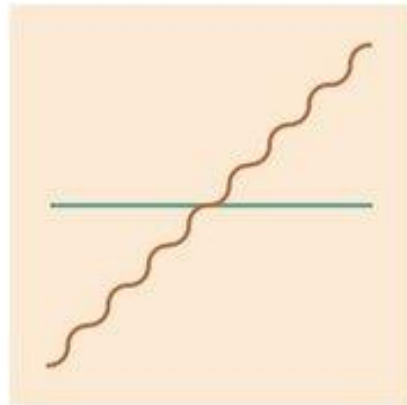
- **Gestalt Grouping Principles**

- Continuity

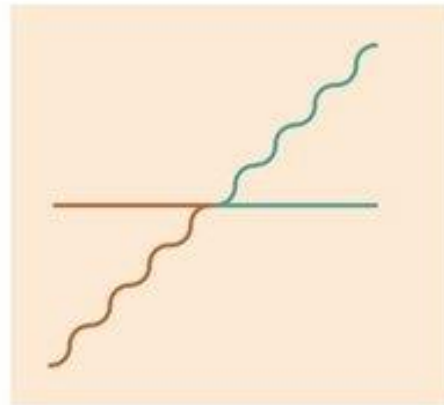
- we perceive smooth, continuous patterns rather than discontinuous ones



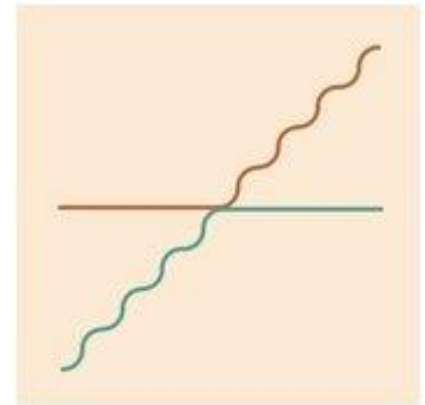
(a)



(b)



(c)



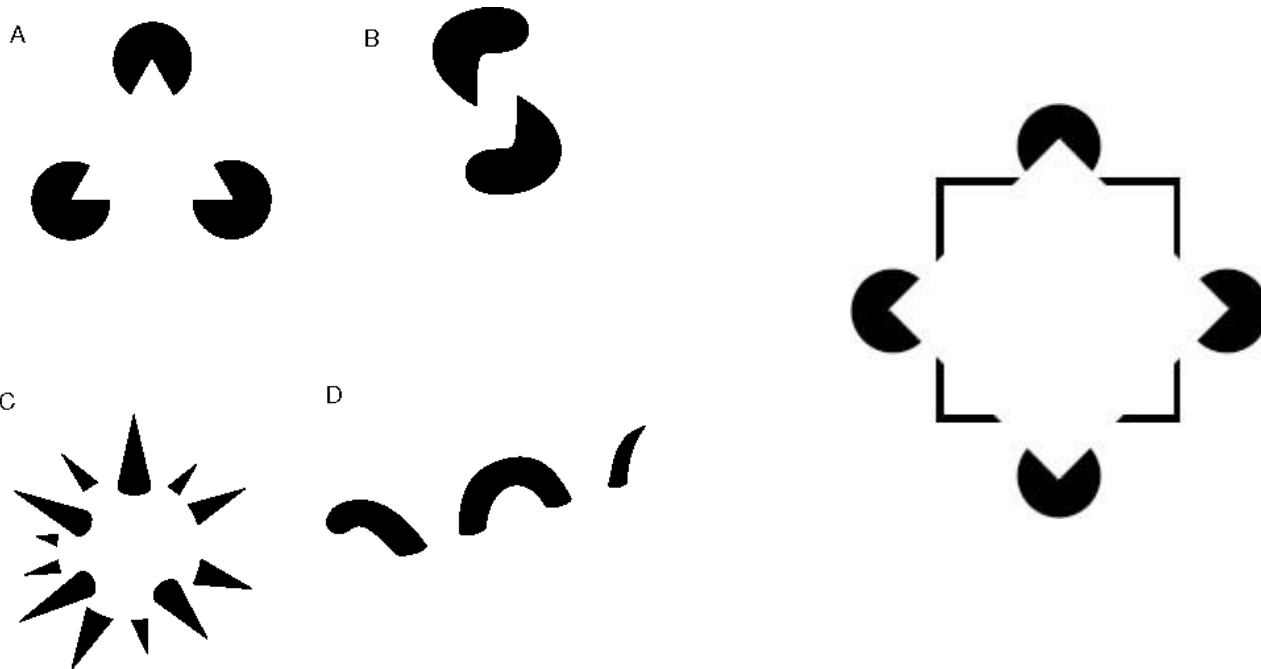
(d)

