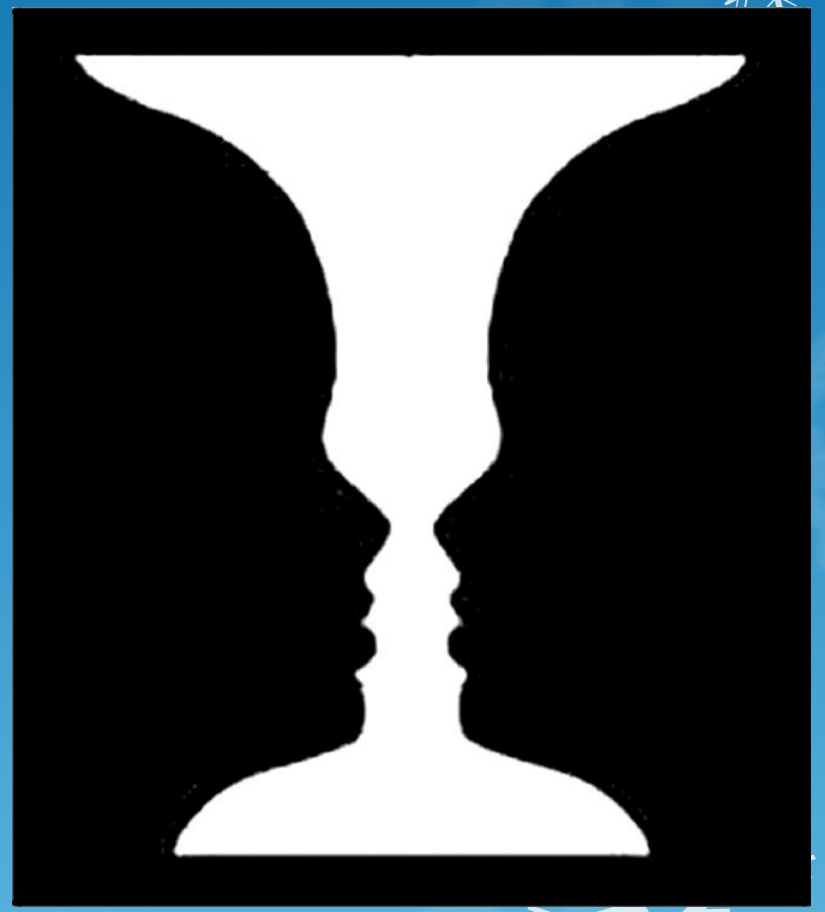
Sensation and Perception

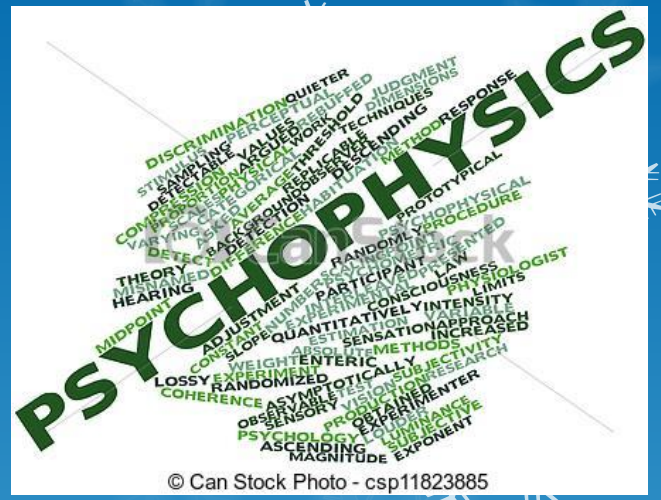
Unit Nine



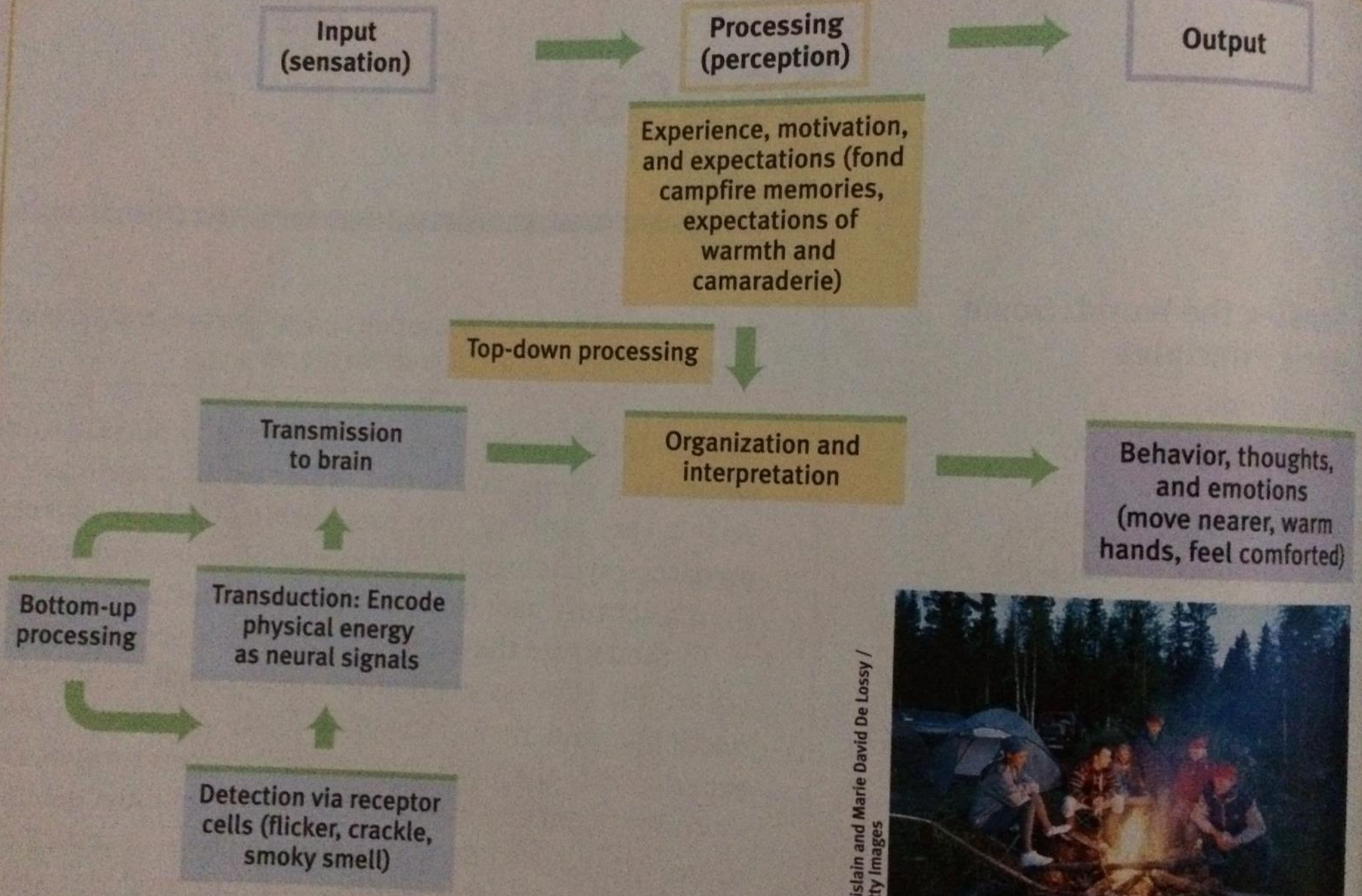
Sensation

Chapter 5

What is sensation?



