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

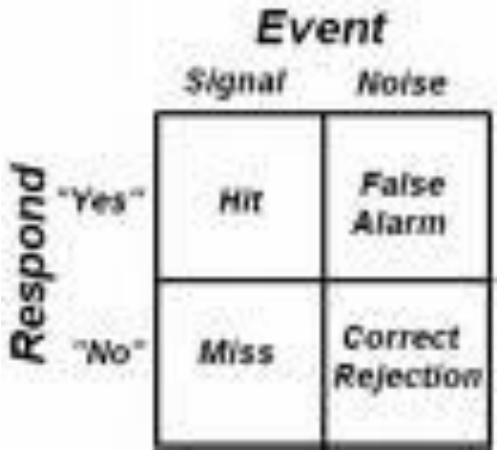
- Absolute Threshold: minimum level of stimulation that can be correctly detected at least 50% of the time
- Subliminal Stimulation: stimulation not detected on a conscious level; below absolute threshold

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

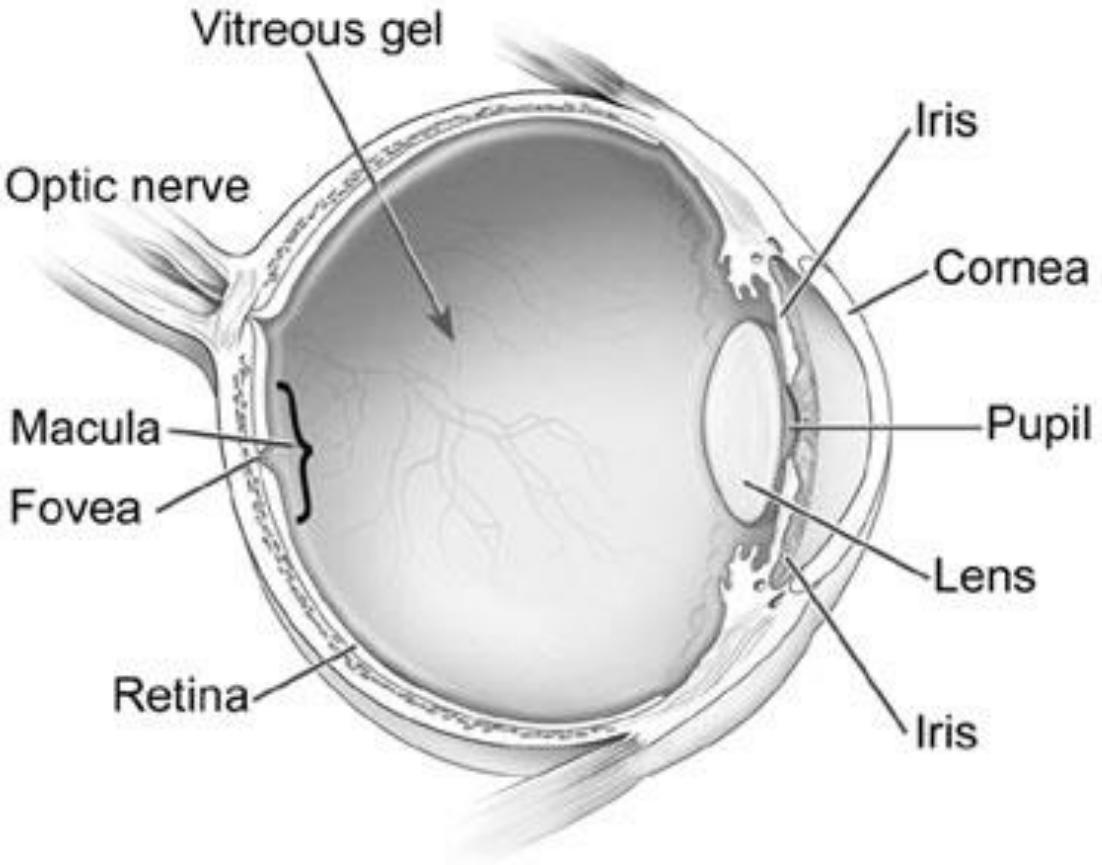
Psychophysics

- **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



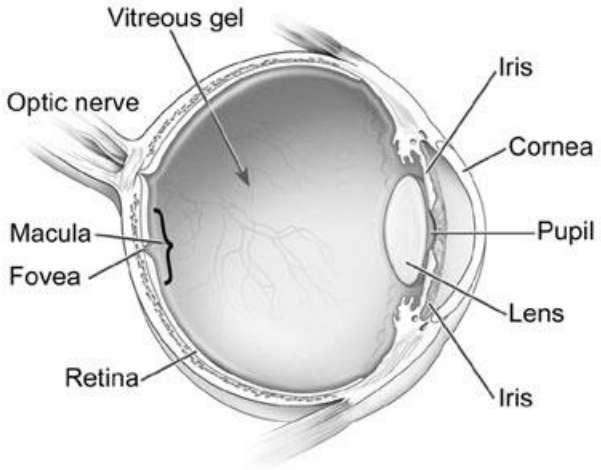
Vision

- **Structures of the Eye & Brain**



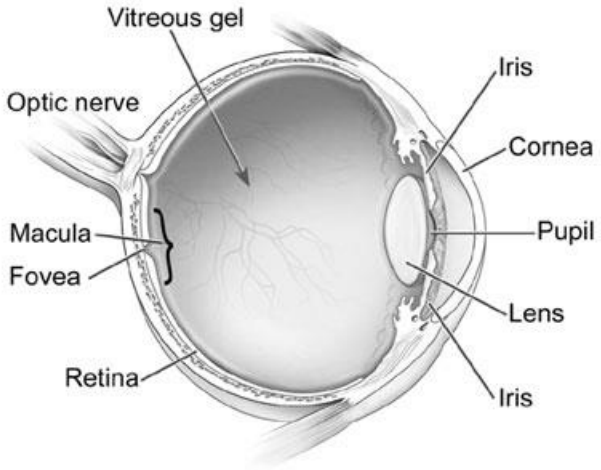
Vision

- **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

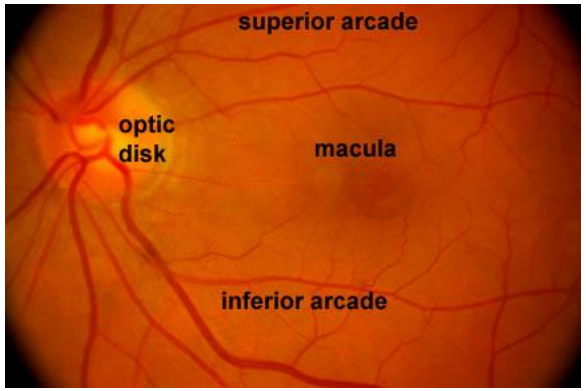


Vision

- **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

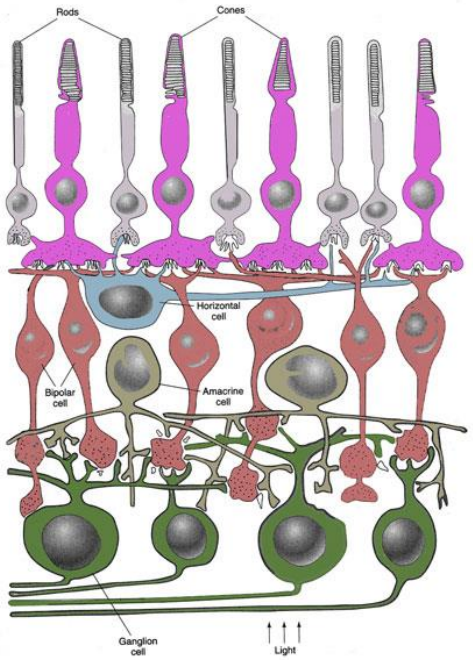


Vision



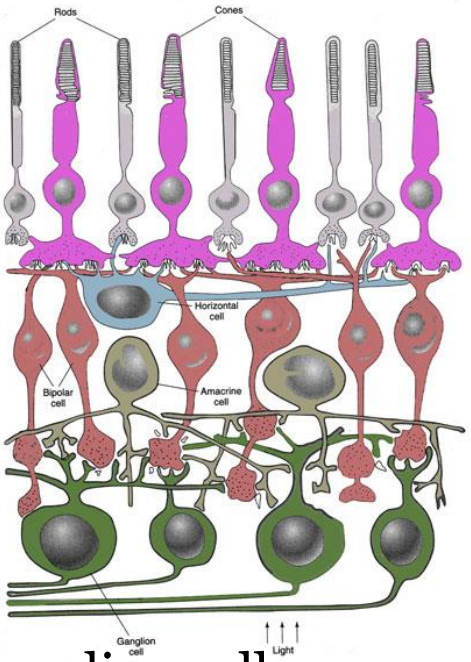
- **Structures of the Eye**
  - Retina
    - neural tissue lining back surface of the eye
    - Macula
      - center of retina responsible for detailed central vision
    - Fovea
      - part of the macula; contains cones only; where visual acuity is greatest

