



Sensation & Perception

PY 211

General Psychology

Sensation & perception

- **Sensation:** the process of receiving, translating, and transmitting messages from the outside world to the brain
- **Perception:** the process of organizing and interpreting information received from the outside world

Sensation

- **Stimulus:** any aspect of the outside world that directly influences our behavior or conscious experience
- **Transduction:** the translation of one form of energy to another
 - Light, sound, chemical, pressure, heat, etc. >> neural impulses

Sensation

- **Sense organs:** organs that receive stimuli i.e. eyes, ears, tongue, nose, and skin
- **Sensory receptor cells:** cells in sense organs that translate messages into neural impulses sent to the brain

Sensory limits

- **Threshold:** the lowest limits of sensory experience
 - **Absolute threshold:** the smallest magnitude of a stimulus that can be detected
 - **Difference threshold:** the smallest difference between two stimulus that can be detected

Sensory limits

Absolute threshold

Vision: a candle flame seen at 30 miles on a clear, dark night

Hearing: a tick of a watch under quiet conditions at 20 feet

Taste: one teaspoon of sugar in 2 gallons of water

Smell: one drop of perfume diffused into the entire volume of a 3-room apartment

Touch: the wing of a bee falling on your cheek from a height of 1 cm

Psychophysics

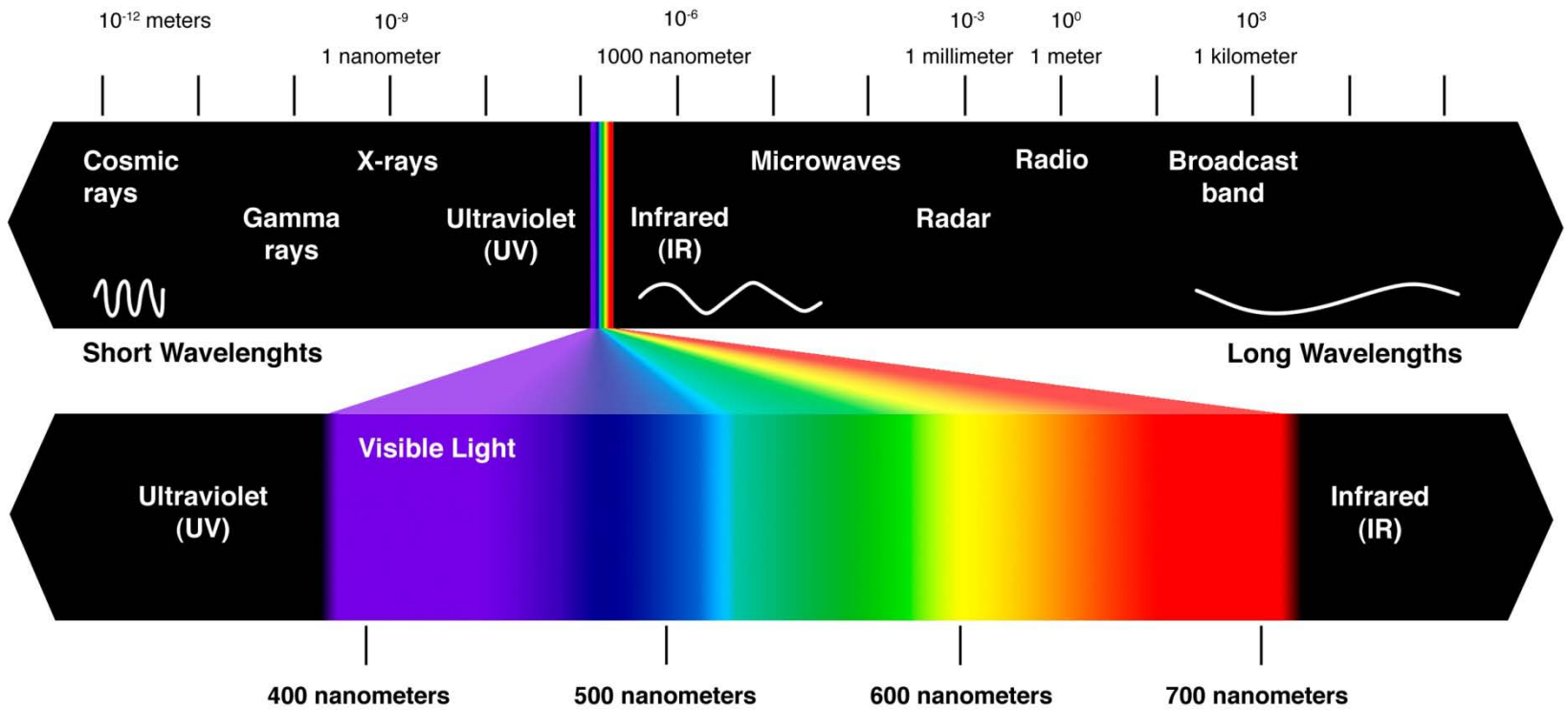
- A specialty area of psychology that studies sensory limits, sensory adaptation, and related topics
- **Weber's law:** the amount of change in a stimulus needed to detect a difference is in direct proportion to intensity of the original stimulus

Sensory adaption

- Receptor cell's fatigue after prolonged presentation of the stimulus
- Weakened magnitude of a sensation

Vision: light

- Light: one small part of electromagnetic radiation (Visual spectrum: 400-700 nm)
- Waves = frequency + intensity
 - Intensity = brightness
 - Frequency = wavelength = color/hue (nm, THz)
 - Purenness = saturation