- Sensation: The process of taking information from the environment and encoding it as neural signals
- Perception: How we select, organize, and interpret the info
- Types of sensory analysis
  - Bottom-Up Processing
    - Analyzing the S/P process from the sensory receptors up to brain analysis of info
  - Top-Down Processing
    - Analyzing the S/P process from a collective or overarching perception
- Psychophysics: the study of the relationship b/w physical stimuli and our psychological experience of them



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Receiving Inputs: Thresholds

- Animals are sensitive to the information that they need to be sensitive towards
  - Evolutionary purposes: human ears are most sensitive to sounds that match the frequencies of babies and human voices
- Thresholds describe how much of the information (sensory stimulation) we need to perceive it
- Absolute threshold: the minimum sensory stimulation we require
  - Defined when we hit 50/50 recognition

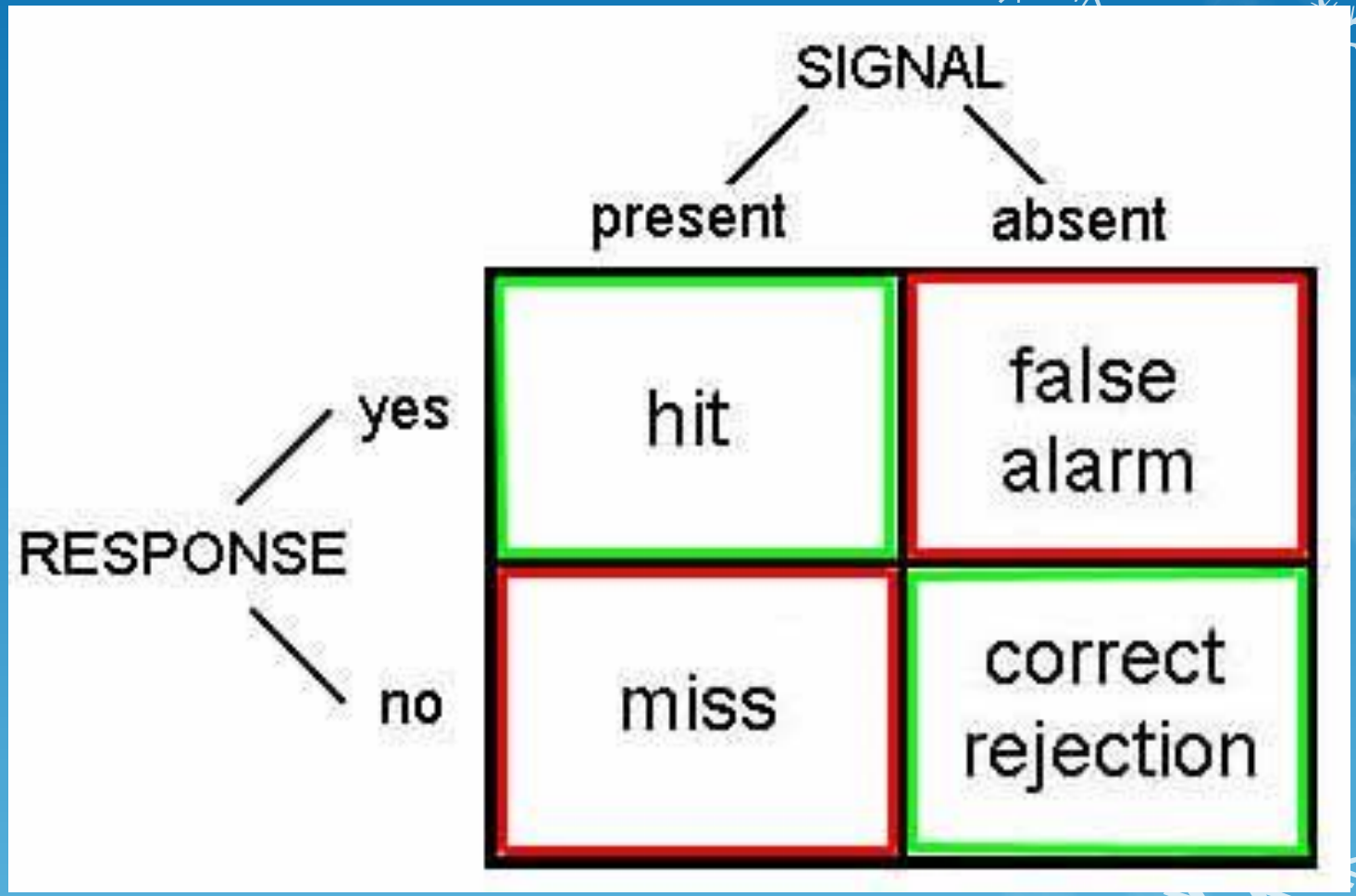
Receiving Inputs: Signal Detection

- Our state (plus signal strength, plus physiological abilities) determines how we perceive input
- Signal Detection Theory: Studies when and why we detect weak signals
  - Measure ratio of hits:false alarms
  - Why do you hear someone whisper your name, but you might not hear someone yelling something else?
  - Effects on PTSD?

Signal Detection Theory

Hits (signal present and affirmative response)

False Alarms (signal not present and affirmative response)



Receiving Inputs: Subliminal Messaging

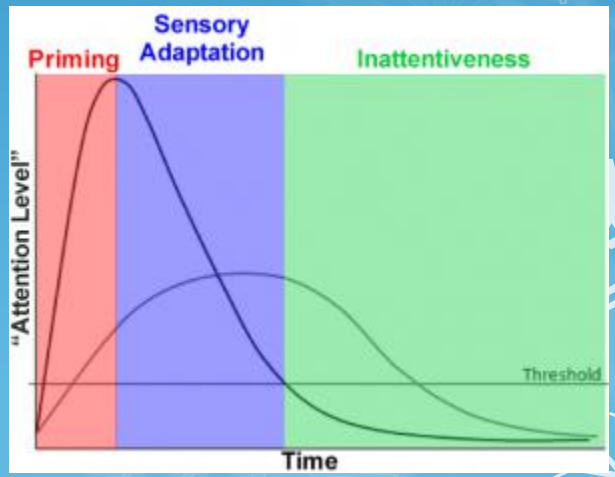
- Subliminal: information we receive without conscious awareness (below threshold)
- Subliminal messaging *can* prime a response
  - Pictures of kittens versus a dead body before seeing someone new
- "We feel what we do not know"
- Subliminal message is not able to produce a powerful, enduring effect on behavior

Receiving Inputs: Difference Thresholds

- Difference threshold=just noticeable difference (JND): minimum difference between two stimuli required for 50% detection
  - Example: Ability to differentiate between sharp and flat notes, 100 lbs versus 110 lbs
- Difference threshold is a constant proportion not amount: Weber's Law
  - 8% difference in light, 2% in weight, .3% frequency

Sensory Adaptation

- Sensory Adaptation: diminishing sensitivity to unchanging info
- In vision if we force ourselves to follow an object it fades in and out
  - Disappearance and reappearance occurs in meaningful units
- Reduces sensitivity, allows us to focus on informative changes
- How can we use this information?
  - Marketing
  - Media



Vision

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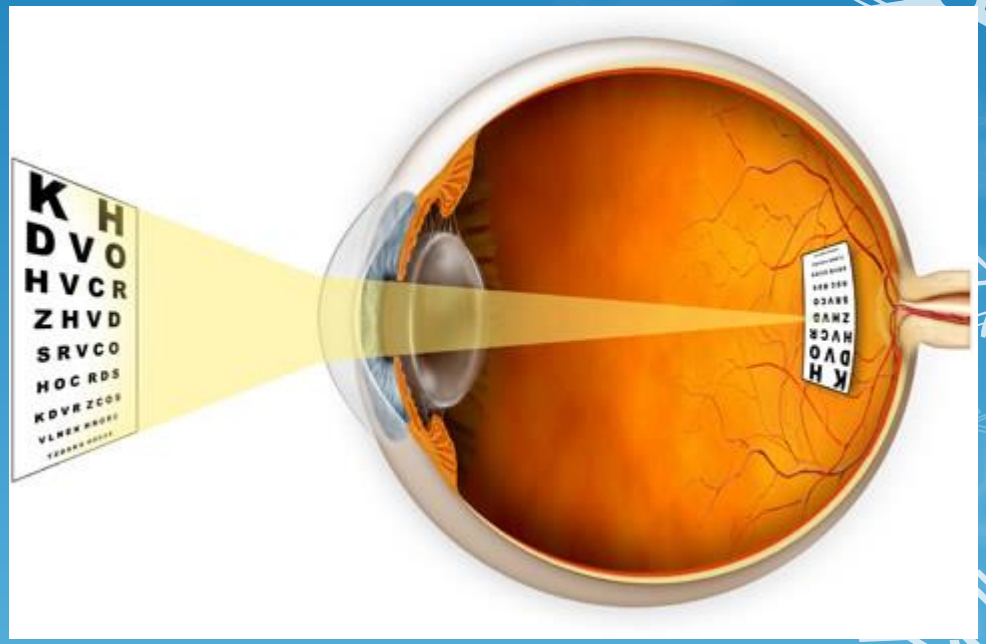
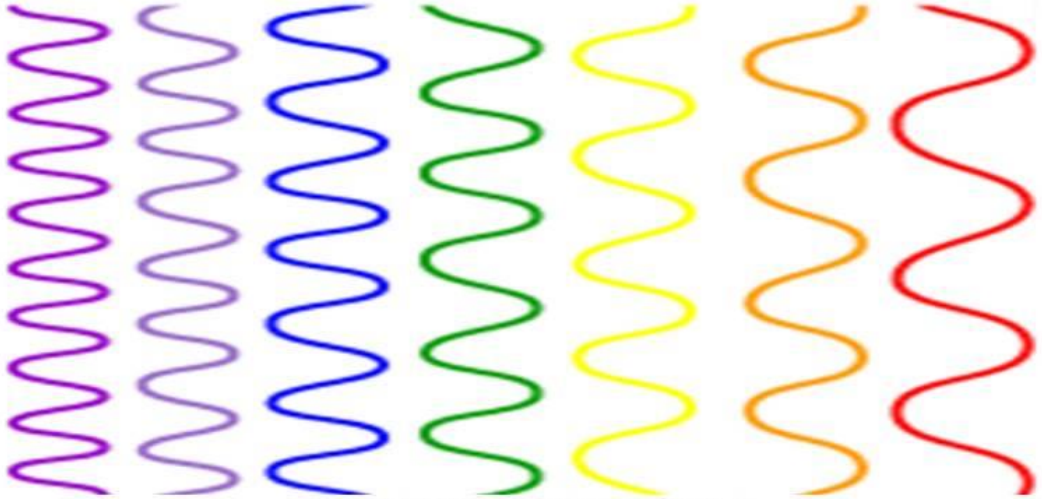
Vision