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

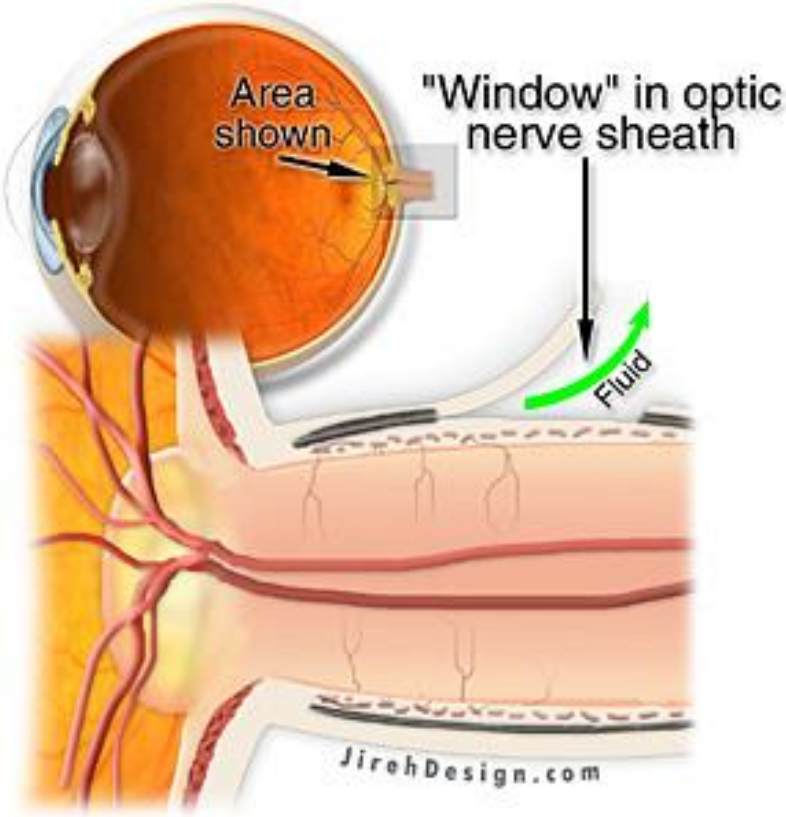
Vision



- **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

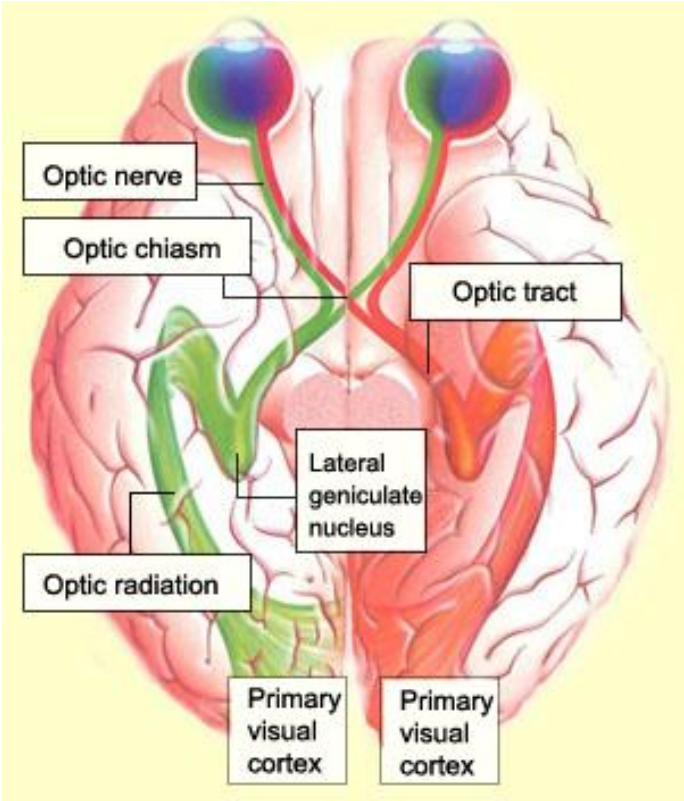
Vision

- **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

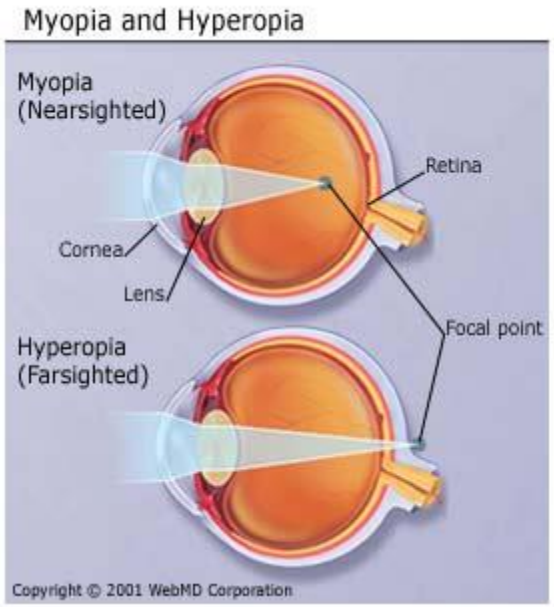
Vision

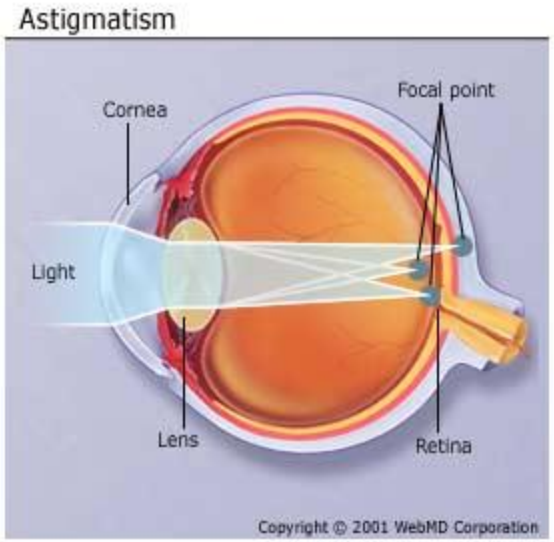
- **Parallel Processing**
  - processing of various aspects of a visual stimulus is simultaneous
  - Color, Form, Depth, Movement
  - Stroop Effect
    - Saying color of words with corresponding semantics is easier and quicker than saying color of words NOT with corresponding semantics
    - Becomes difficult after people learn how to read

      RED BLUE GREEN vs. BLUE GREEN RED

Vision

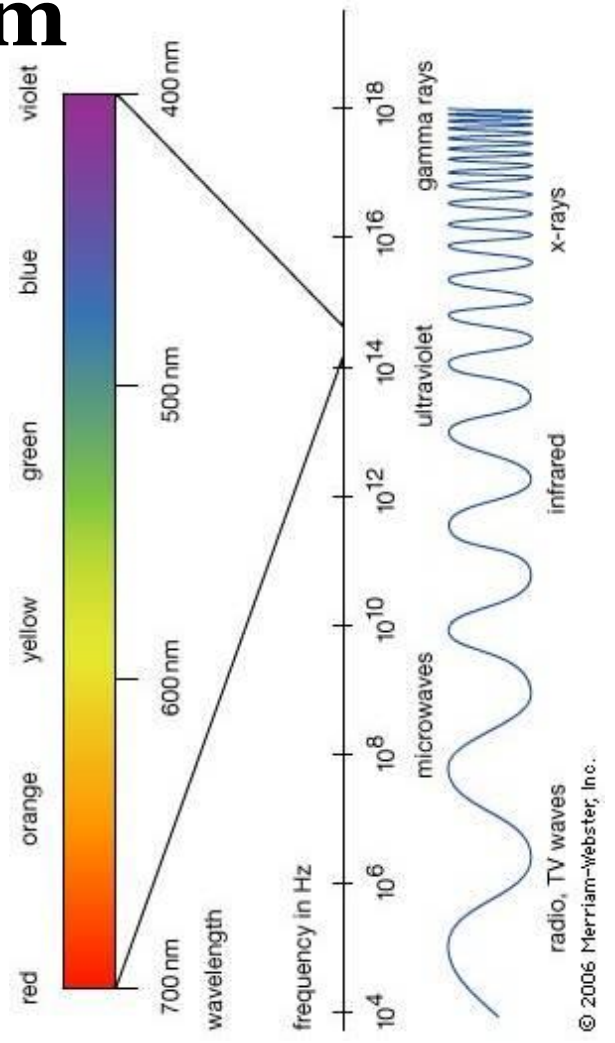
- **Visual Acuity**
  - sharpness & detail of image
    - Myopia
      - nearsightedness; light focused before it gets to the retina for far objects
    - Hyperopia
      - farsightedness; light focused after it gets to the retina for near objects
    - Astigmatism
      - irregularity in the shape of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





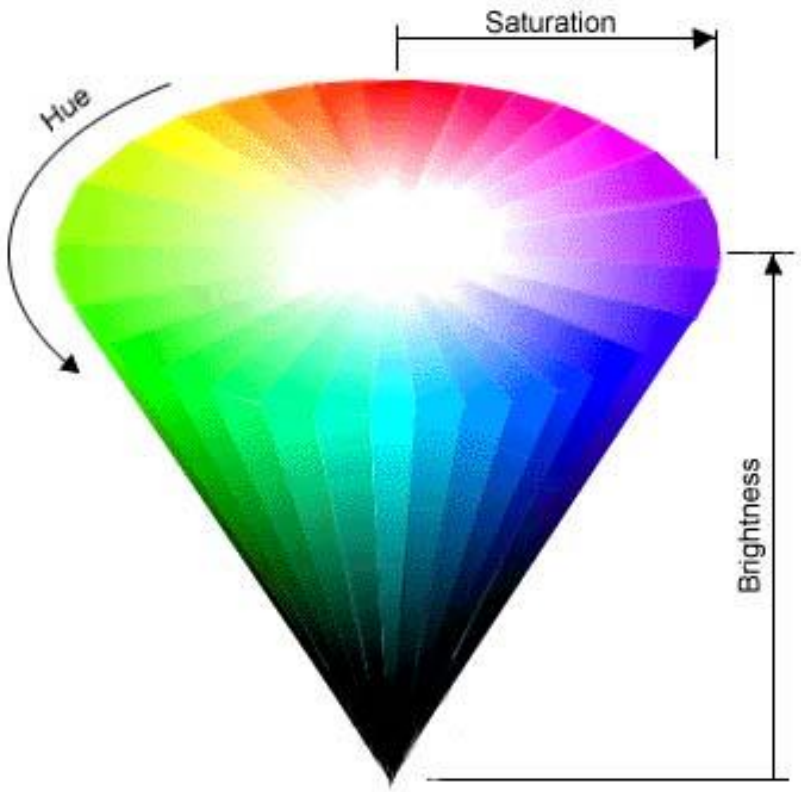
Vision

- **Electromagnetic Spectrum**
  - Wavelength
    - distance between peaks
  - Frequency
    - number of wavelengths per given amount of time
  - Amplitude
    - height of wave

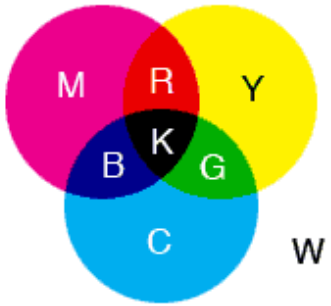


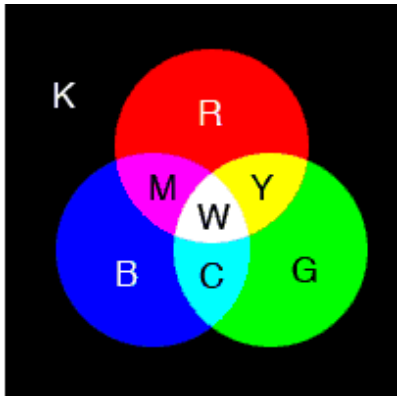
Vision

- **Perception of Light**
  - Brightness
    - determined by amplitude; how dark or light a color is
  - Hue/Color
    - determined by wavelength/frequency
  - Saturation
    - richness of color