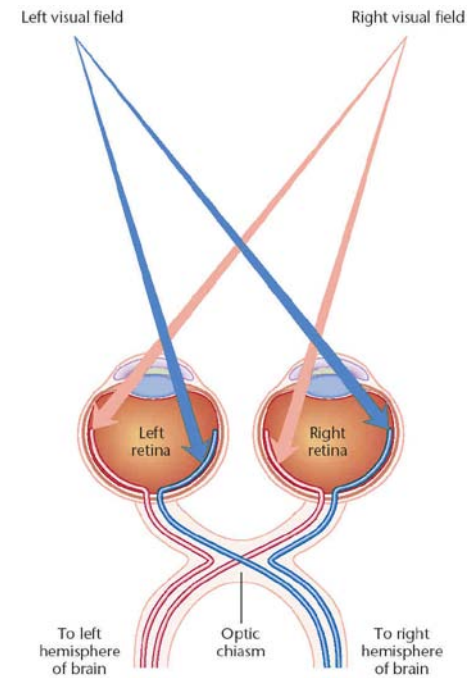
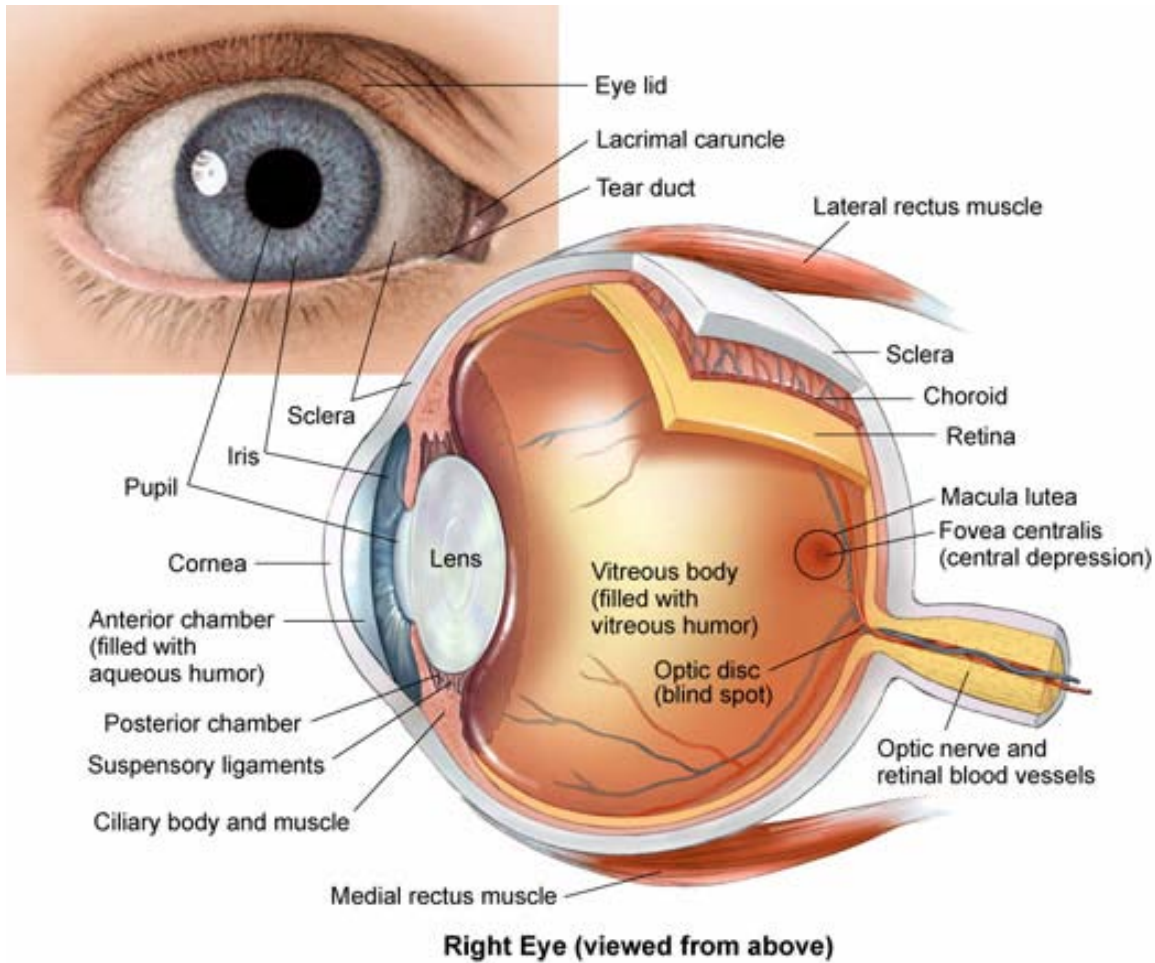
<http://deserthighlandspr.com/is-infrared-light-a-problem/>

Vision: the eye

- **Cornea:** the protective coating
- **Iris:** the colored part that regulates the amount of light that enters
- **Pupil:** the opening of the iris
- **Lens:** the transparent portion that focuses light
- **Ciliary muscle:** the muscle that controls the shape of the lens
- **Aqueous humor:** a transparent, gelatinous fluid in the space between the lens and the cornea
- **Vitreous humor:** the clear gel that fills the space between the lens and the retina

Vision: the eye

- **Retina:** the area at the back of the eye where images are formed by rods and cones
- **Fovea:** the central spot of the retina which cones are concentrated
- **Optic nerve:** the nerve that transmits neural impulses to the brain
- **Blind spot:** the spot near the center of the retina where the optic nerve is attached which renders the area blind
- **Optic chiasm:** the area in the brain where the optic nerves cross



Find your blind spot! Using the diagram below, fixate on the cross, close your right eye and hold the figure about 1.5 feet from your face. When the filled circle disappears, its image is on your blind spot. Fixate on the lower cross. Note how the line appears continuous.



Vision: the eye

- **Rods**

- 125 million cells
- Locate outside the center of the retina
- Light and dark

- **Cones**

- 6 million cells
- Locate mostly in the center of the retina
- Light, dark, and color

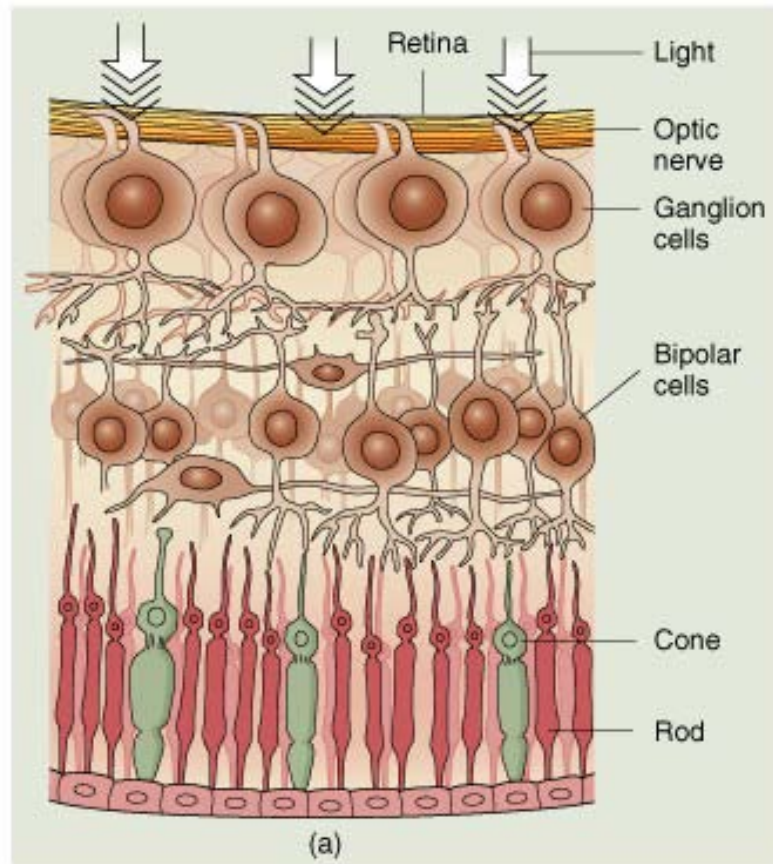
Vision: the eye

Rods VS cones

- Peripheral vision
- Light sensitivity
- Visual acuity
- Color vision

Visual processing in the brain

- Receptor cell > Bipolar cell > Ganglion cell > Optic nerve > Primary visual cortex
- Parallel processing
 - What: Temporal lobe
 - Where: Parietal lobe



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Dark & light adaptation

- **Dark adaptation:** increased sensitivity of the eye in semidarkness following an abrupt reduction in overall illumination
 - Stop firing
 - Regain sensitivity
 - Cones become fully sensitive within about 5 minutes
 - Rods continue to improve in sensitive, 100,000 times greater sensitivity after 30 minutes in the dark

Dark & light adaptation

- **Light adaptation:** regaining sensitivity of the eye to bright light following an abrupt increase in overall illumination
 - Overload
 - Bleach out some of the receptor chemicals and reduce the sensitivity
 - Take place in about 1 minute