- Eyes receive light→neural messages→images
- Transduction: process of converting energy from one form into another

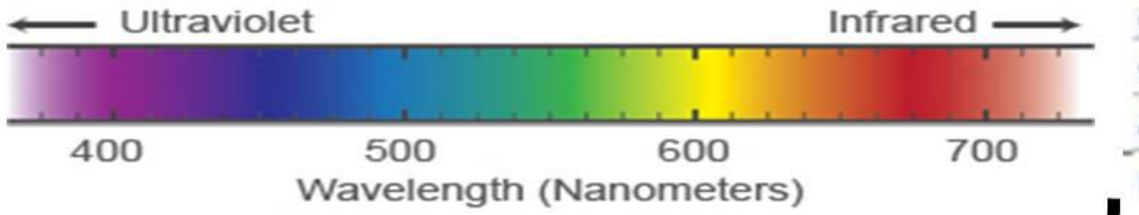


Stimulus: Light Energy

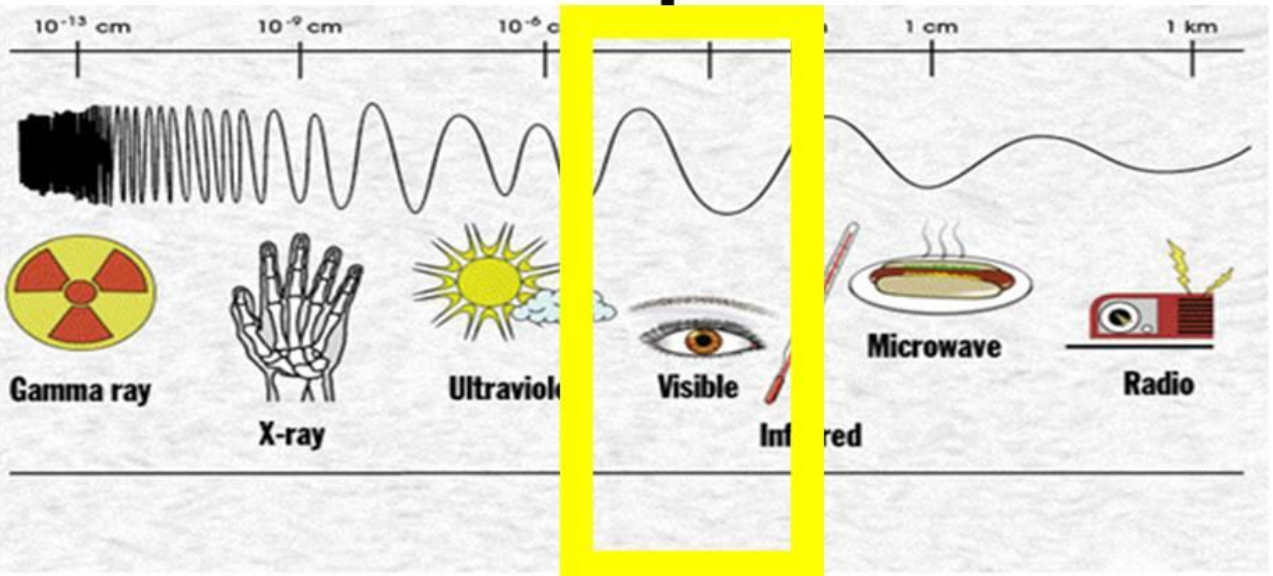
- Our eyes receive pulses of light
- Light runs on a spectrum from gamma rays-infrared rays (well really all they way to AC circuits)
- Different animals see different parts of the light spectrum
- To humans our visual light spectrum is interpreted as color



Visible Light Spectrum

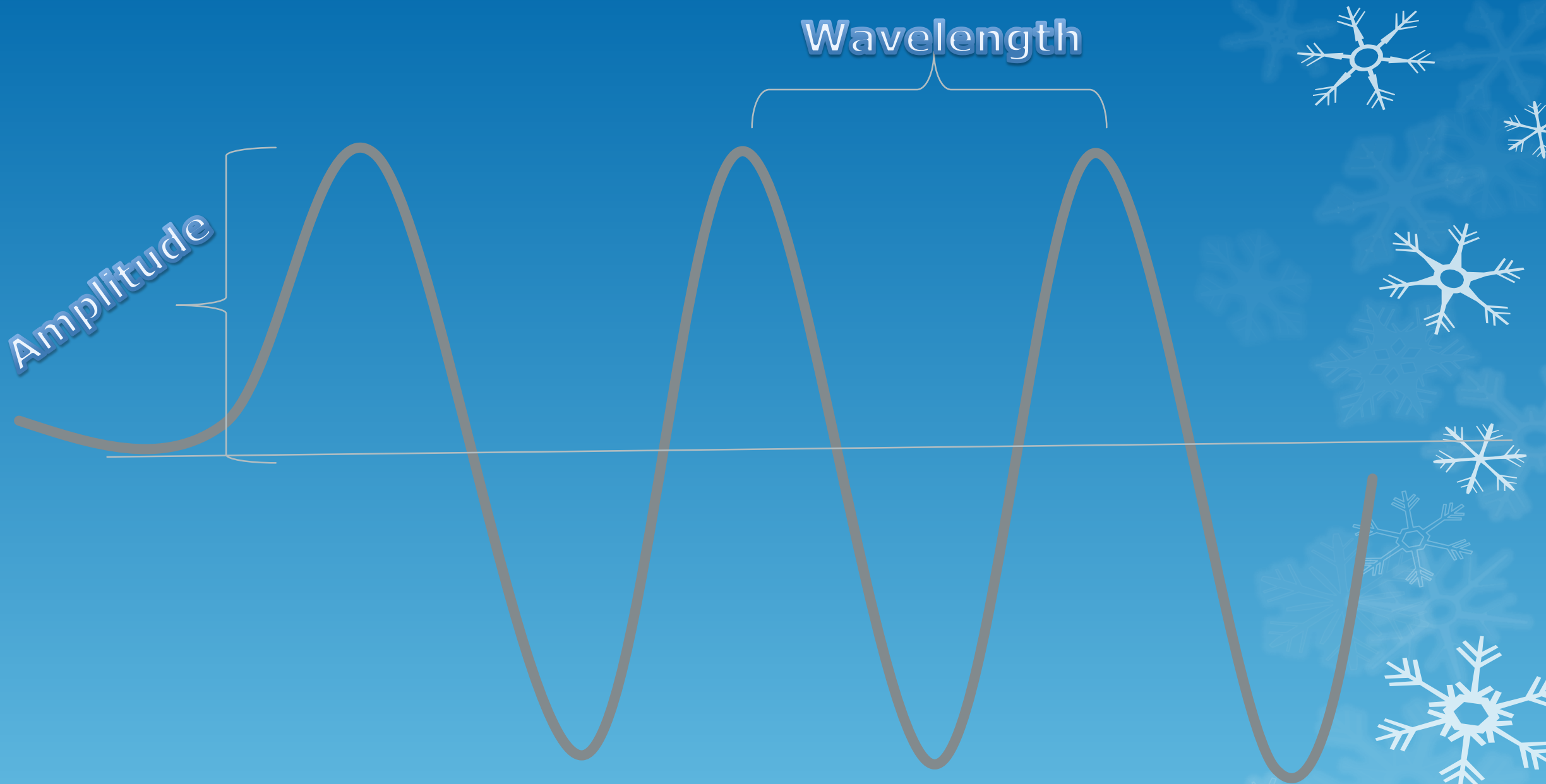


Color	Wavelength interval
violet	~ 430 to 380 nm
blue	~ 500 to 430 nm
cyan	~ 520 to 500 nm
green	~ 565 to 520 nm
yellow	~ 590 to 565 nm
orange	~ 625 to 590 nm
red	~ 740 to 625 nm