Form Perception

- **Gestalt Grouping Principles**

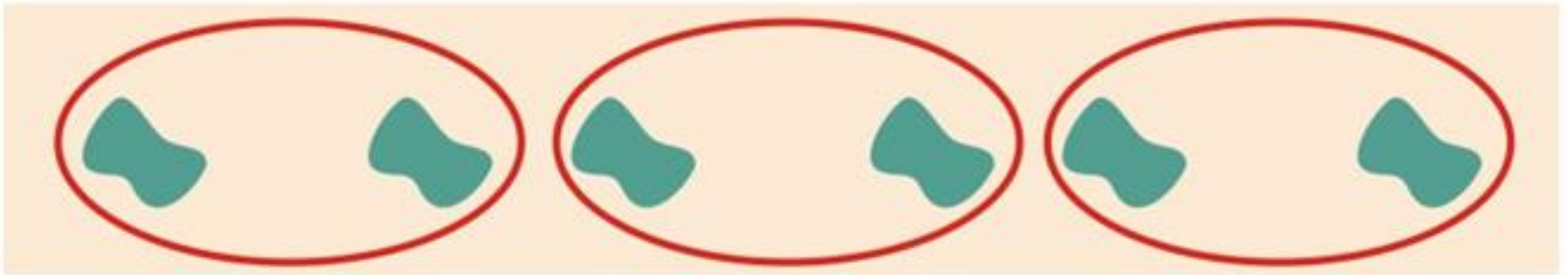
- Closure

- we fill in gaps to create a complete whole object



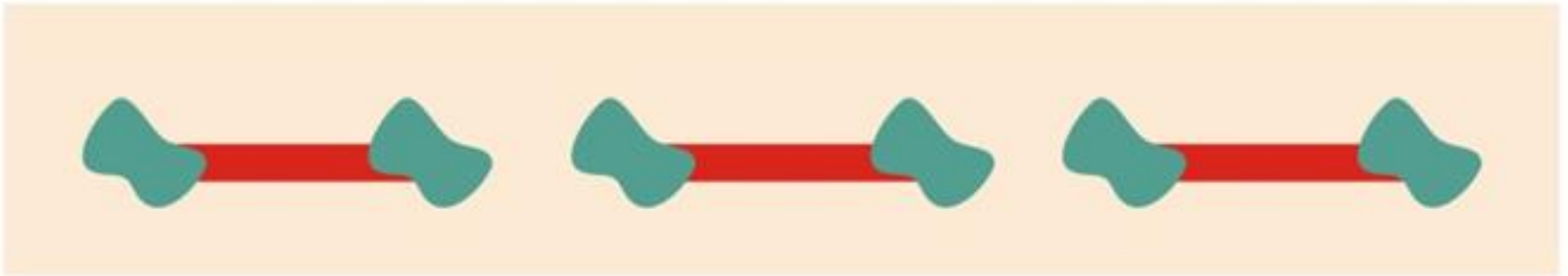
Form Perception

- **Gestalt Grouping Principles**
 - Common Region
 - group items together which share similar regions