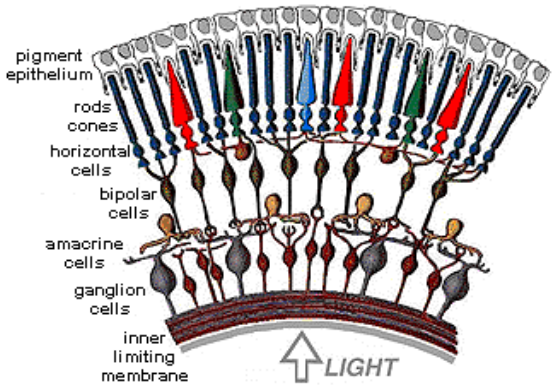
Vision





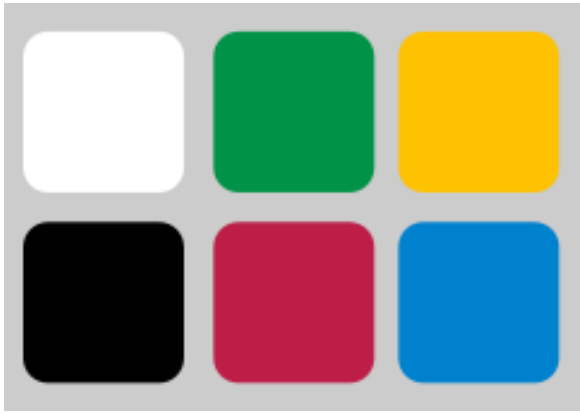
- **Color Mixing**
  - Subtractive Color Mixing
    - primary colors are magenta, cyan & yellow
    - mixing colors *subtracts* wavelengths and absorbs all but black
  - Additive Color Mixing
    - primary colors are red, blue, & green
    - mixing colors *adds* wavelengths and reflects white

Vision

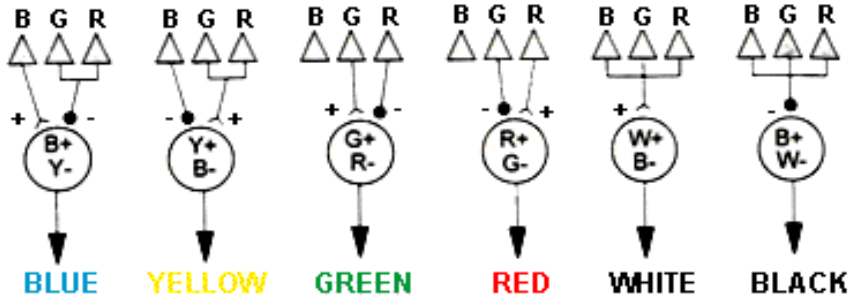


- **Theories of Color Vision**
  - Trichromatic Theory (Young-Helmholtz)
    - Eyes have 3 different color photoreceptors (blue, green, red) sensitive to certain wavelengths of light
    - All other colors are seen through firing of combination of cones
    - Proposed by Hermann von Helmholtz & Thomas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

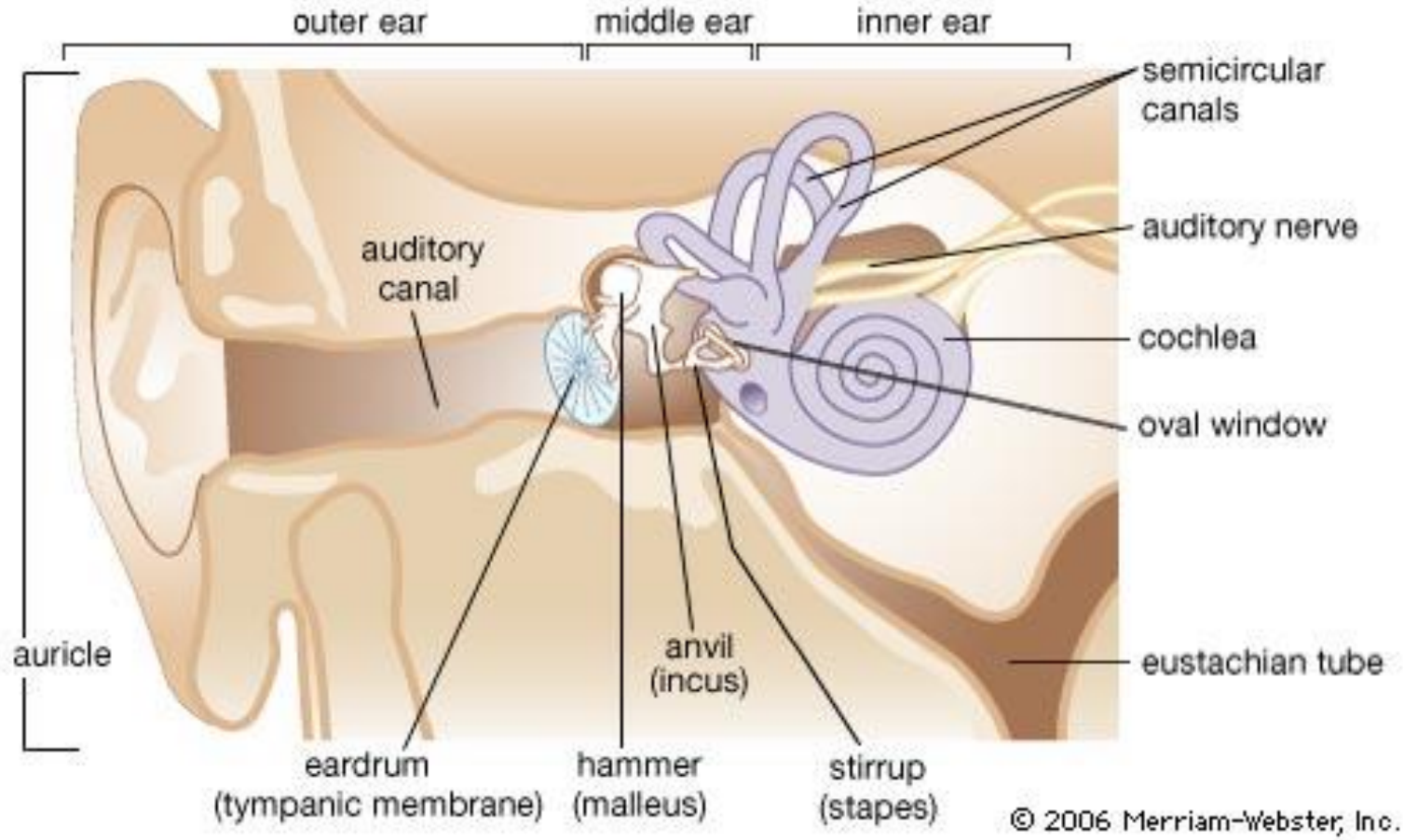
- **Adaptation**
  - Light Adaptation
    - Gradual decrease in sensitivity to high levels of light
    - Shift from using predominantly rods to using cones
  - Dark Adaptation
    - Gradual increase in sensitivity to low levels of light
    - Shift from using predominantly cones to using rods

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

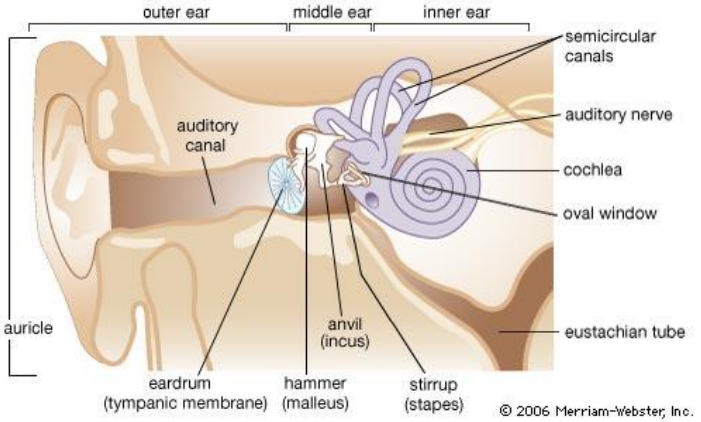
Audition

- **Structures of the Ear**

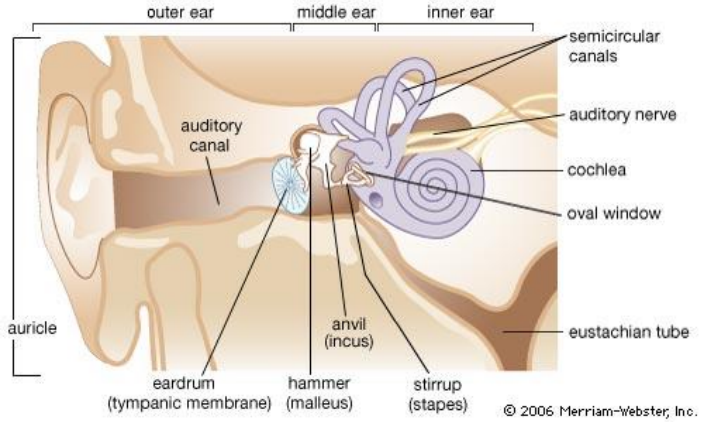


Audition

- **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



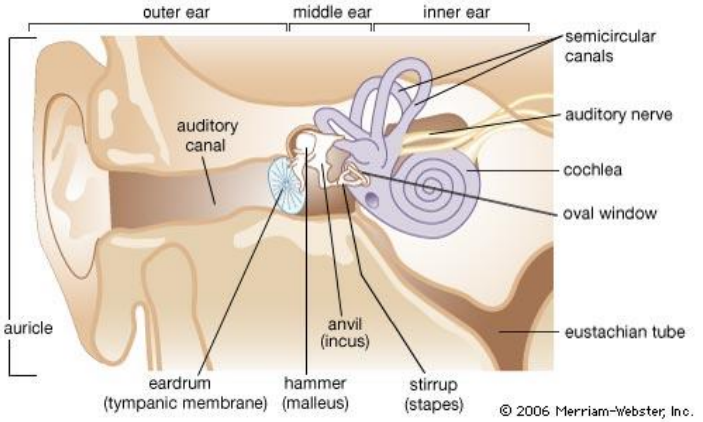
Audition



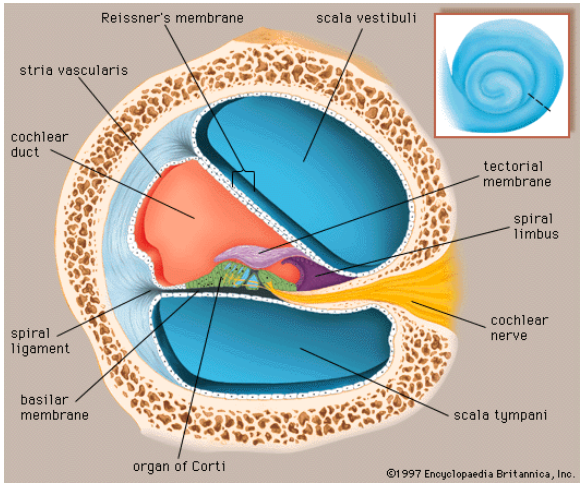
- **Structures of the Ear**
  - Middle Ear
    - Ossicles
      - middle ear bones; smallest bones in the body; transfer and amplify sound
      - Hammer (Malleus)
        - » transfers vibration from eardrum to anvil
      - Anvil (Incus)
        - » transfers vibration from hammer to stirrup
      - 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