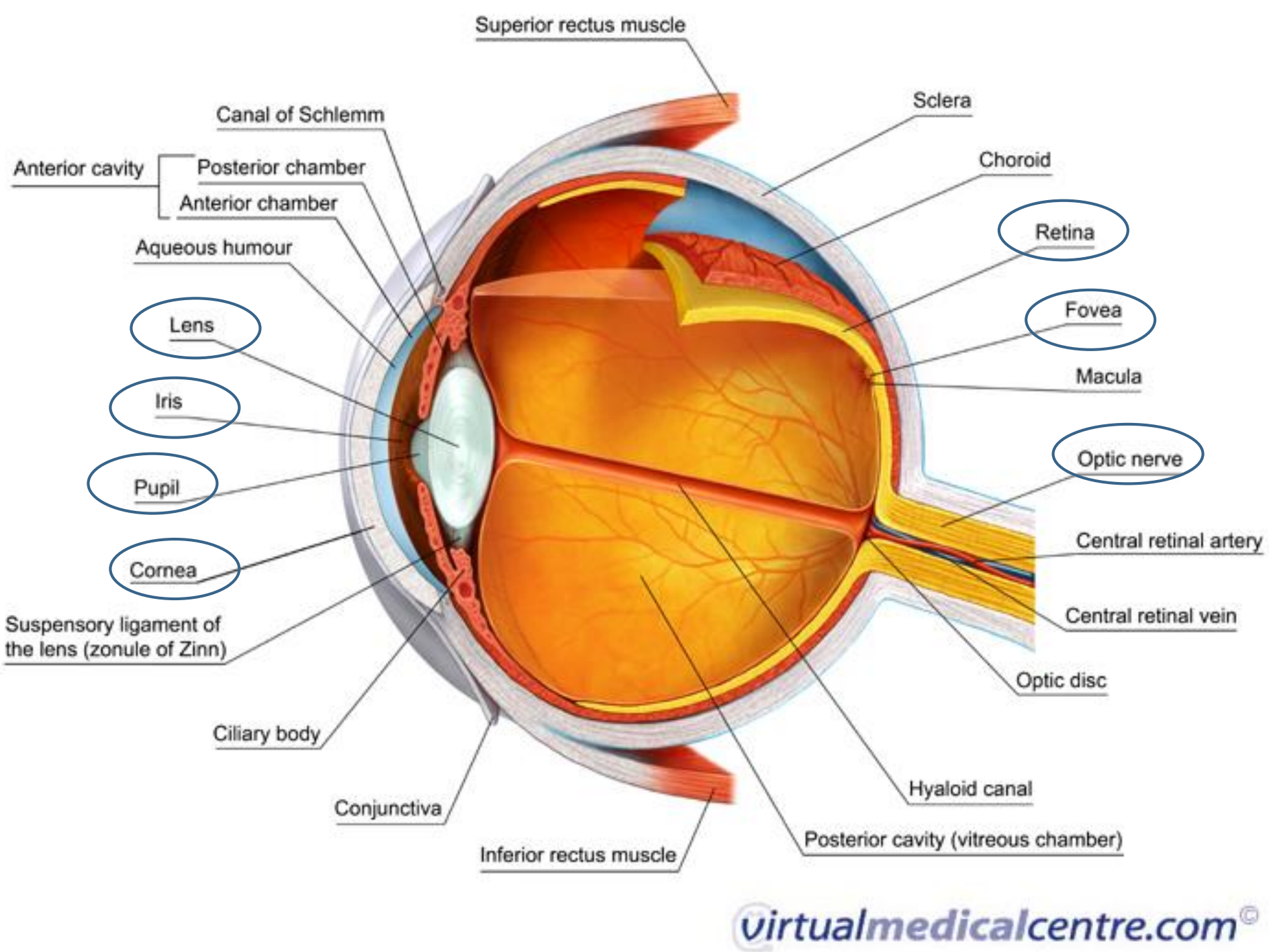
Stimulus: Light Energy

- How do we define the light spectrum
  - It is all about waves!
    - Wavelength: distance from one peak to the next
      - Determines hue (or the actual color/placement on the spectrum)
    - Amplitude: distance from wave peak
      - Determines intensity
- Other fun wave words: period (time taken for the event) and frequency (v/wavelength or periods within a unit of time)


Wavelength
Amplitude

The Eye: Structure

- Pupil: adjustable opening in the center of the eye, lets in light
- Iris: Muscle tissue, which controls the pupil (colored)
- Lens: transparent structure behind the pupil that changes shape to help focus images
- Cornea: Covering of the eye
- Fovea: Central focus point on the retina
- Retina: Light sensitive inner surface of the eye, home to rods and cones and neurons.
- Optic Nerve: Nerve that carries neural impulses from eye to brain


Superior rectus muscle
Canal of Schlemm
Anterior cavity
Posterior chamber
Anterior chamber
Aqueous humour
Lens
Iris
Pupil
Cornea
Suspensory ligament of the lens (zonule of Zinn)
Ciliary body
Conjunctiva
Inferior rectus muscle
Sclera
Choroid
Retina
Fovea
Macula
Optic nerve
Central retinal artery
Central retinal vein
Optic disc
Hyaloid canal
Posterior cavity (vitreous chamber)
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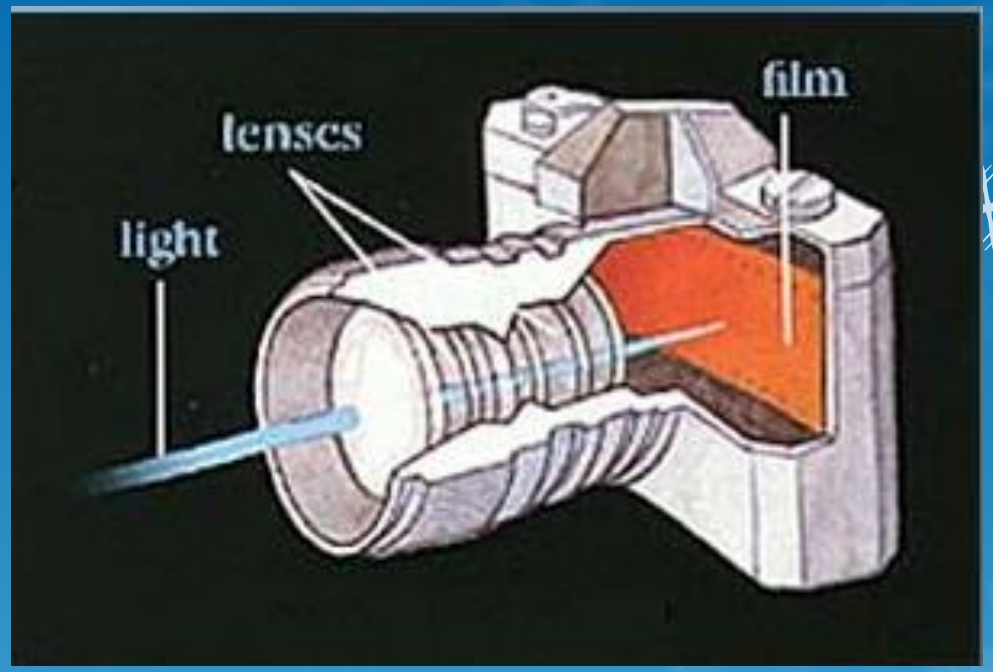
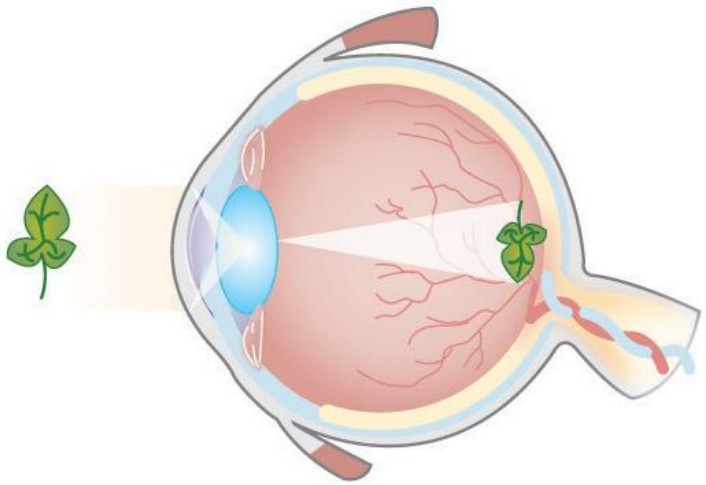
The Eye: Function