Color vision

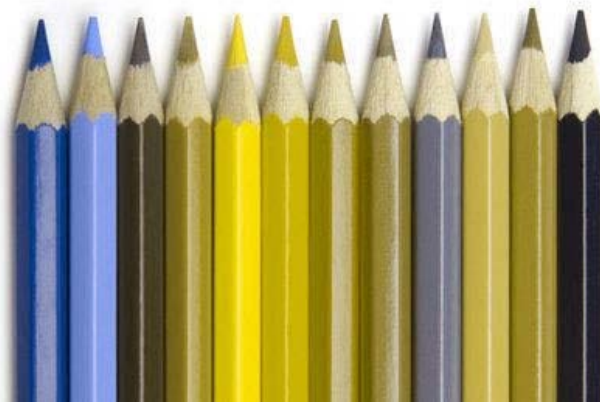
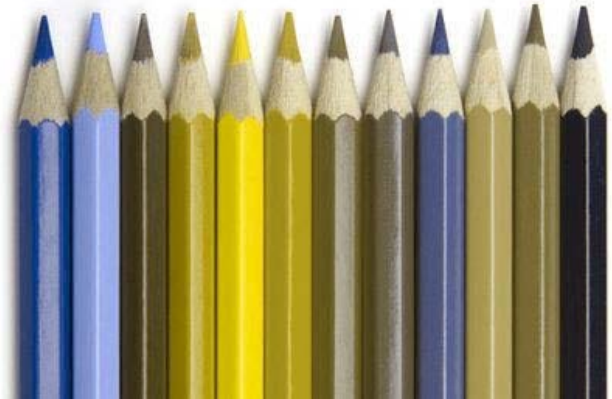
Trichromatic theory (Young & Helmholtz)

Three kinds of cones in the retina that responds mostly to light either the red (L), green (M), or blue (S) range of wavelengths

Unexplainable phenomena

- Complementary colors
- Color afterimages
- Partial color blindness

Color vision

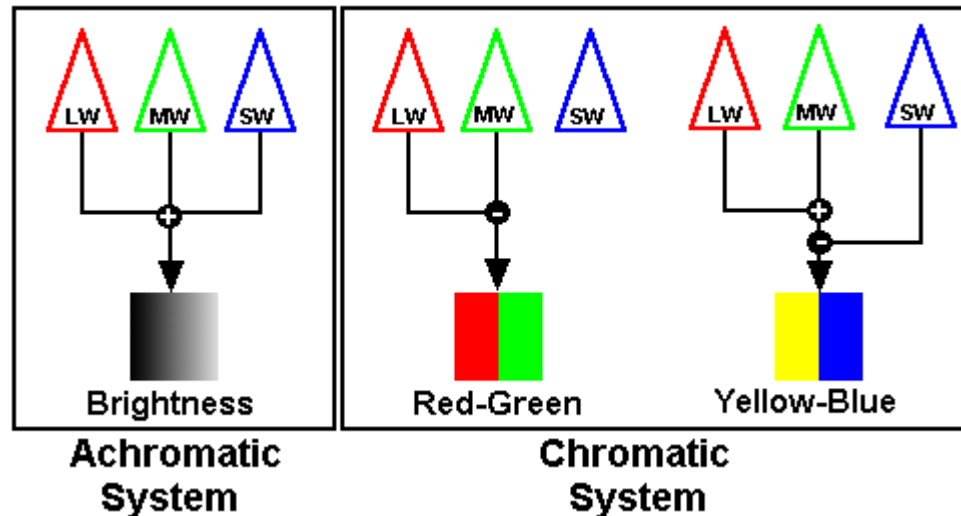


Color vision

Opponent-process theory

Two kinds of color-processing mechanisms

- Yellow-blue (Y-B) opponent mechanism
- Red-green (R-G) opponent mechanism
- White-black (W-B) opponent mechanism



Hearing: sound

- Wave = compression and rarefaction of the molecules of the air
- Wave = frequency + intensity
 - Frequency: the rate of vibration >> pitch
 - Intensity: the density of vibrating air molecules >> loudness

Hearing: sound

- Herz (Hz): 20 to 20,000 Hz
- Decibel (db): 0 to 120 + db
 - Normal conversation ~ 60 db

Hearing: the ear

Outer ear

Pinna: sound localization

External auditory canal: the waxy hollow

Middle ear

Eardrum: the thin membrane that catches vibratory movement

Hammer, Anvil and Stirrup: three linked bones, which pass sound waves to the inner ear > Amplifying vibration