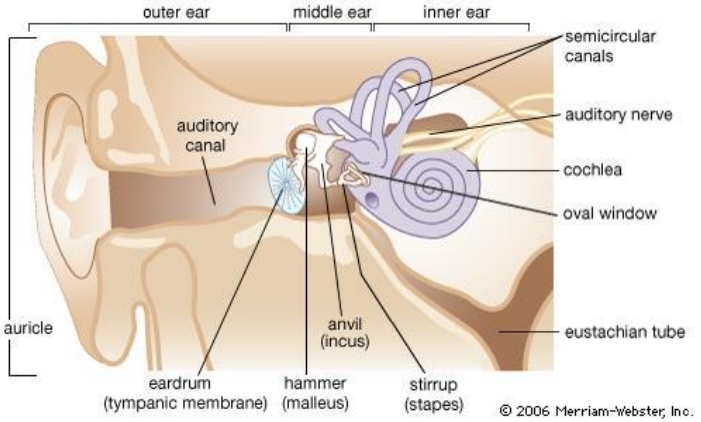
Audition



- **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)

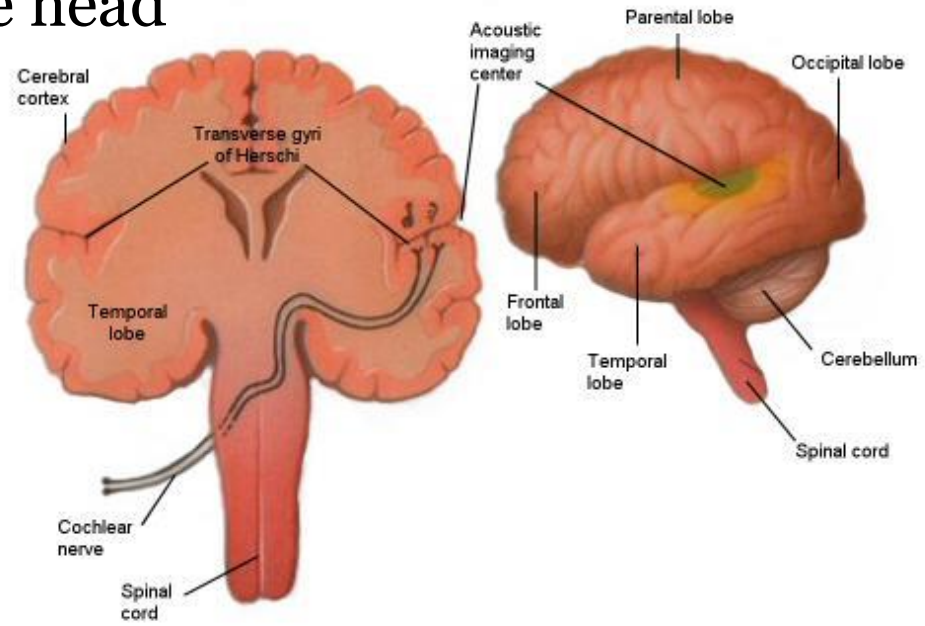
Audition

- **Structures of the Ear**
  - Inner Ear
    - Auditory Nerve
      - takes impulses from ear to auditory cortex



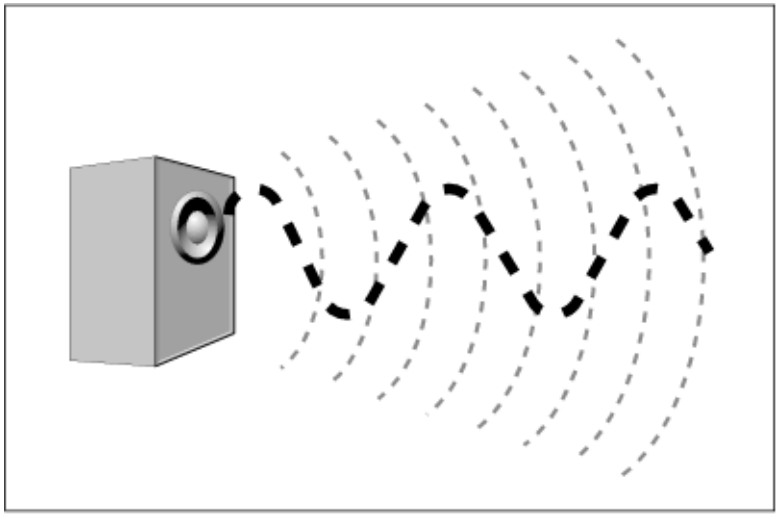
Audition

- **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

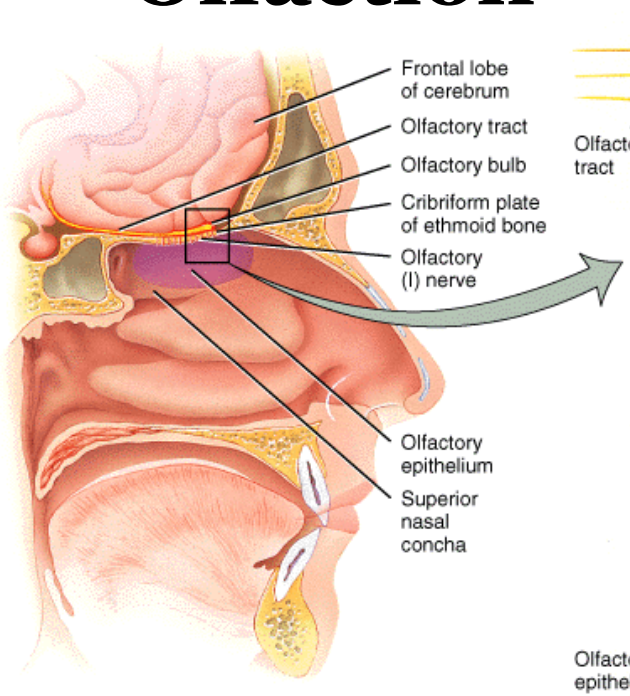
- **Theories of Hearing**
  - Locating Sounds
    - Sound Localization
      - Process of locating sounds
      - Sound wave will reach one ear faster than the other
      - Ear that hears quicker is closer to sound
      - Brain interprets the angle to locate the source of sound

Audition

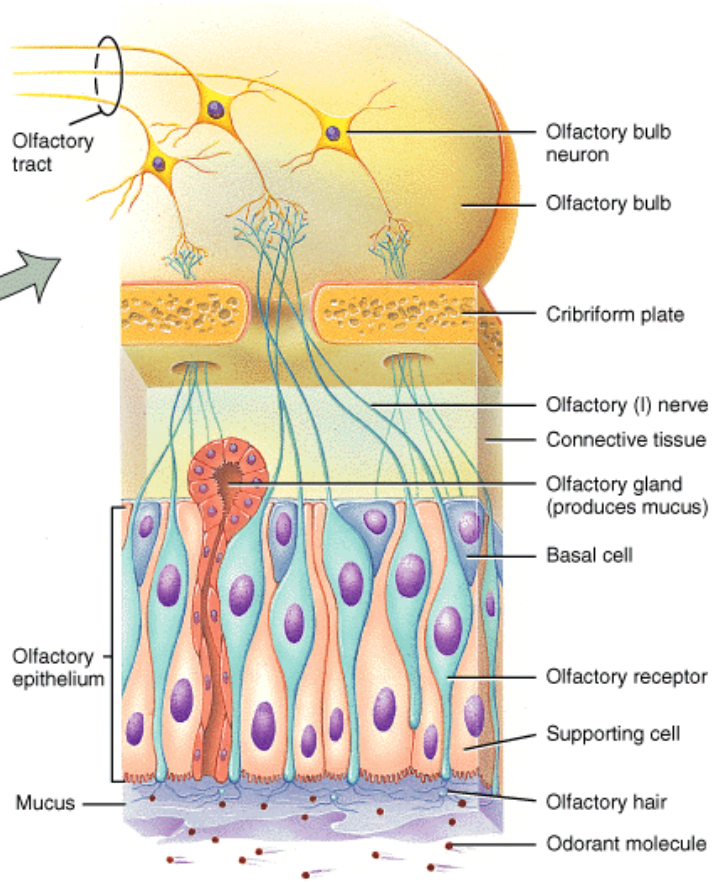
- **Hearing Loss**
  - Conduction/Conductive Hearing Loss
    - hearing loss as a result of damage to the outer or middle ear
  - Nerve Deafness/Sensorineural Hearing Loss
    - hearing loss as a result of damage to the inner ear or auditory nerve
  - Assistive Devices
    - Hearing aids amplify sounds
    - Cochlear implants communicate sound directly to the inner ear