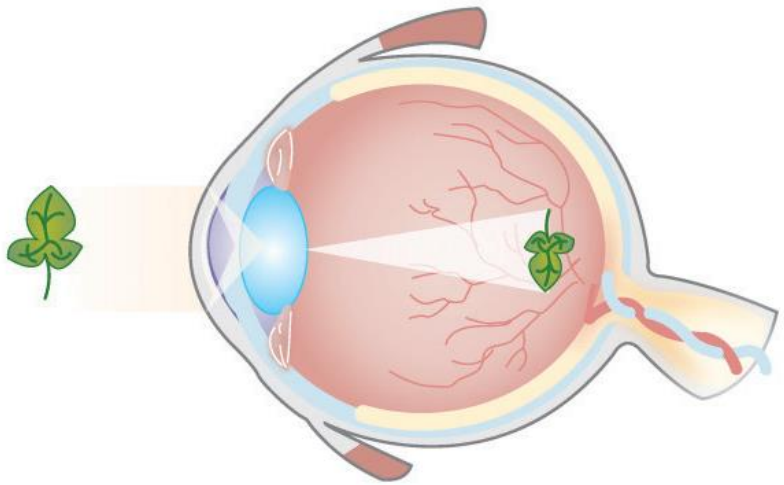
- Like a camera!
  - Cornea=lens cover
  - Iris/pupil=aperture
  - Lens=lenses
  - Retina=film
- Lens focuses through accommodation: changing curvature

Eye Sight

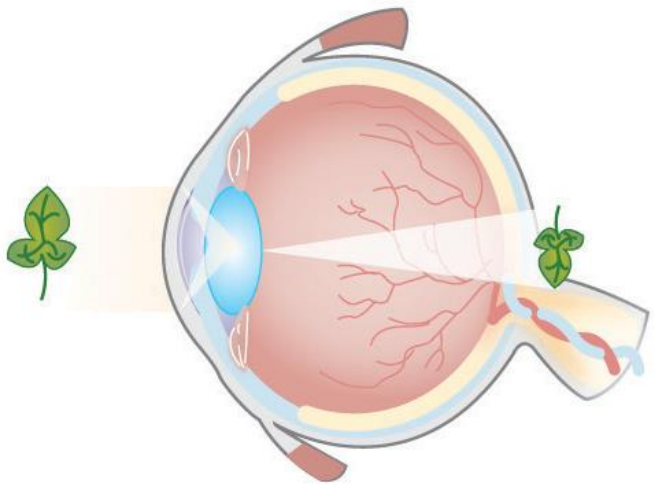
- Retina images are actually upside down, brain rightside-ups them
- Shape of eye affects vision sharpness (aka acuity)
  - Nearsightedness: items from far away are focused in front of retina
    - Glasses, contacts, or LASIK to reshape cornea help
  - Farsightedness: items near by focus behind the retina
    - Eyes can accommodate for this, but as people get older it gets worse—muscles are weaker and lens is less flexible