Eustachian tube: pressure equalization and mucus drainage

Hearing: the ear

Inner ear

Oval window: the membrane creating sound waves in the fluid of cochlea

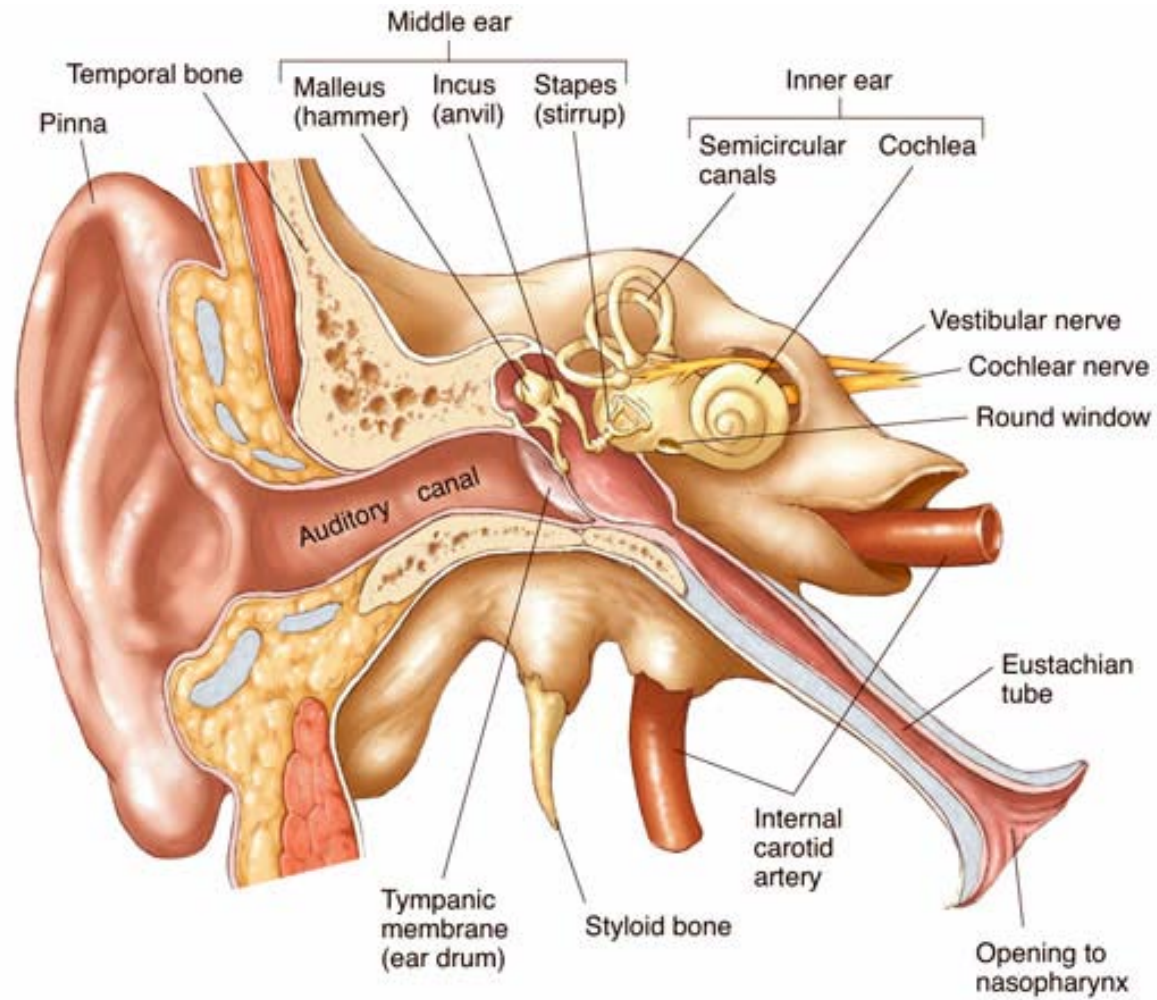
Cochlea: fluid filled, curve structure

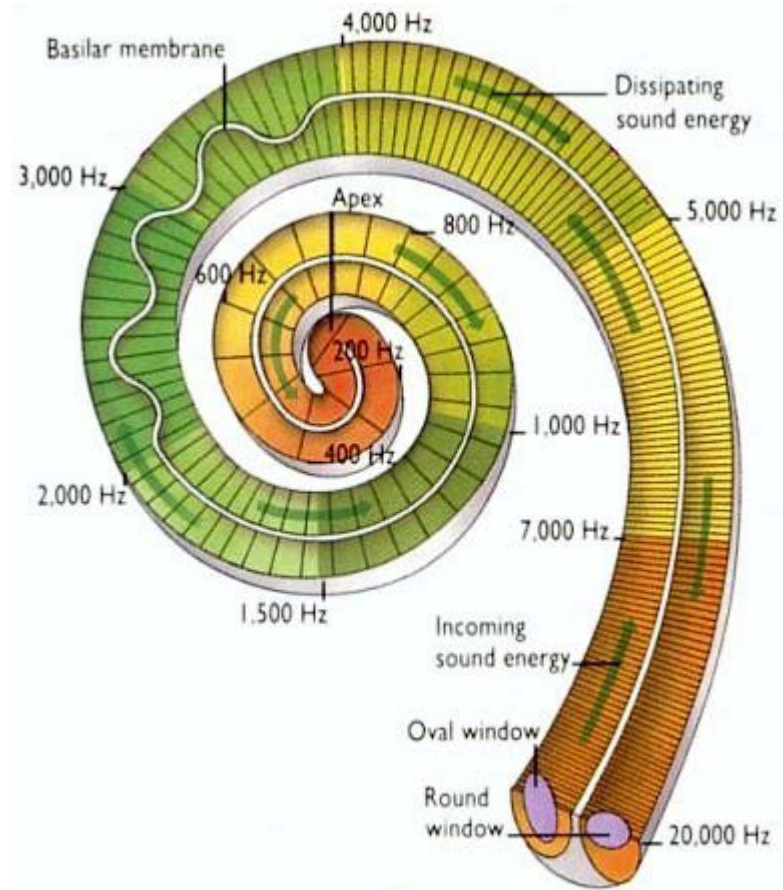
Round window: the membrane that relieves pressure from the vibrating waves in the cochlea fluid

Basilar membrane: one of the membranes that separate the two tubes of cochlea

Organ of Corti: containing hairlike receptor cells

Semicircular canals: providing sensory input for rotary movements





https://classes.lt.unt.edu/Spring_8WI_2014/CECS_5420_080/epb0021/cochlea.htm

Theories of hearing

- Place theory
 - Sound waves of various frequencies stimulate receptor cells at different places along the organ of Corti.
 - High – close to the oval window, low – close to the apex
- Frequency theory
 - The frequency of the sound waves = the frequency of the signals sent to the brain
 - Volley principle: At high frequencies, the coding is achieved by volleys of neural impulses.

Hearing: the ear

Bone conducting hearing

- When we hear ourselves talking
- Important for diagnosing hearing problem

Sound localization

- Ear position
- The head dampens some of the sound.

Body senses: orientation and movement

Vestibular organ (Semicircular canals + saccule & utricle)

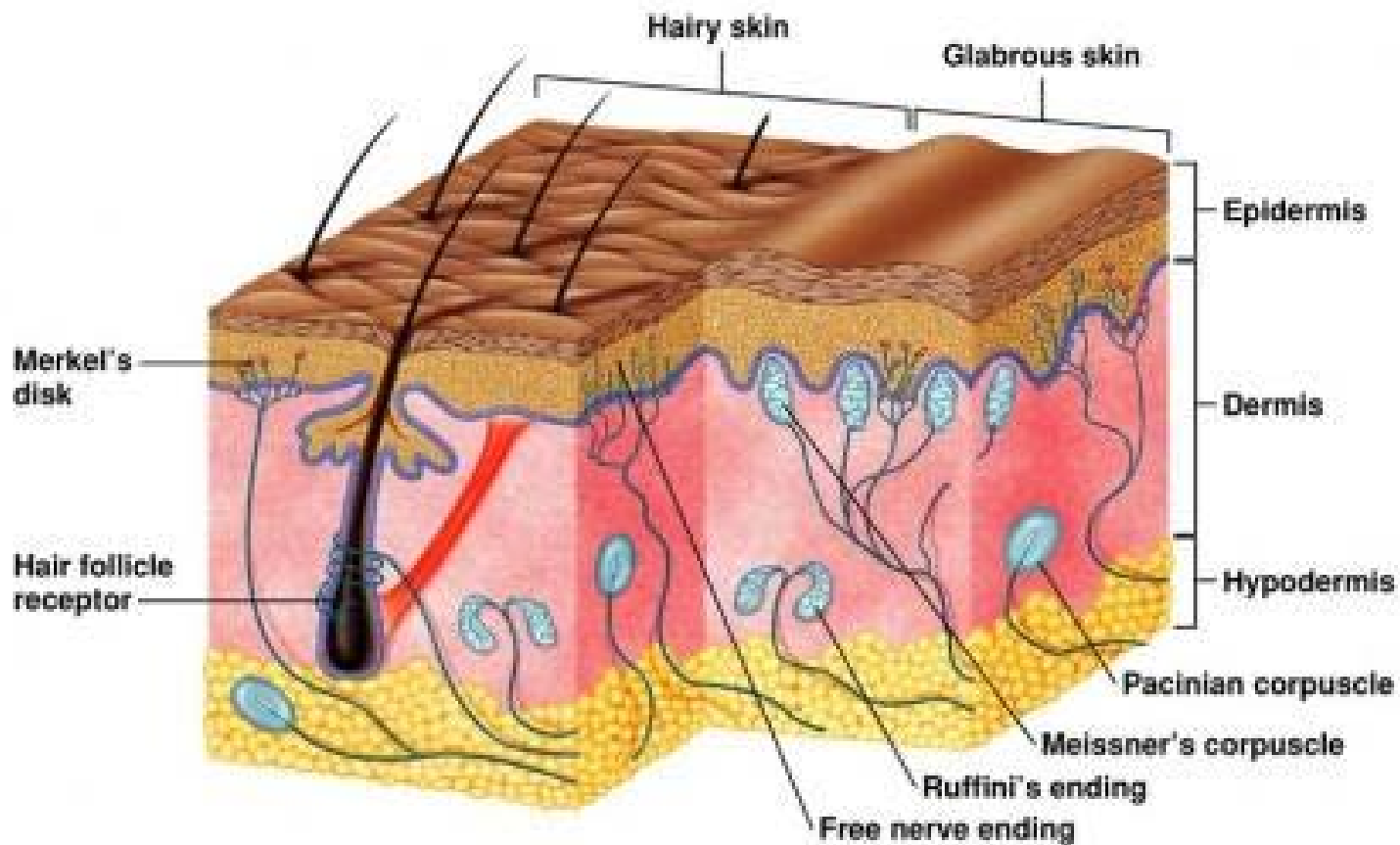
- In the inner ear
- Orientation and movement