Chemical Senses

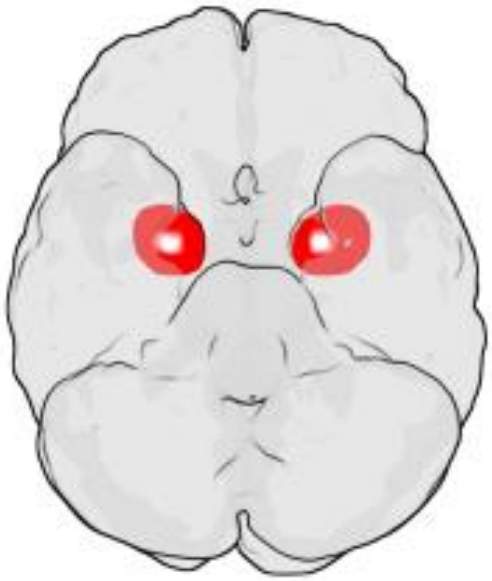
- **Olfaction**



(a) Sagittal view



(b) Enlarged view of olfactory receptors



Chemical Senses

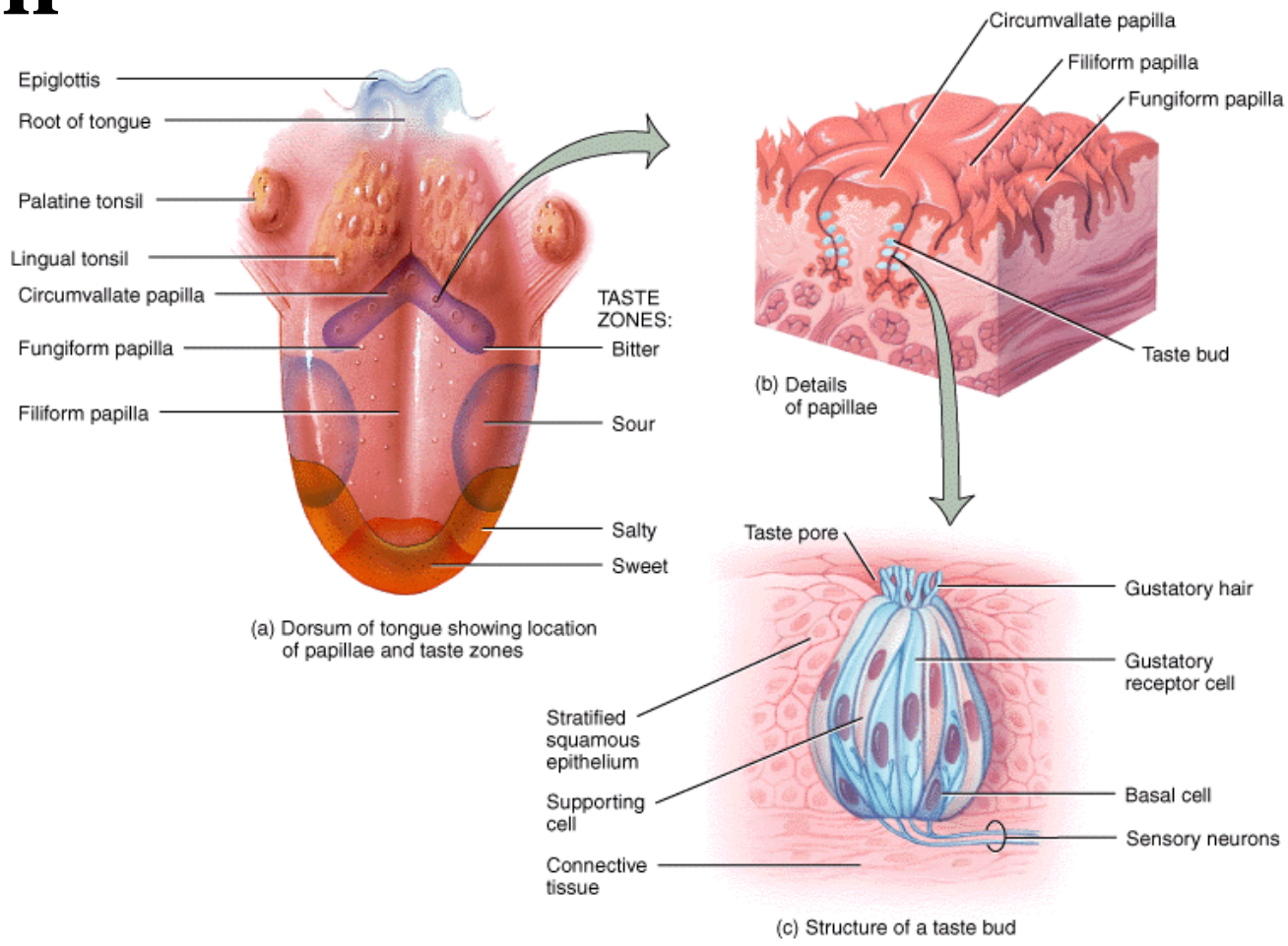
- **Olfaction**
  - Odor molecules are sensed in the olfactory epithelium at the top of the nasal cavity
  - Dissolved odorants bind to receptor sites for olfactory receptors which triggers an action potential
  - Axons pass impulses into the olfactory bulb which sends impulses to the olfactory cortex

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

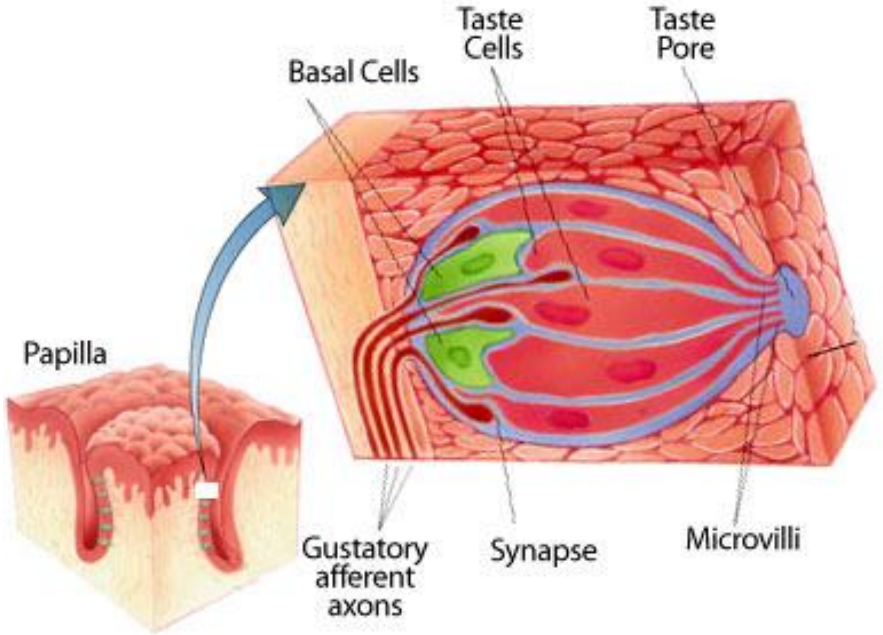
Chemical Senses

- **Gustation**



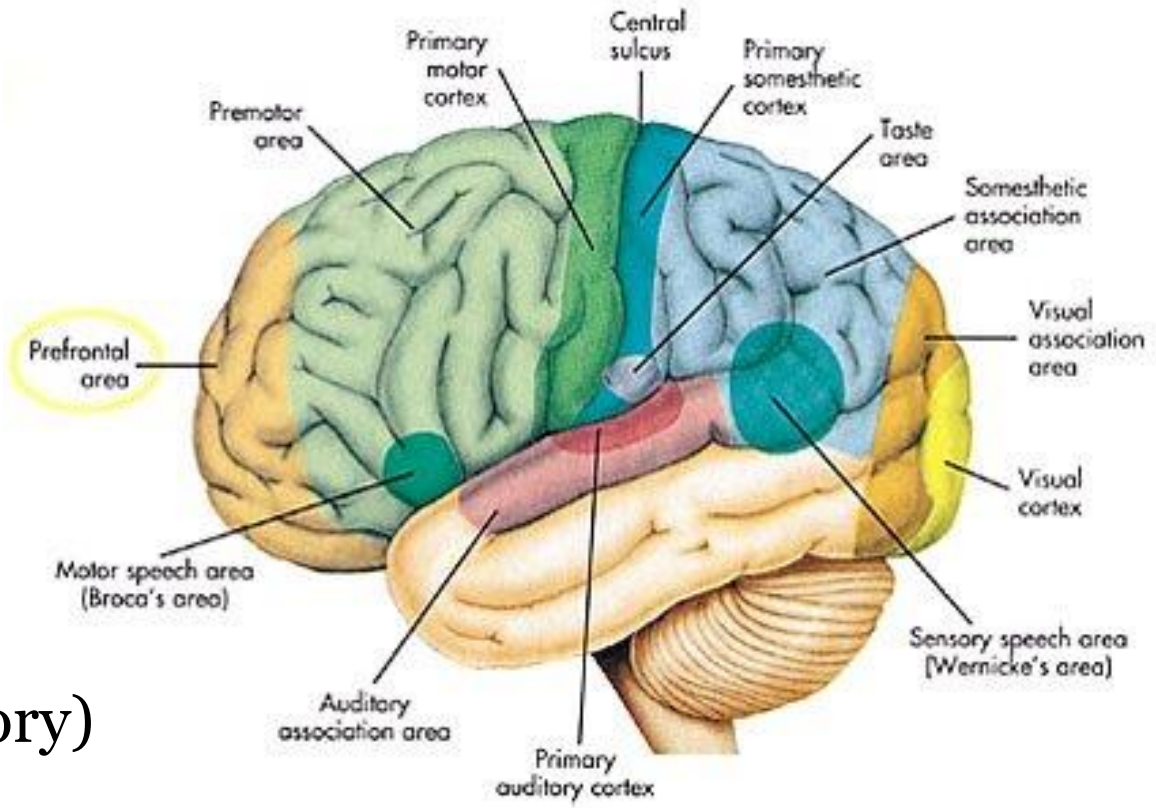
Chemical Senses

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



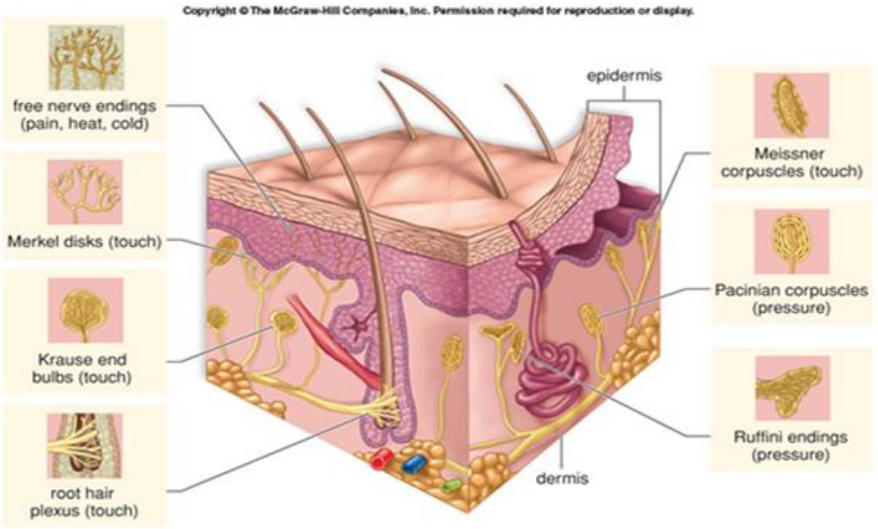
Chemical Senses

- **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

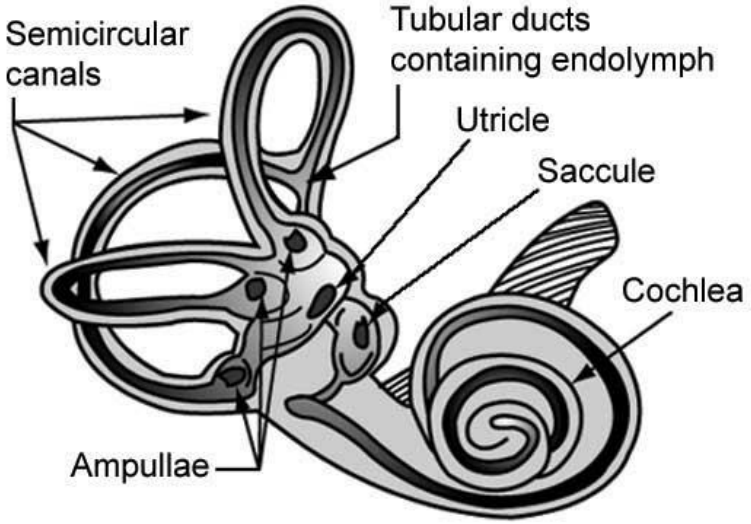
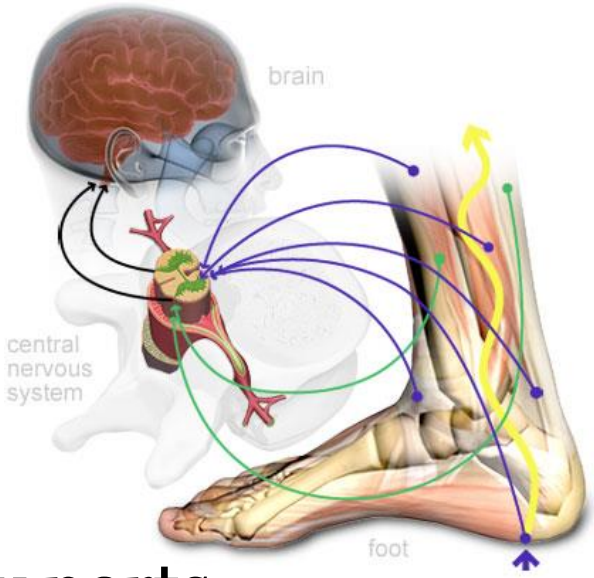