Normal vision

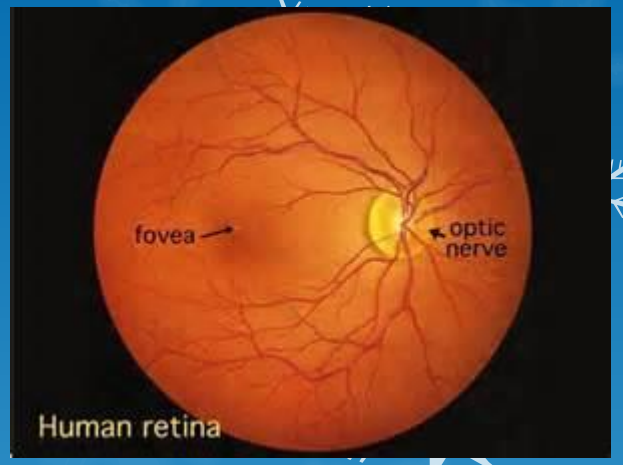


Nearsighted vision

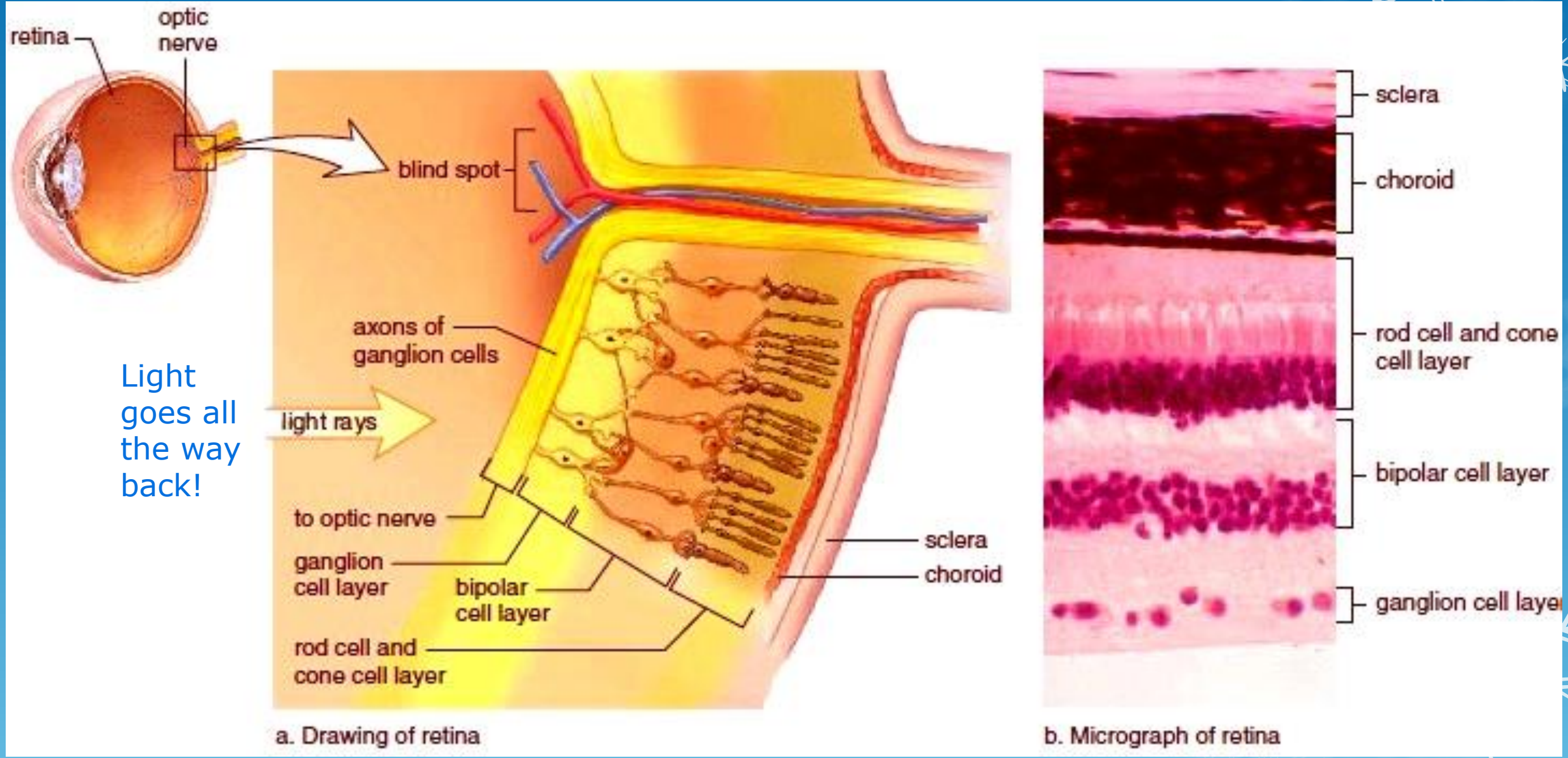


Farsighted vision

The Retina



- Retina is composed of rods and cones
- Rods and cones are the retinas receptor cells
- How it works
  - Light hits the rods and cones
  - Produces chemical changes→neural signals
  - Activates bipolar cells
  - Activates ganglion cells (form the optic nerve)
    - Blind spot is the place where your optic nerve leaves the eye
  - Sends info to your thalamus



Light goes all the way back!

Rods versus Cones

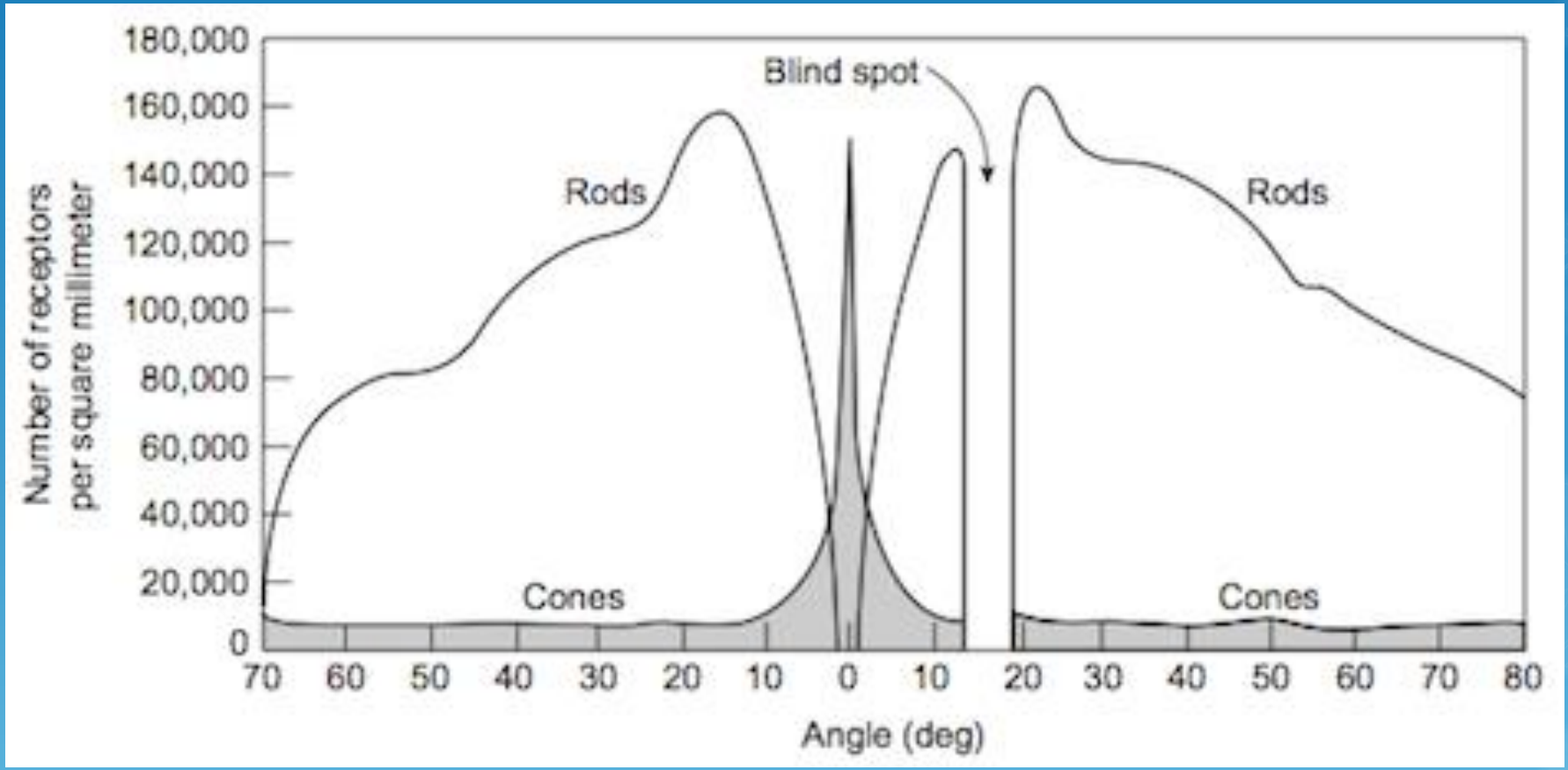
Rods

- No direct connection, they share bipolar cells with cones
- Rods are responsible for blurry peripheral detail
- Black and White
- Better at night/in faint light
  - Pupils dialate to allow light to reach the rods (takes 20 min)
  - 20 minutes matches natures twilight transition!

Cones

- Cones cluster around the fovea
- Fovea contains only cones (cones help us focus)
- Some cones run directly to the brain through bipolar cells that head to the visual cortex
- Better at fine detail
- Color
- Ineffective during the day

Distribution of rods and cones

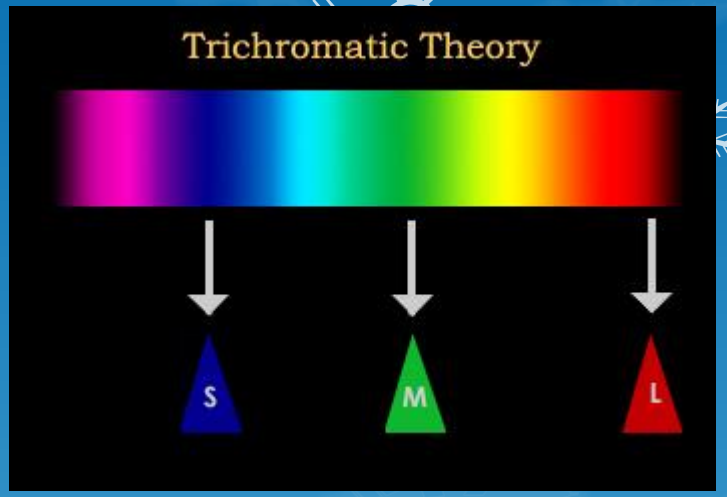


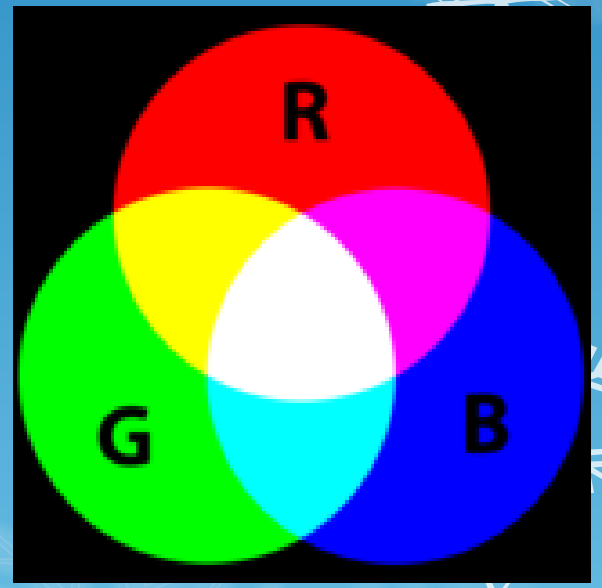
Color Vision

- Items get color by reflecting versus absorbing light
  - If my pencil is yellow it absorbs all other light waves and reflects yellow wavelength
  - Our brain then translates wavelength as color
- Difference threshold for color is very fine, we see 7 million color variations…except…

How color vision works?