Kinesthetic receptor

- Muscles, joints, and skin
- Movement, posture, and orientation

Body senses: skin senses

- **Mechanoreceptor: pressure**
 - Slowly adaptive (continuous)
 - Merkel receptor: fine details
 - Ruffini ending: stretching
 - Rapidly adaptive (on-and-off)
 - Meissner corpuscle: handgrip control
 - Panician corpuscle: vibration
- **Thermoreceptor: temperature**
 - Free nerve ending
 - Warmth fibers (C-fibers)
 - Cold fibers (A delta fibers)
- **Nociceptor: pain**
 - Free nerve ending



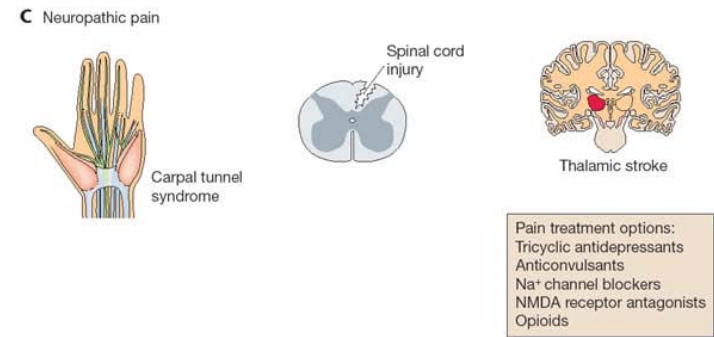
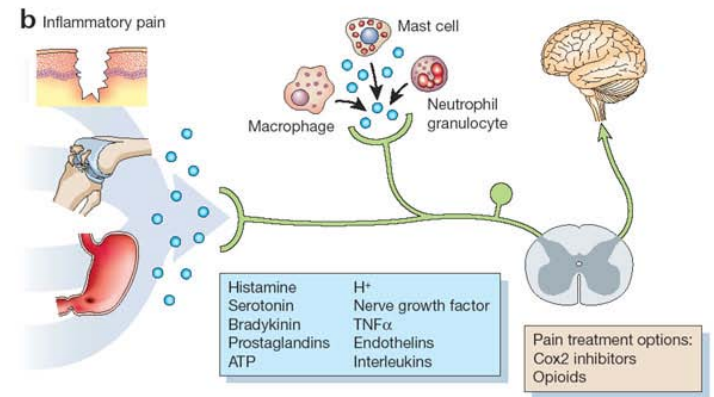
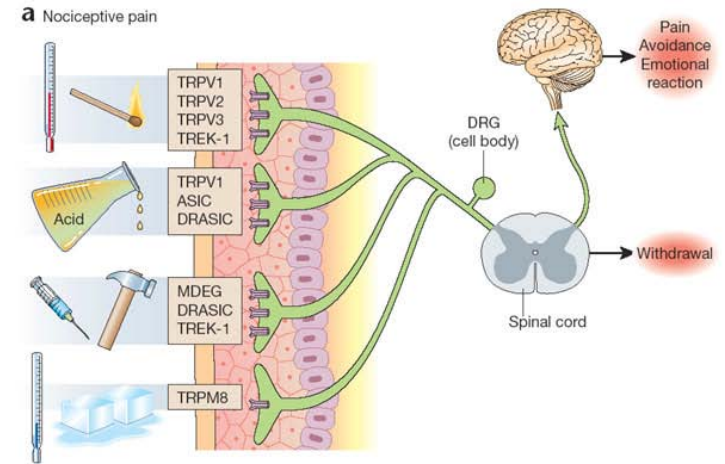
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Body senses: pain

Types of pain

- Nociceptive pain
- Inflammatory pain
- Neuropathic pain

http://www.nature.com/neuro/journal/v5/n11s/fig_tab/nn942_F1.html

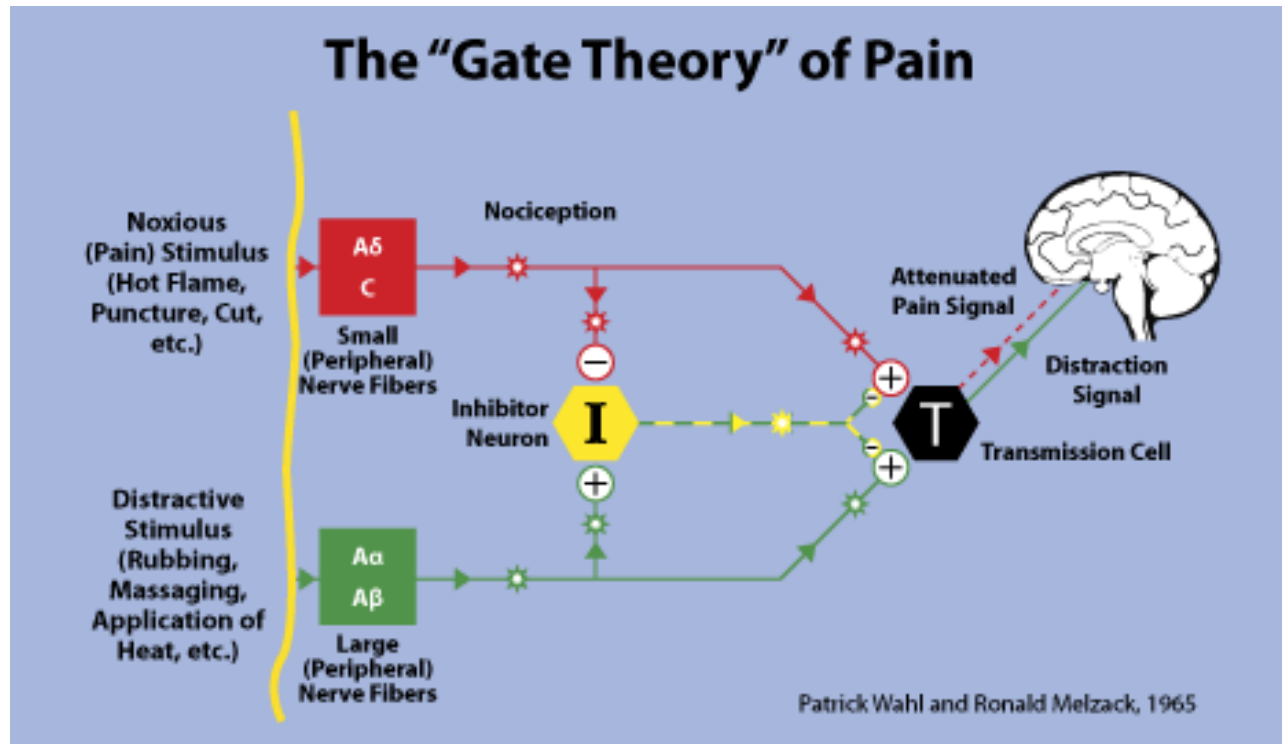


Body senses: pain

- Two pathways of pain
 - Rapid / slow
 - Myelinated / unmyelinated
 - Thalamus + somatosensory area/ limbic system
- Gate control theory
 - Substantia gelatinosa (as inhibitor neurons)
 - S-fibers (for noxious stimuli)
 - L-fibers (for distractive stimuli)
 - Transmission cells