Figure 2: The Vestibular System - semicircular canals and otolith organs

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

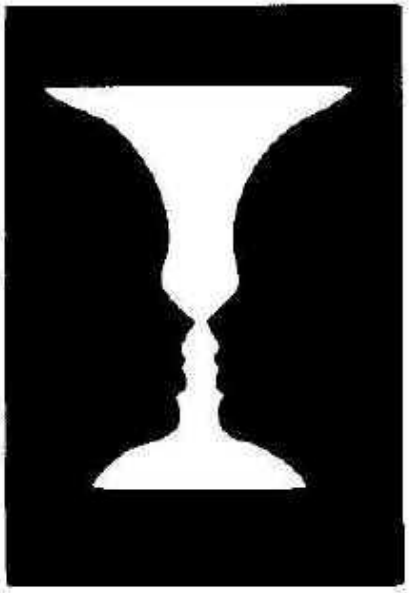
- **Sensory Compensation**
  - People who lose one aspect of sensation seem to compensate with slight enhancement of other sensory abilities
  - Brain plasticity can account for some changes, like blind using occipital lobe to read Braille

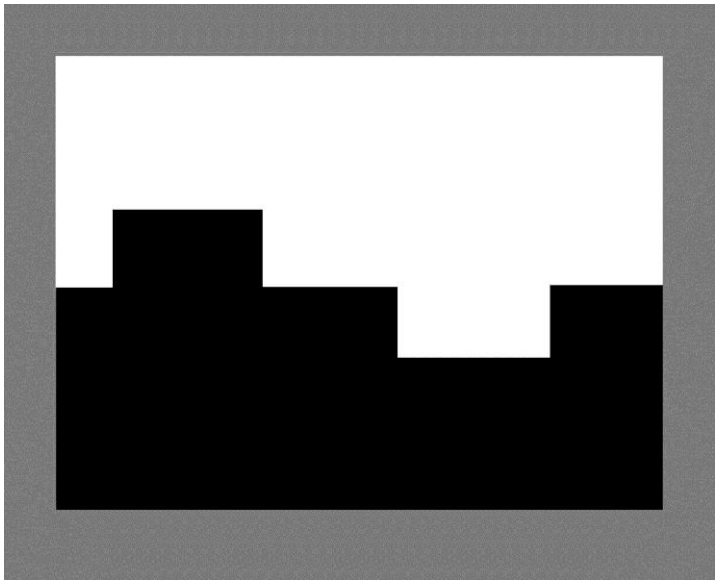
Perception

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

Form Perception

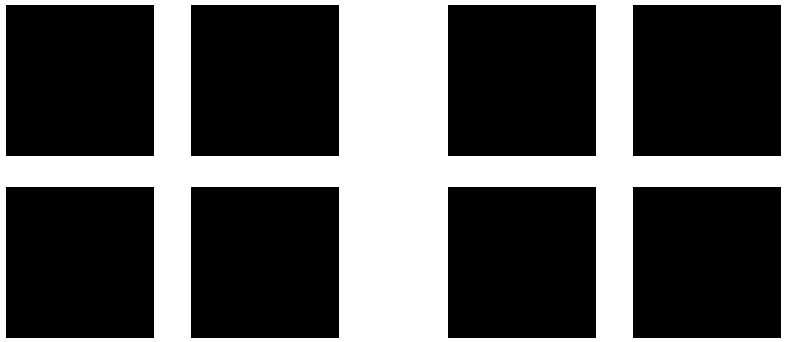
- **Figure-Ground**
  - organization of visual field into objects (figures) that stand out from their surroundings (ground)

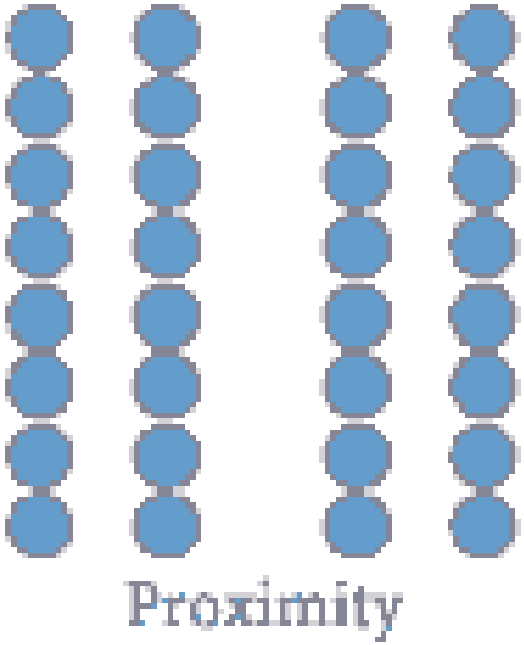




Form Perception

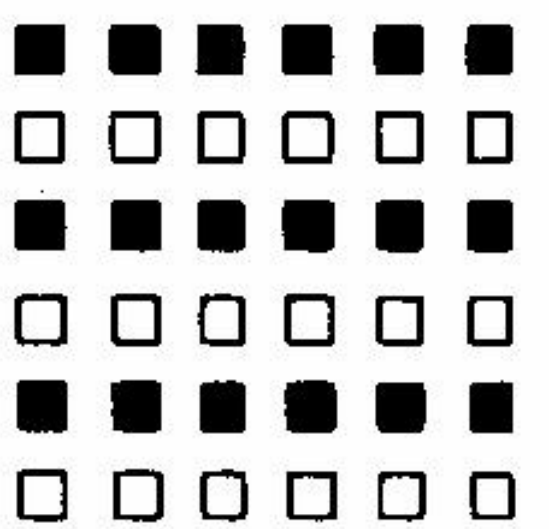
- **Gestalt Grouping Principles**
  - Proximity
    - group objects together based on proximity to other objects

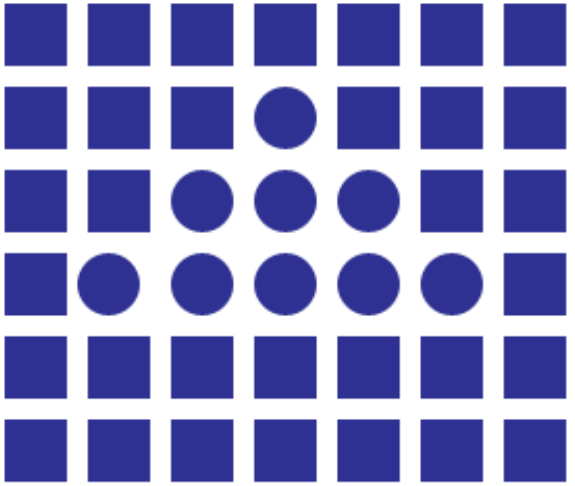




Form Perception

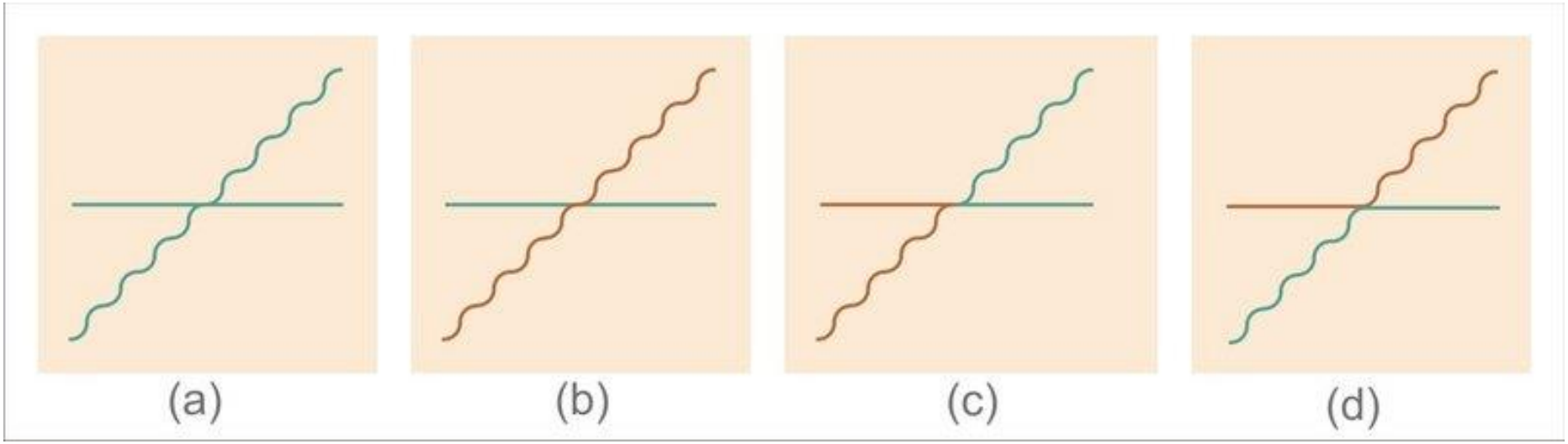
- **Gestalt Grouping Principles**
  - Similarity
    - group objects together according to which objects are most similar to it





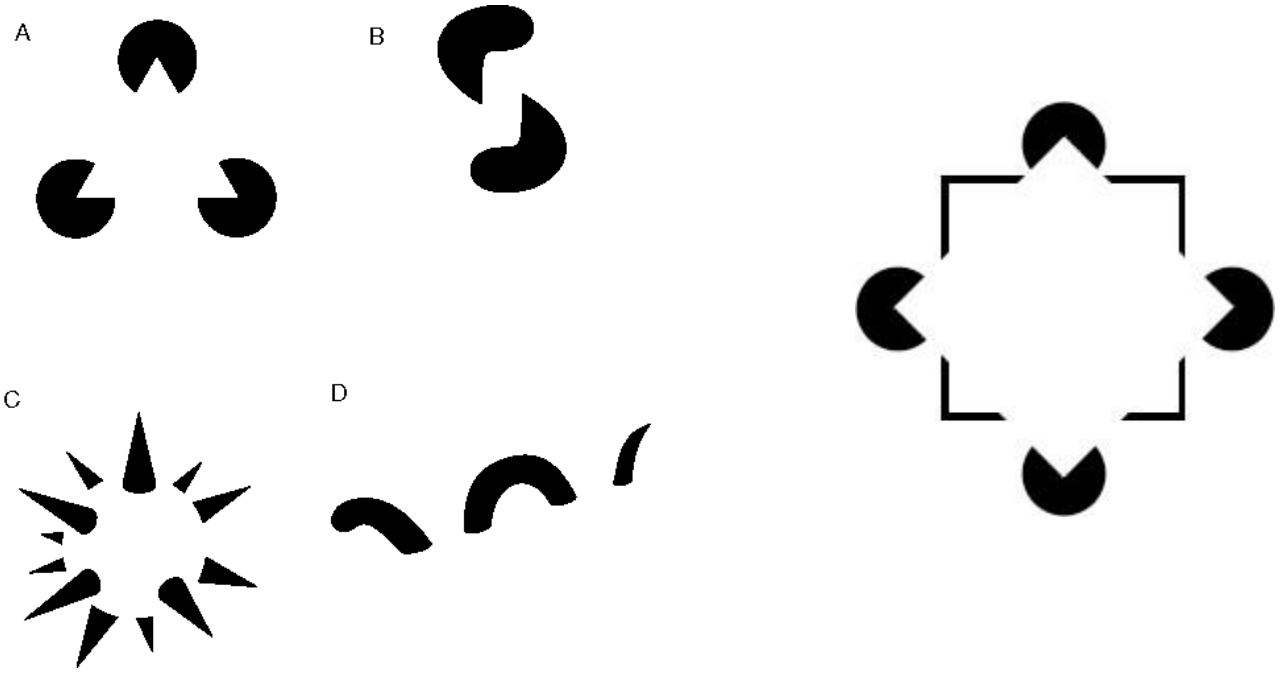
Form Perception

- **Gestalt Grouping Principles**
  - Continuity
    - we perceive smooth, continuous patterns rather than discontinuous ones