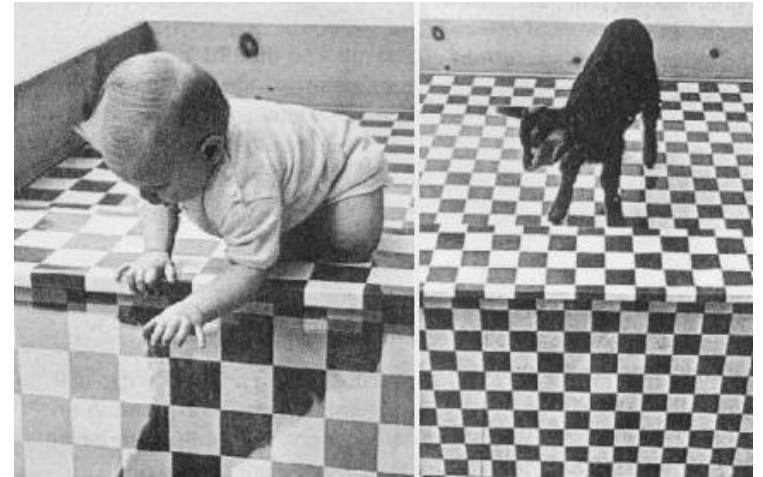
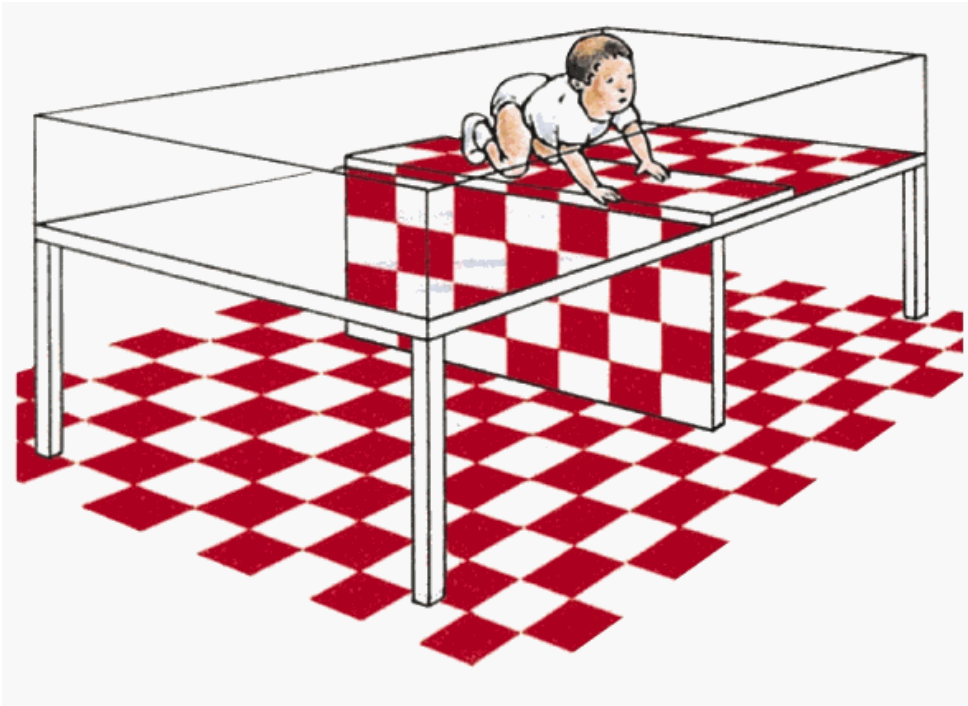
Form Perception

- **Gestalt Grouping Principles**
 - Connectedness
 - perceive connected objects as a single unit