Body senses: pain

- Gate control theory



Chemical senses: taste

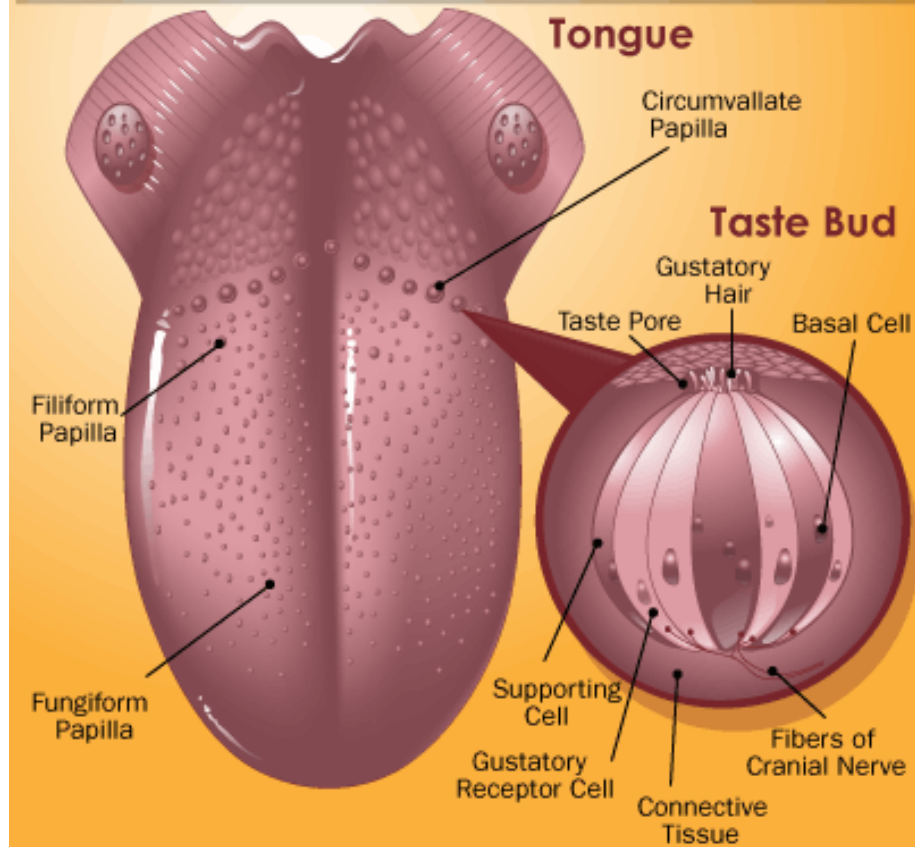
- Basic taste qualities
 - Sweet: sugars (sucrose)
 - Salty: sodium ions (NaCl)
 - Sour: acidity - H^+ (HCl)
 - Bitter: (quinine)
 - Umami: glutamate (MSG)

Chemical senses: tongue

- Papillae
 - Filiform: cone, found over the entire surface
 - Fungiform: mushroom, found at the tip and the sides
 - Foliate: a series of fold along the back
 - Circumvallate: flat mound surrounded by trench at the back
- Taste bud: about 10,000, not found in filiform
 - Taste cell
 - Taste pore

How Taste Works The Tongue

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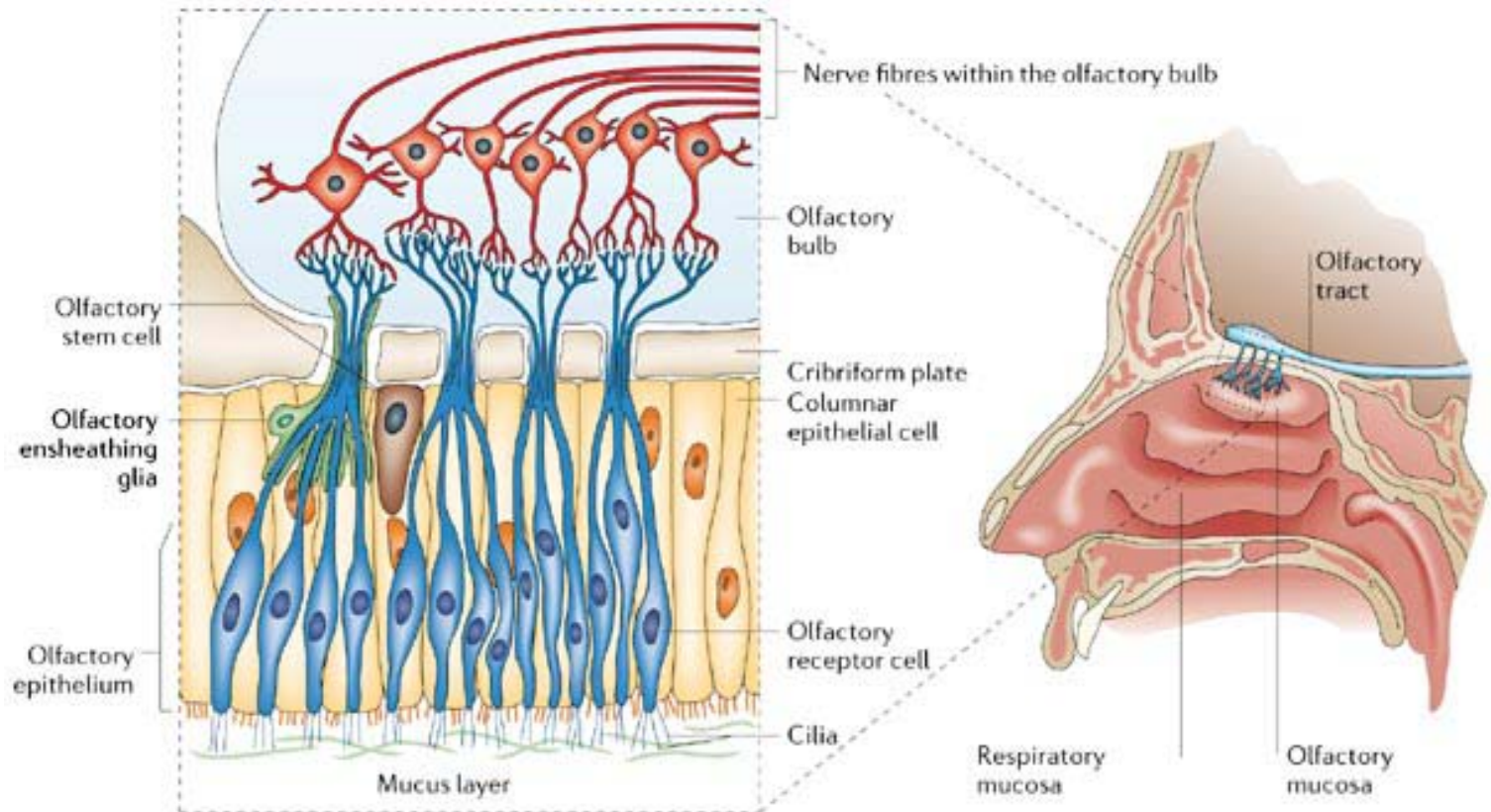
Chemical senses: odor