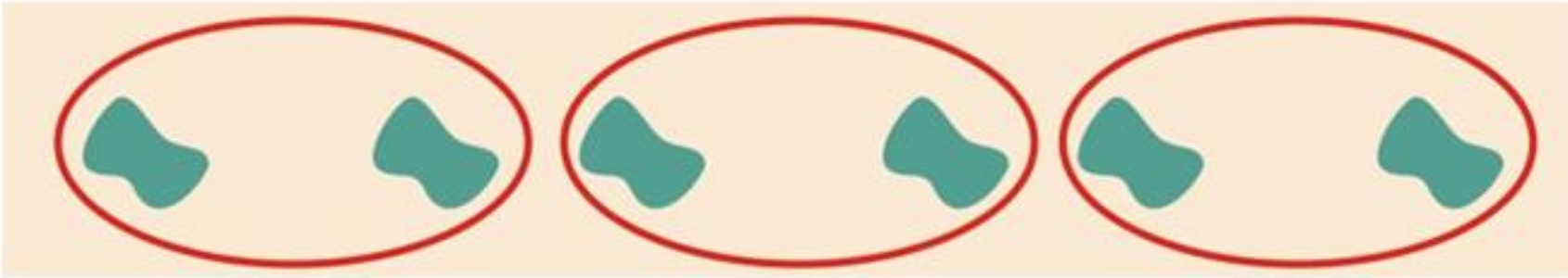
Form Perception

- **Gestalt Grouping Principles**
  - Closure
    - we fill in gaps to create a complete whole object



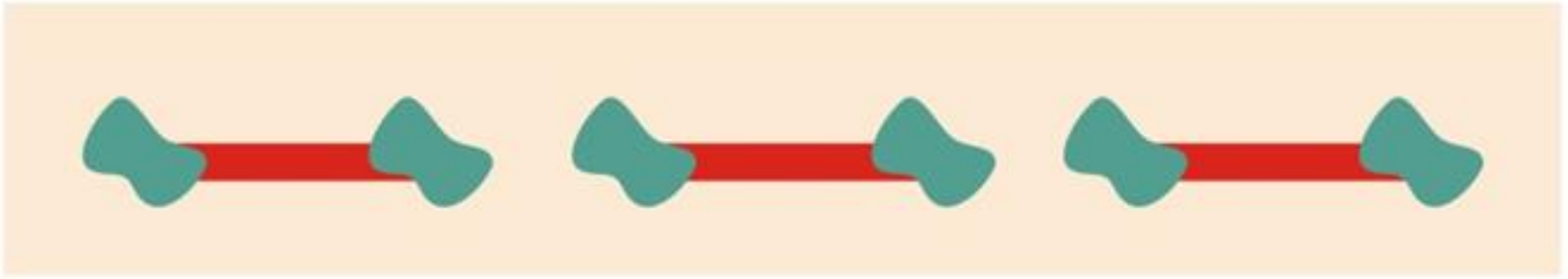
Form Perception

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



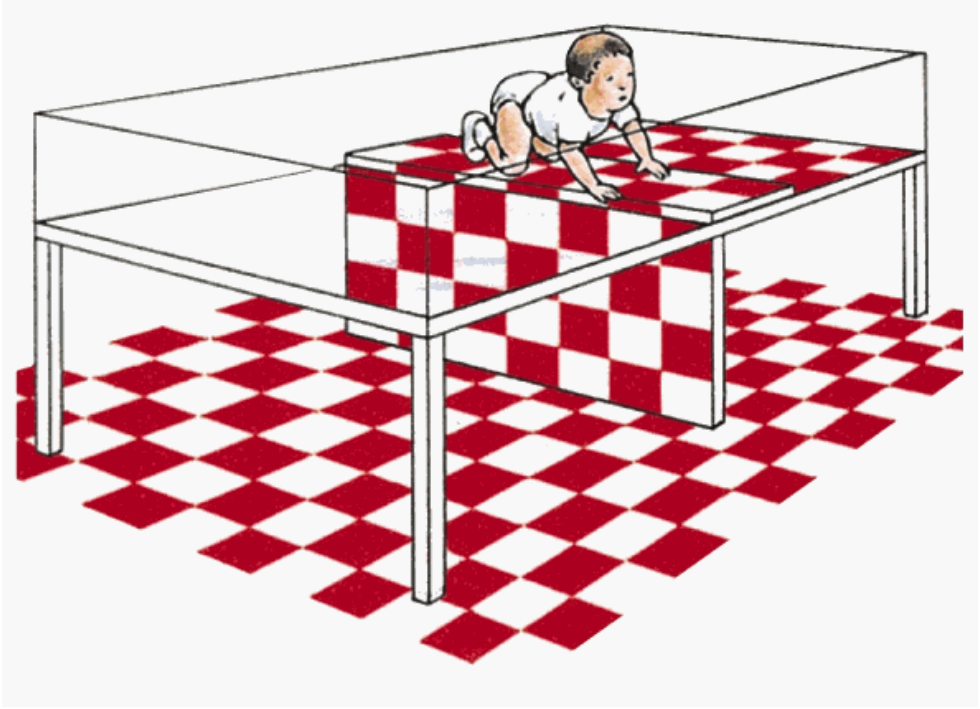
Form Perception

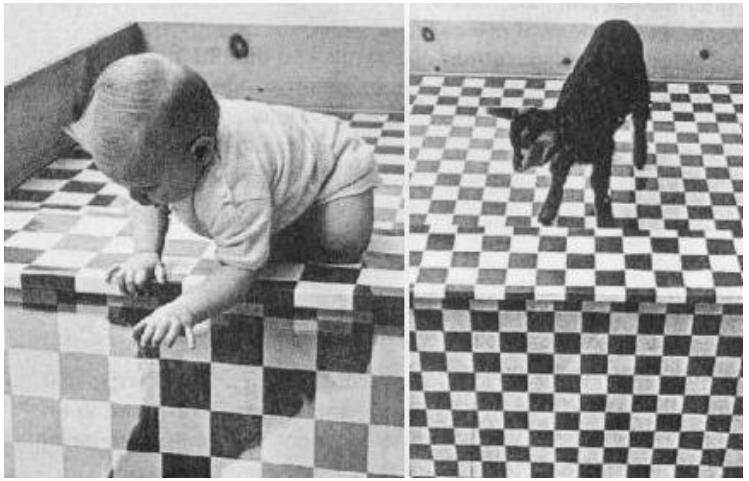
- **Gestalt Grouping Principles**
  - Connectedness
    - perceive connected objects as a single unit



Depth Perception

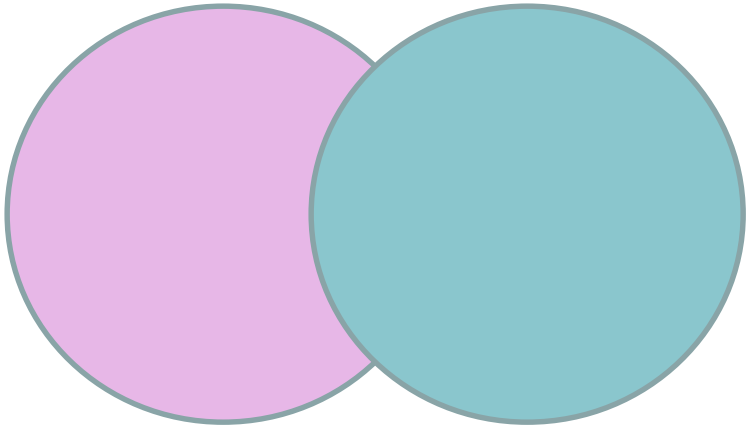
- Visual Cliff: device to test depth perception in infants and young animals





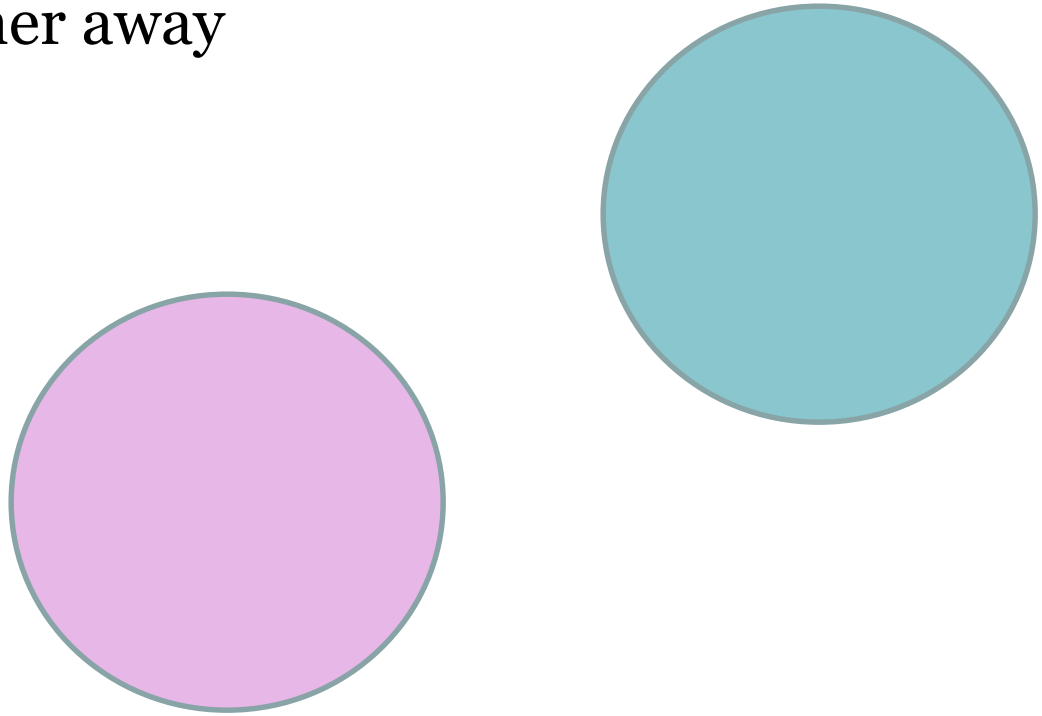
Depth Perception

- **Monocular Cues**
  - Interposition
    - If one object blocks view of another, that object is closer