Depth Perception

- Visual Cliff: device to test depth perception in infants and young animals

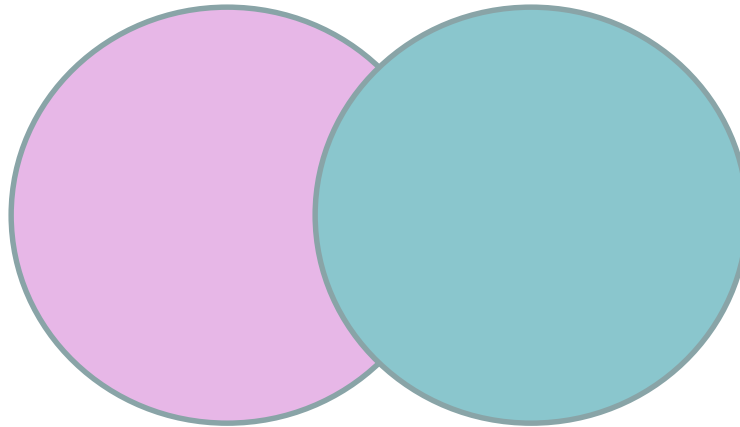


Depth Perception

- **Monocular Cues**

- Interposition

- If one object blocks view of another, that object is closer

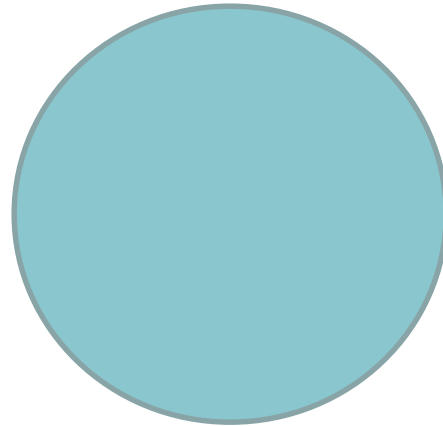
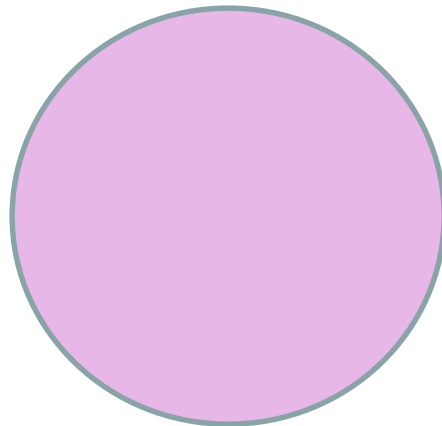


Depth Perception

- **Monocular Cues**

- Relative Height

- Objects higher in visual field are perceived as farther away

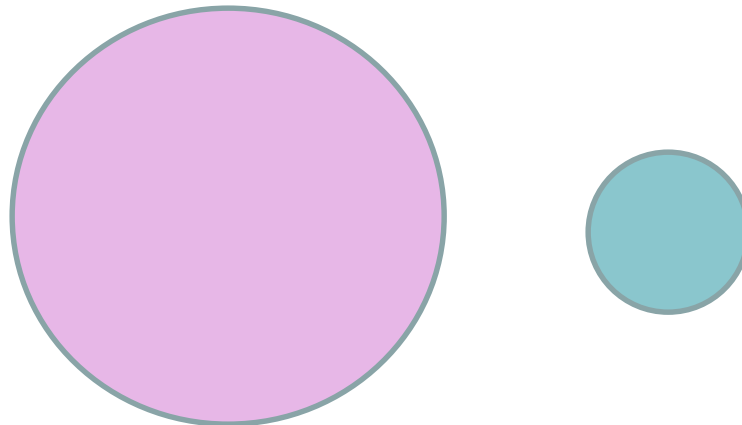


Depth Perception

- **Monocular Cues**

- Relative Size

- Smaller object is perceived as farther away



Depth Perception

- **Monocular Cues**

- Texture Gradient

- Gradual change from coarse, distinct texture to a fine, indistinct texture signals increasing distance