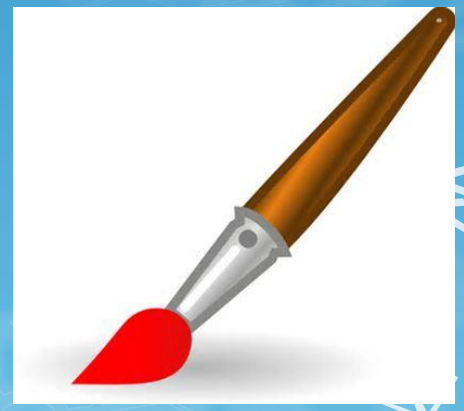
- Colors are created by combining three primary colors
  - Red, green, blue
  - Hypothesis: Thus your eye must have three color receptors! One for each color
- Young-Helmholtz Trichromatic Theory
  - Hypothesis confirmed: retina has three color receptors per color (RGB)
  - Color results for combining these different primary colors.



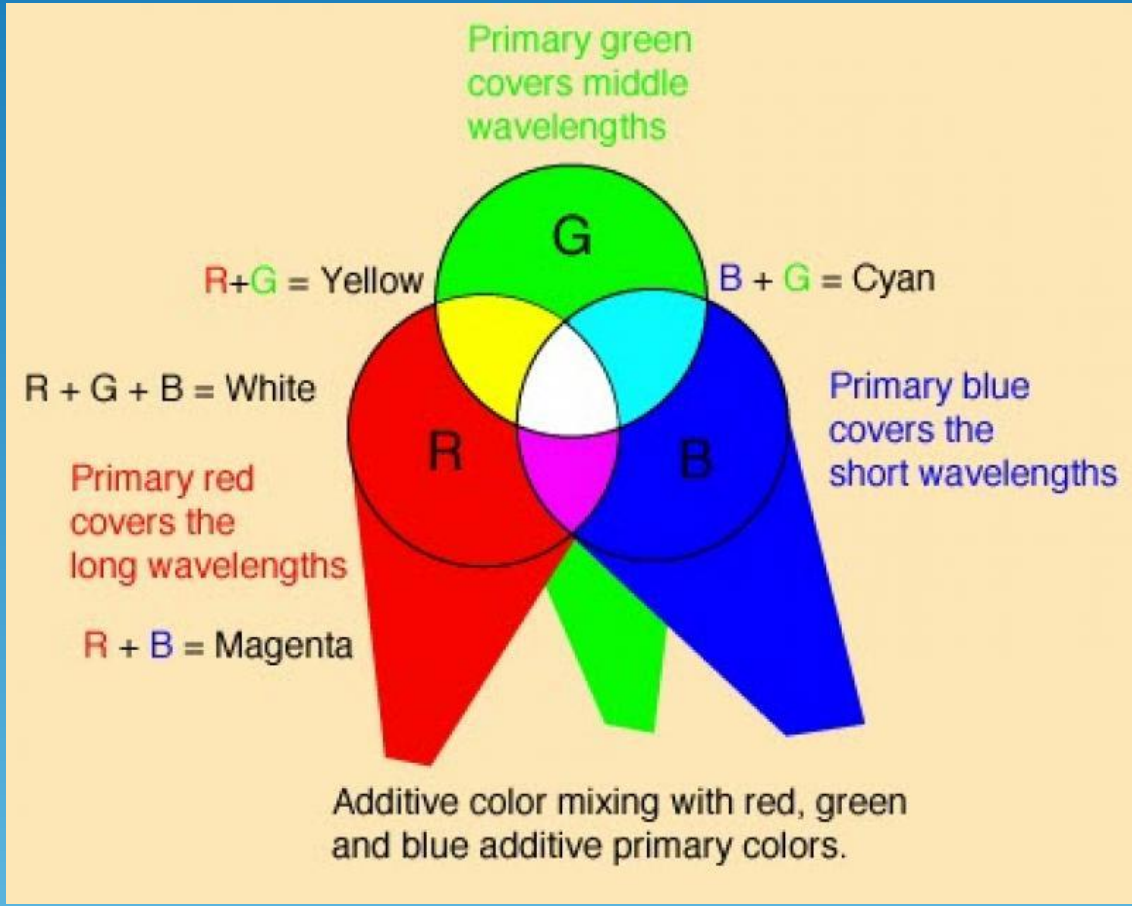


Mixing Colors

- Subtractive Color Mixing
  - Subtracting wavelength from the reflected light
  - Ex. painting
    - More paint you add the fewer wavelengths reflect
    - Mixing blue and yellow leaves only green to be reflected
    - All the colors together? =black/brown
- Additive Color Mixing
  - Adding wavelengths to increase light
  - Ex. lights
    - Add red, blue, green lights=white!
    - Prism

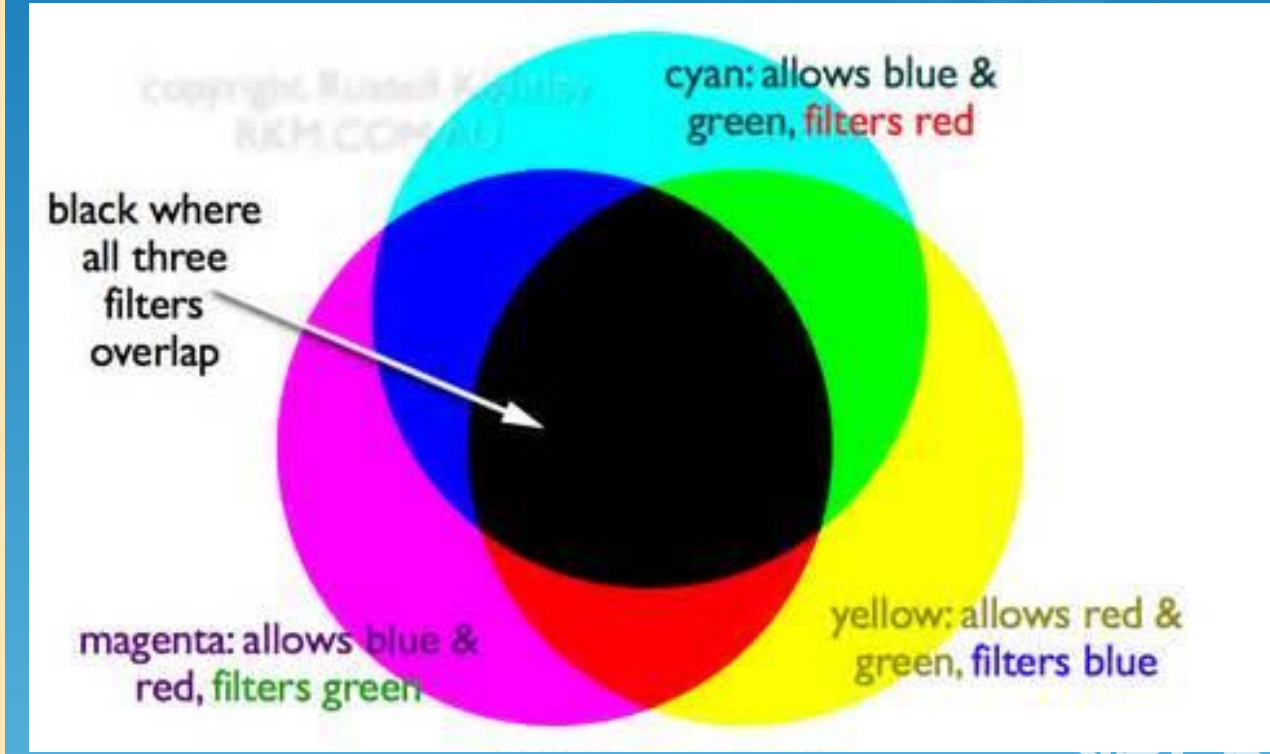


Additive Color Mixing



Additive color mixing with red, green and blue additive primary colors.