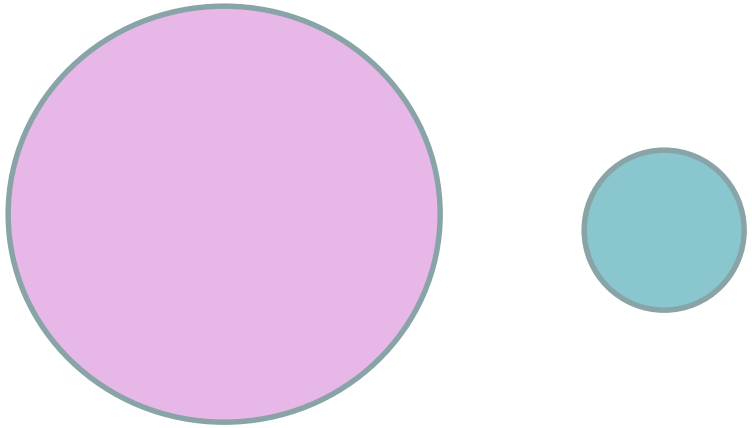
Depth Perception

- **Monocular Cues**
  - Relative Height
    - Objects higher in visual field are perceived as farther away



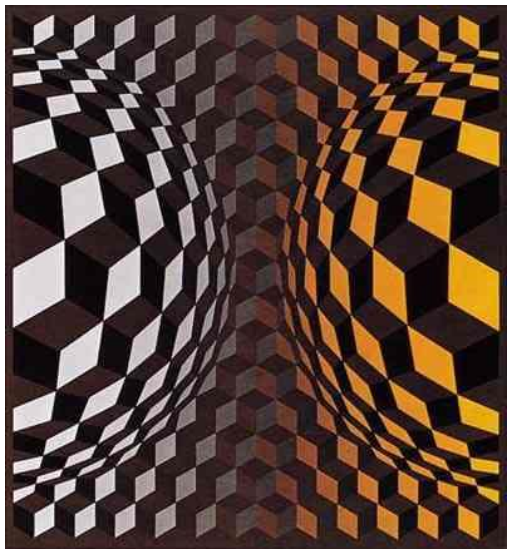
Depth Perception

- **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

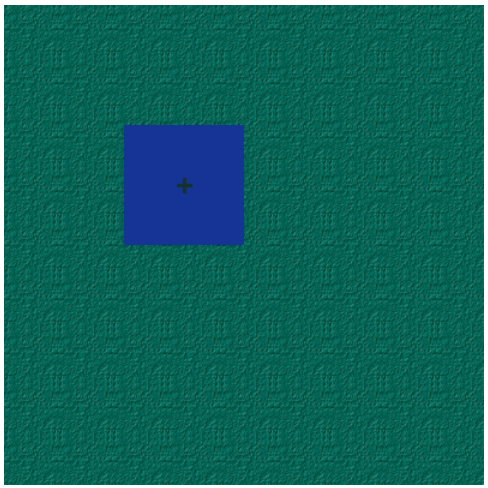
- **Monocular Cues**
  - Linear Perspective
    - Parallel lines seem to converge with greater distances

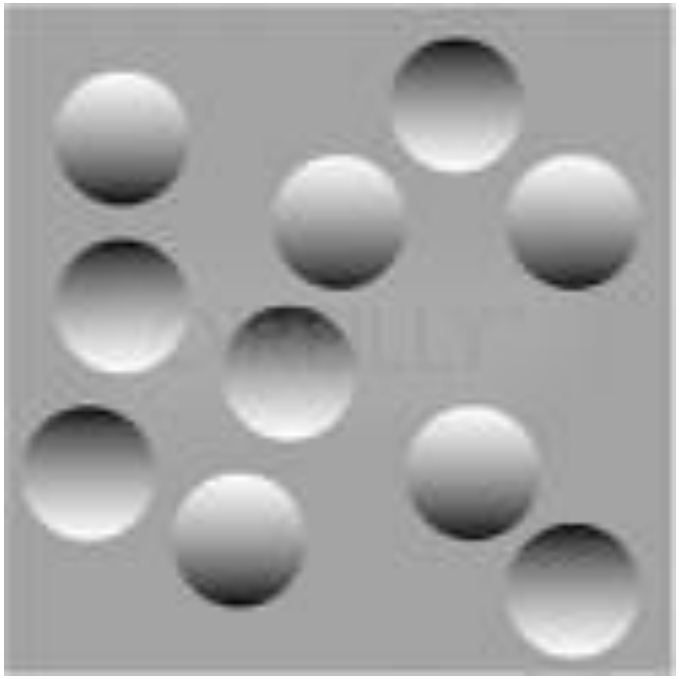
Depth Perception

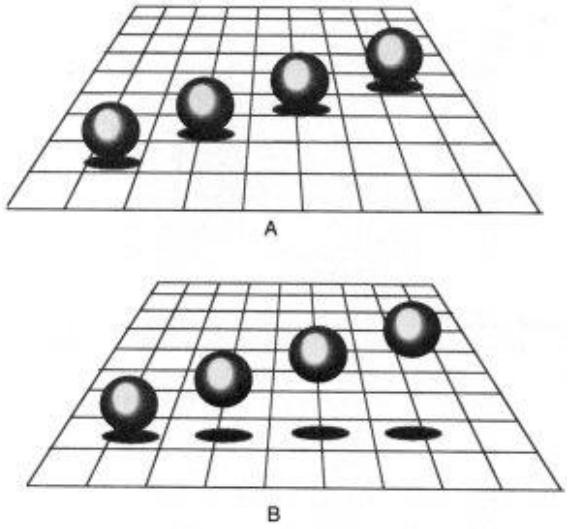
- **Monocular Cues**
  - Relative Clarity
    - Hazy objects are perceived as being farther away

Depth Perception

- **Monocular Cues**
  - Light & Shadow
    - Dimmer objects seem farther away
    - We assume that light comes from above

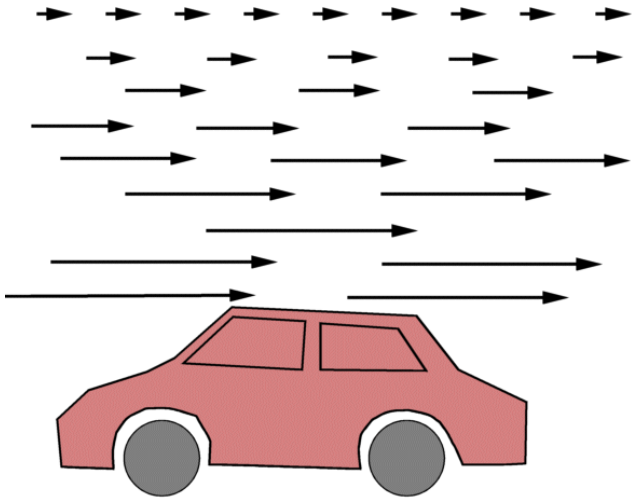






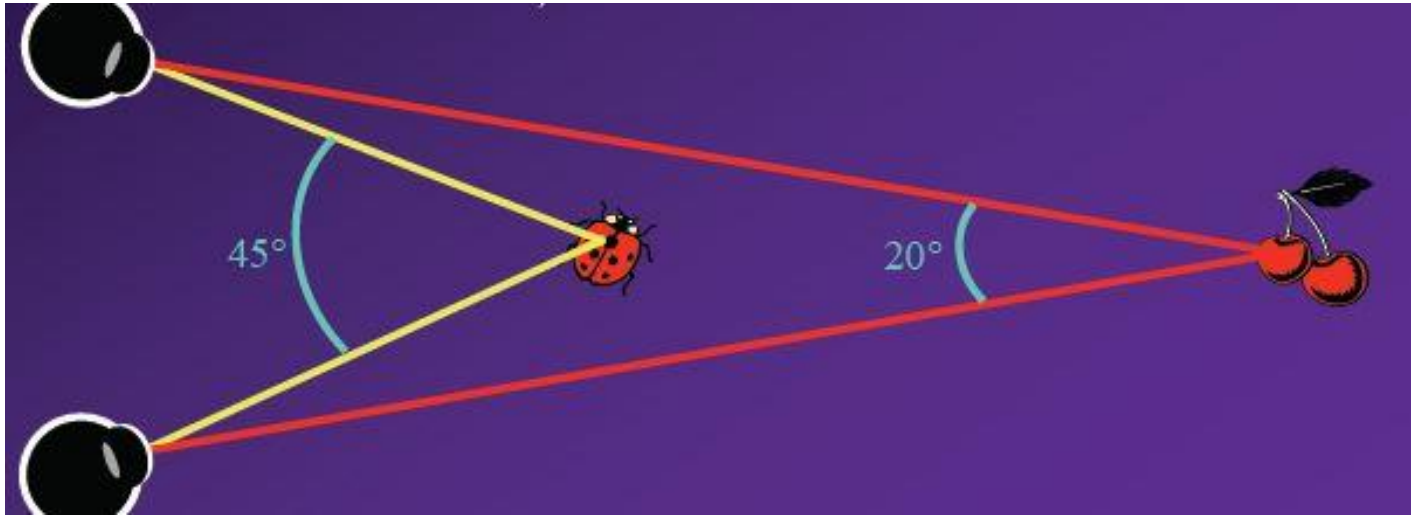
Depth Perception

- **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

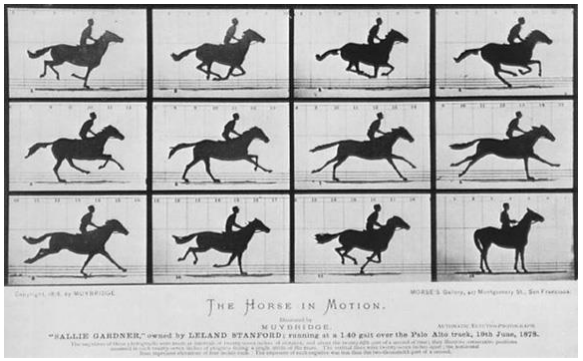


Depth Perception

- **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

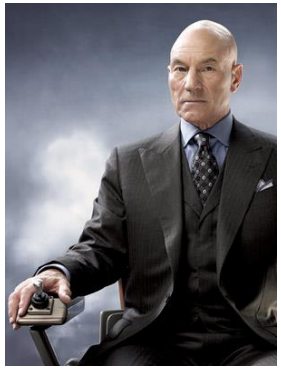
Perceptual Constancy

- 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