Depth Perception

- **Monocular Cues**

- Linear Perspective

- Parallel lines seem to converge with greater distances



Depth Perception

- **Monocular Cues**

- Relative Clarity

- Hazy objects are perceived as being farther away

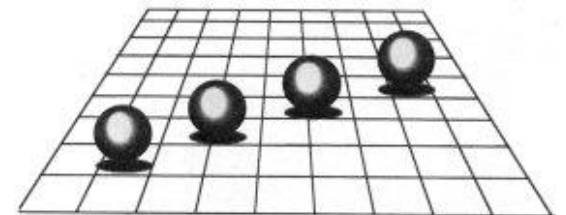
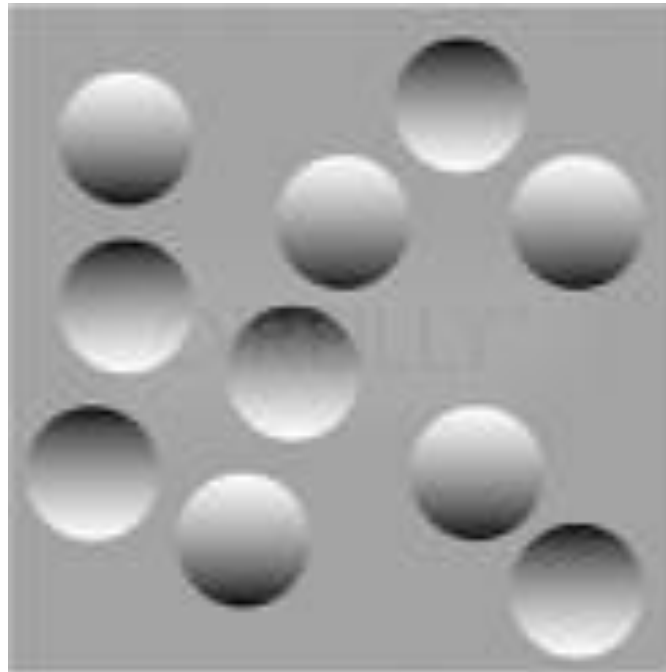
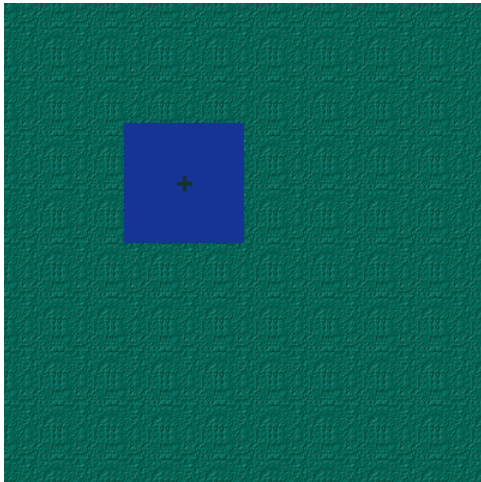


Depth Perception

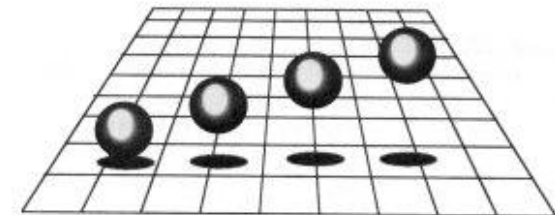
- **Monocular Cues**

- Light & Shadow

- Dimmer objects seem farther away
 - We assume that light comes from above



A



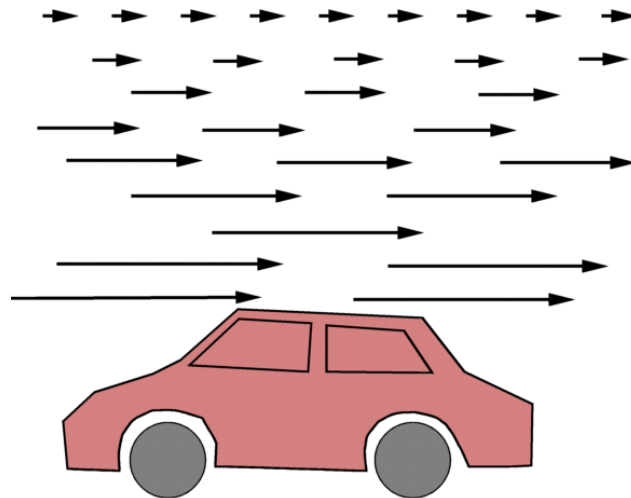
B

Depth Perception

- **Monocular Cues**

- Relative Motion/Motion Parallax

- As we move, objects that are actually stable may appear to move; the nearer the object is to you, the faster it seems to move