- Different threshold for each odor
- 10 million receptors for human
- Detection threshold VS recognition threshold
- A lack of specific language for odor quality
- Molecular properties & odor quality

Chemical senses: nose

- Nasal cavity
- Olfactory epithelium: A membrane that receptor cells and supporting structures are located
- Olfactory receptor: ~350 different types
- Olfactory bulb: Connection between receptor cells and olfactory nerve

Chemical senses: nose



Perception

- Organization & interpretation
- Learning, experiences, memories, motives, and emotions can influence perception
- Shared properties
- Hard to distinguish sensation and perception in practice

Visual perception

Perceptual organization

Based on Gestalt principles

- Figure & ground
- Proximity
- Similarity
- Continuity
- Closure

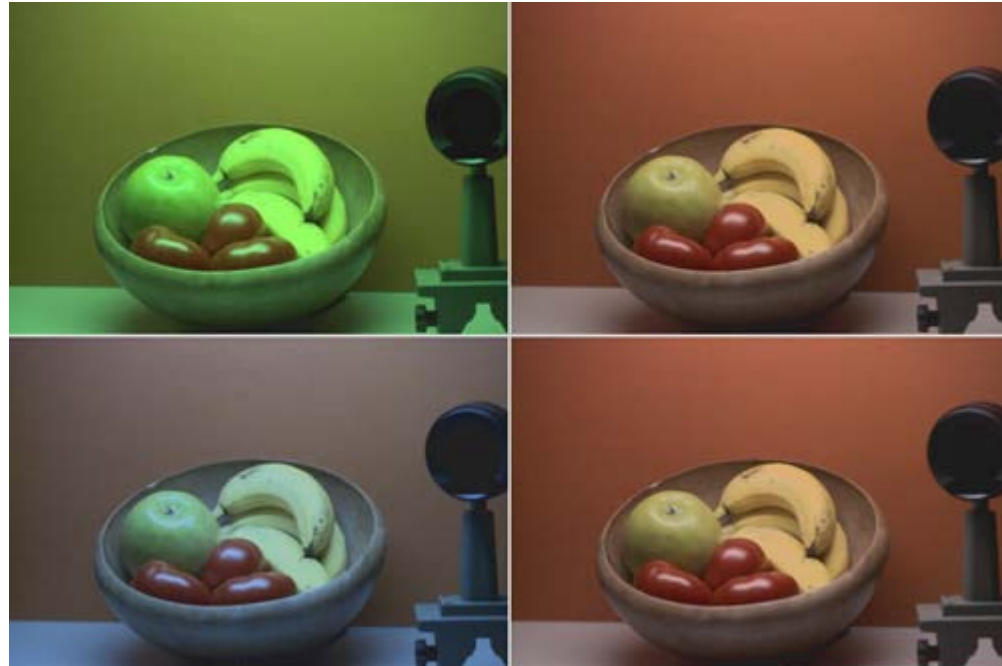
Visual perception

Perceptual constancy

- Brightness constancy
- Color constancy
- Size constancy
- Shape constancy

Visual perception

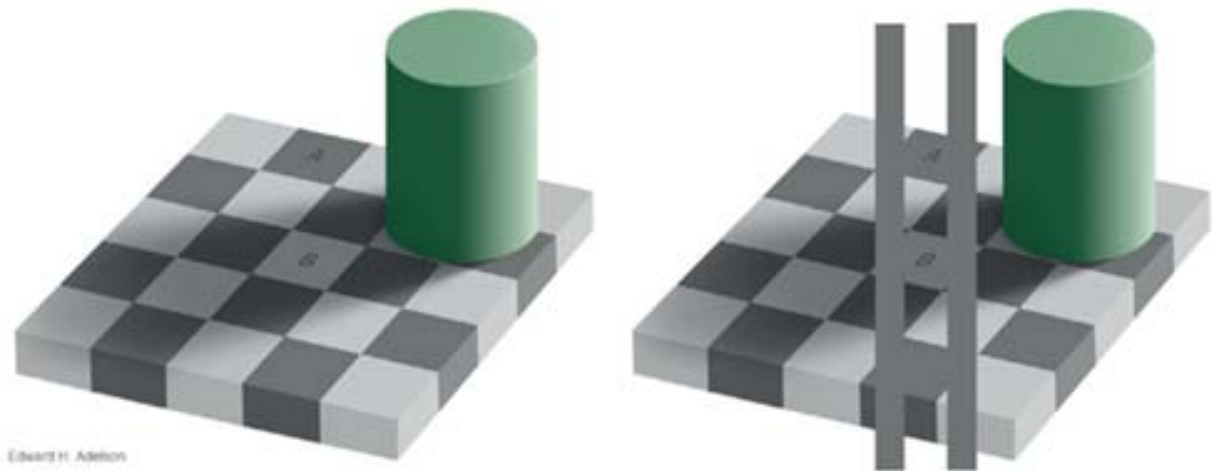
- **Perceptual constancy**



<http://www.cs.sfu.ca/~colour/research/colour-constancy.html>

Visual perception

- **Perceptual constancy**



Visual perception

Depth perception

Two-dimensional retina >> three-dimensional world?

Visual cues

- Monocular cues
- Binocular cues
- Oculomotor cues

Visual perception

Monocular cues

- Relative size
- Texture gradient
- Linear perspective
- Superposition
- Shadowing
- Speed of movement/motion parallax
- Aerial perspective
- Vertical position
- Accommodation