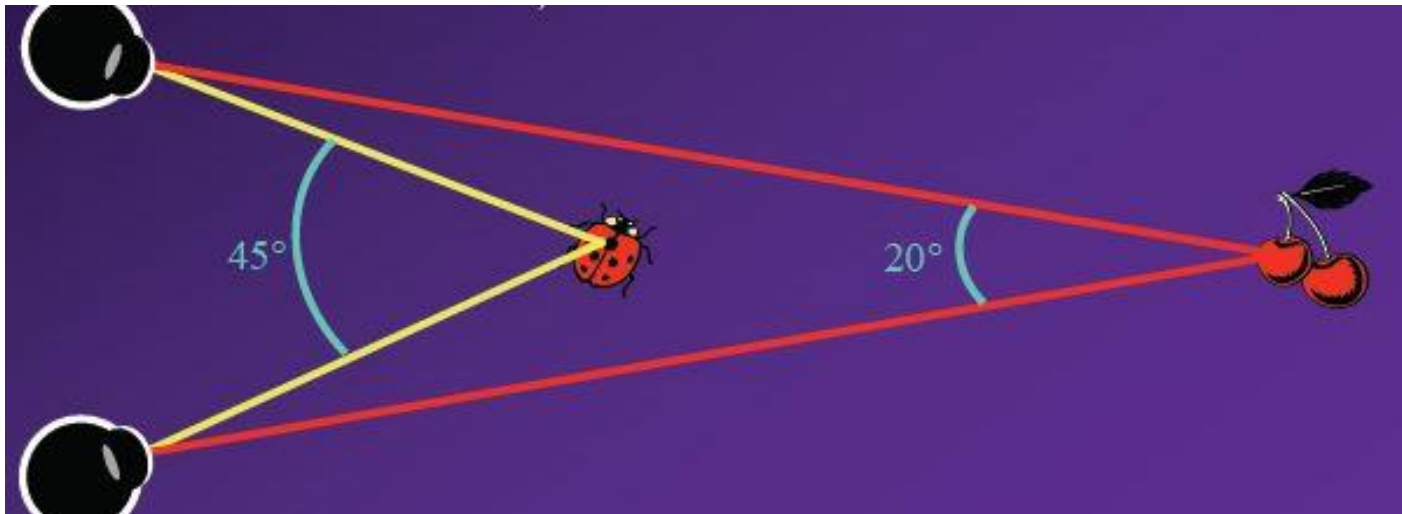


Depth Perception

- **Binocular Cues**

- Convergence

- Extent to which the eyes converge inward when looking at an object; the greater the inward strain, the closer the object



Depth Perception

- **Binocular Cues**

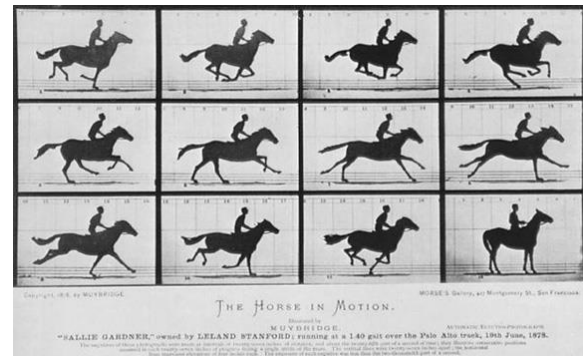
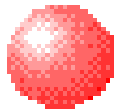
- Retinal Disparity

- By comparing images from the two eyeballs, the brain computes distance- the greater the disparity between the two images, the closer the object



Motion Perception

- Phi Phenomenon: illusion of movement created when 2 or more adjacent lights blink on and off in quick succession
- Stroboscopic Motion: brain perceives continuous movement in a rapid series of slightly varying images



Perceptual Constancy

- Color Constancy: in differing illumination conditions, colors look the same
- Size Constancy: even though an object casts smaller image on retina when far away, it is understood the size is the same
- Shape Constancy: when looking at objects from multiple angles, we know the shape stays the same

Perceptual Constancy

- Brightness Constancy: objects keep constant brightness even in different lighting conditions

Perception

- Perceptual Adaptation: in vision, the ability to adjust to an artificially displaced or even inverted visual field
- Perceptual Set: mental predisposition to perceive one thing and not another





Extrasensory Perception

- Telepathy
 - reading minds
- Clairvoyance
 - perceiving remote events
- Precognition
 - perceiving future events
- Psychokinesis/Telekinesis
 - moving objects with the mind