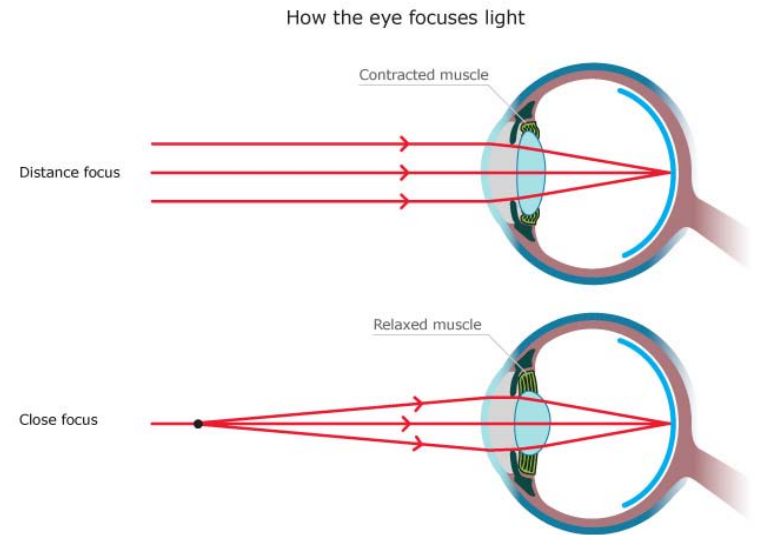
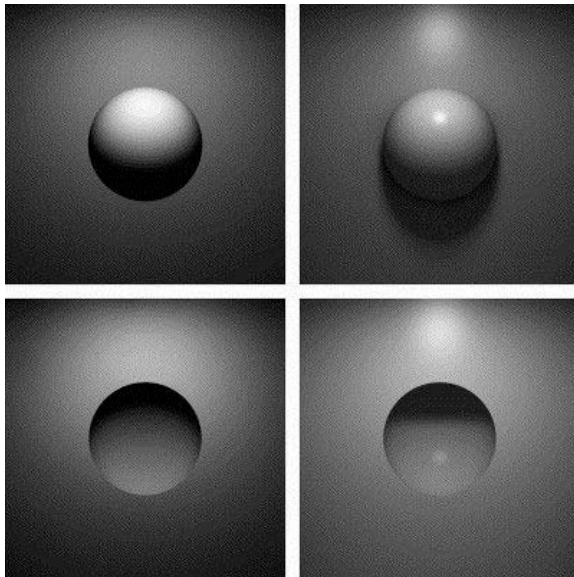
Visual perception

Monocular cues



Visual perception

Monocular cues

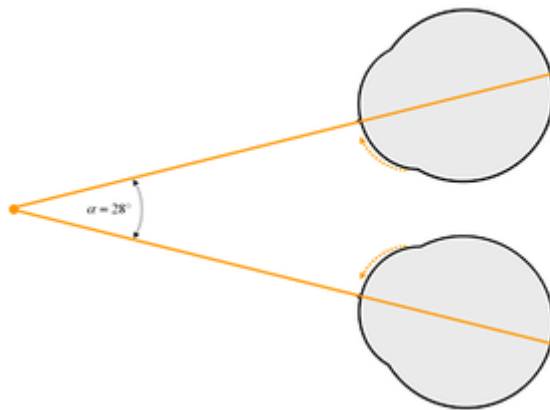


Visual perception

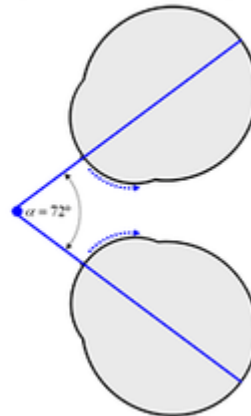
Binocular cues

- Convergence
- Stereopsis or Retinal disparity

Convergence for a far target



Convergence for a near target



Visual perception

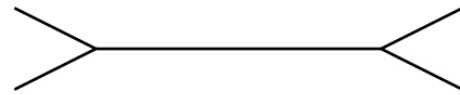
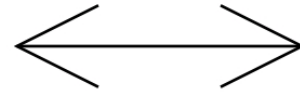
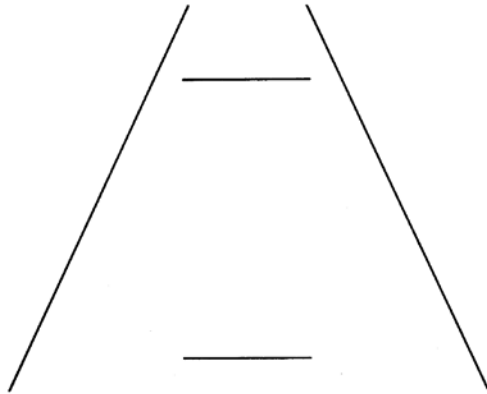
Visual illusion

Our visual system can be tricked

- Müller-Lyer illusion
- Ponzo illusion
- Ames room
- Moon illusion

Visual perception

Visual illusion

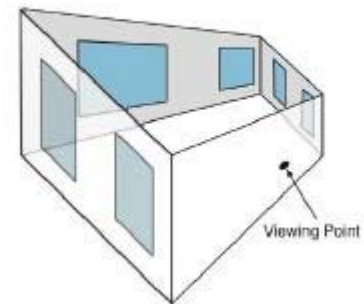


Visual perception

Visual illusion

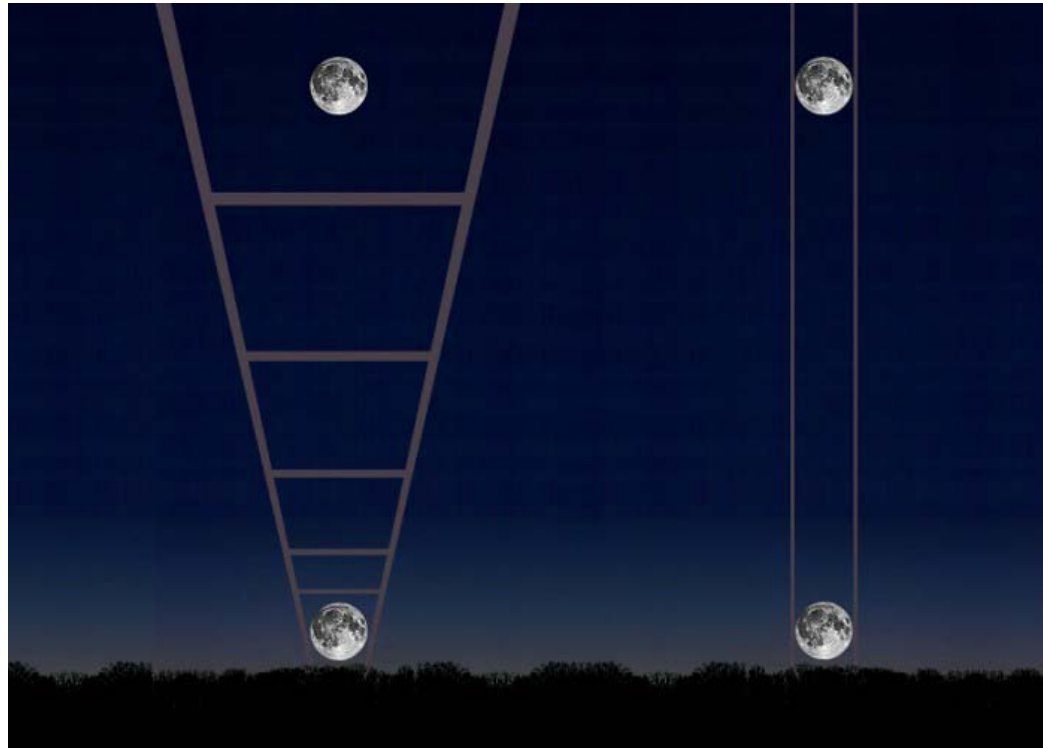


Ames Room Explained



Visual perception

Visual illusion



<http://blog.lib.umn.edu/meriw007/myblog/2012/02/it-can-be-amusing-and.html>

Subliminal perception

- Priming
 - Implicit memory
- Extrasensory perception (ESP)
 - Parapsychology
 - Psychic abilities
 - Telepathy
 - Clairvoyant
 - Astral projection
 - Psychokinesis