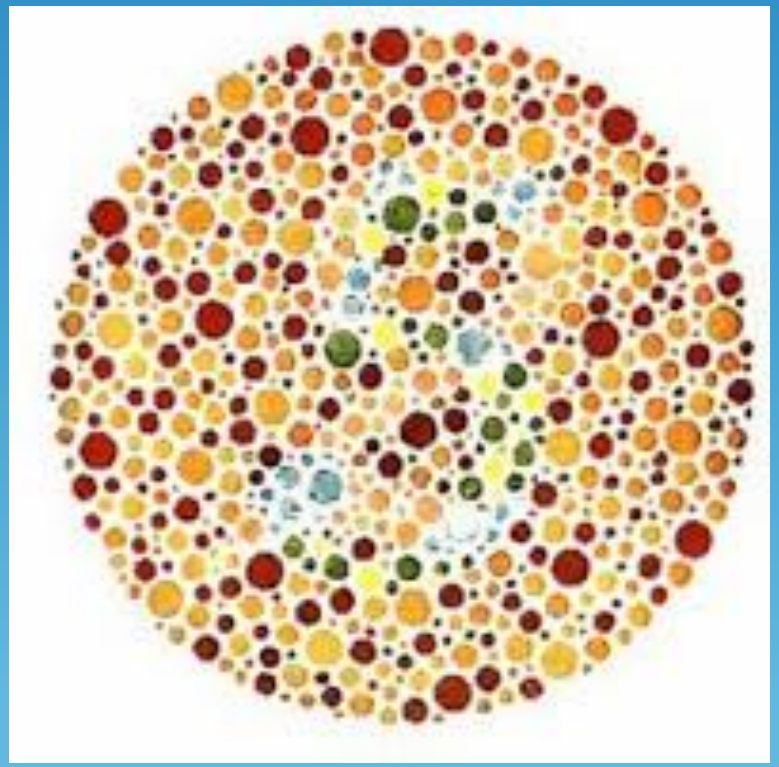
Subtractive Color Mixing

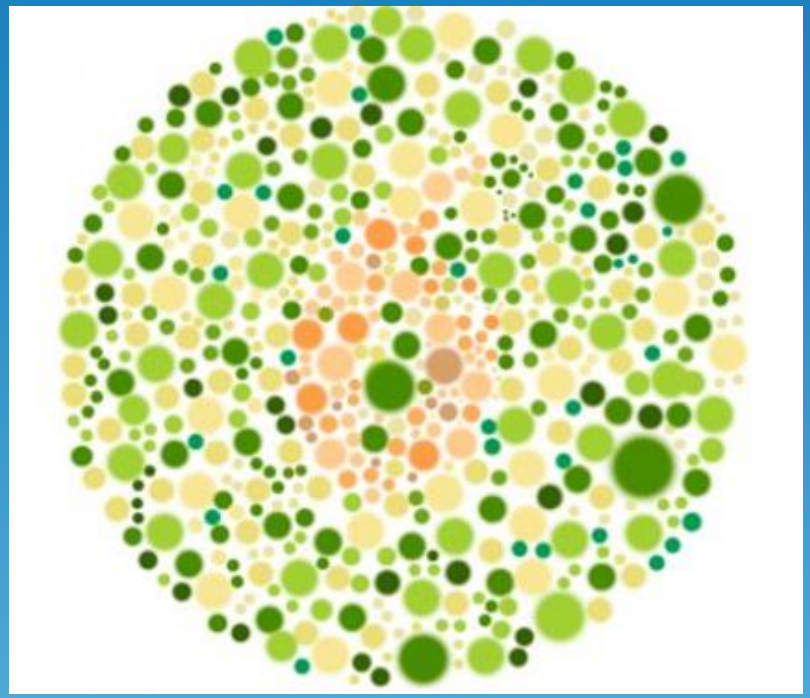


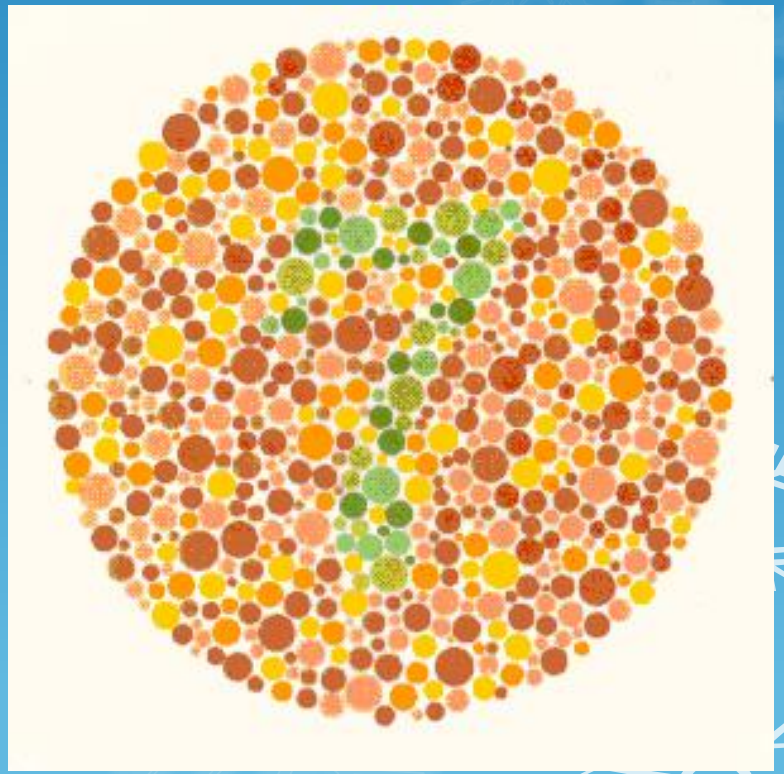
Color Blindness

- About 1/50 individuals are color-deficient
- More common in men
  - Sex linked
    - Genes that produce photopigments are carried on the X chromosome, guys only have one X chromosome, so they only get one shot
- Most people are not actually “colorblind”
  - They lack red and/or green cones: red/green color bind
- Vision is mono- or dichromatic
  - Can’t see the difference b/w red and green
- Dogs: missing red cones

Color Blind Test







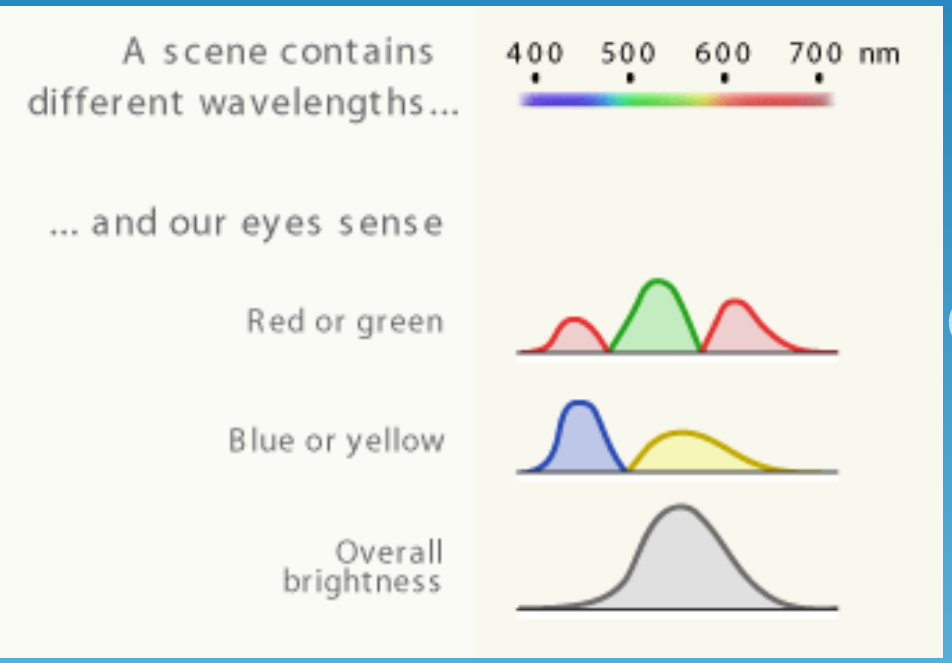
Problems with Young-Helmholtz Trichromatic Theory

- If red+green=yellow
  - WHY? Can people who are red/green color blind still yellow
  - WHY? Does yellow look like its own color (it's not like a mix of red/blue as purple is)
- Solution: opponent-process theory

Opponent-Process Theory

- We perceive opposite stimuli at the same place
  - Receptor cells process red/green, blue/yellow, and rods process white/black
  - Cells are either stimulated by green and inhibited by red or vice versa.
- We don’t see bluish-yellow, but we do see greenish-yellow
- Clues to get here
  - If you stare at a red apple then look at a white paper, the afterimage is green (the opponent color)

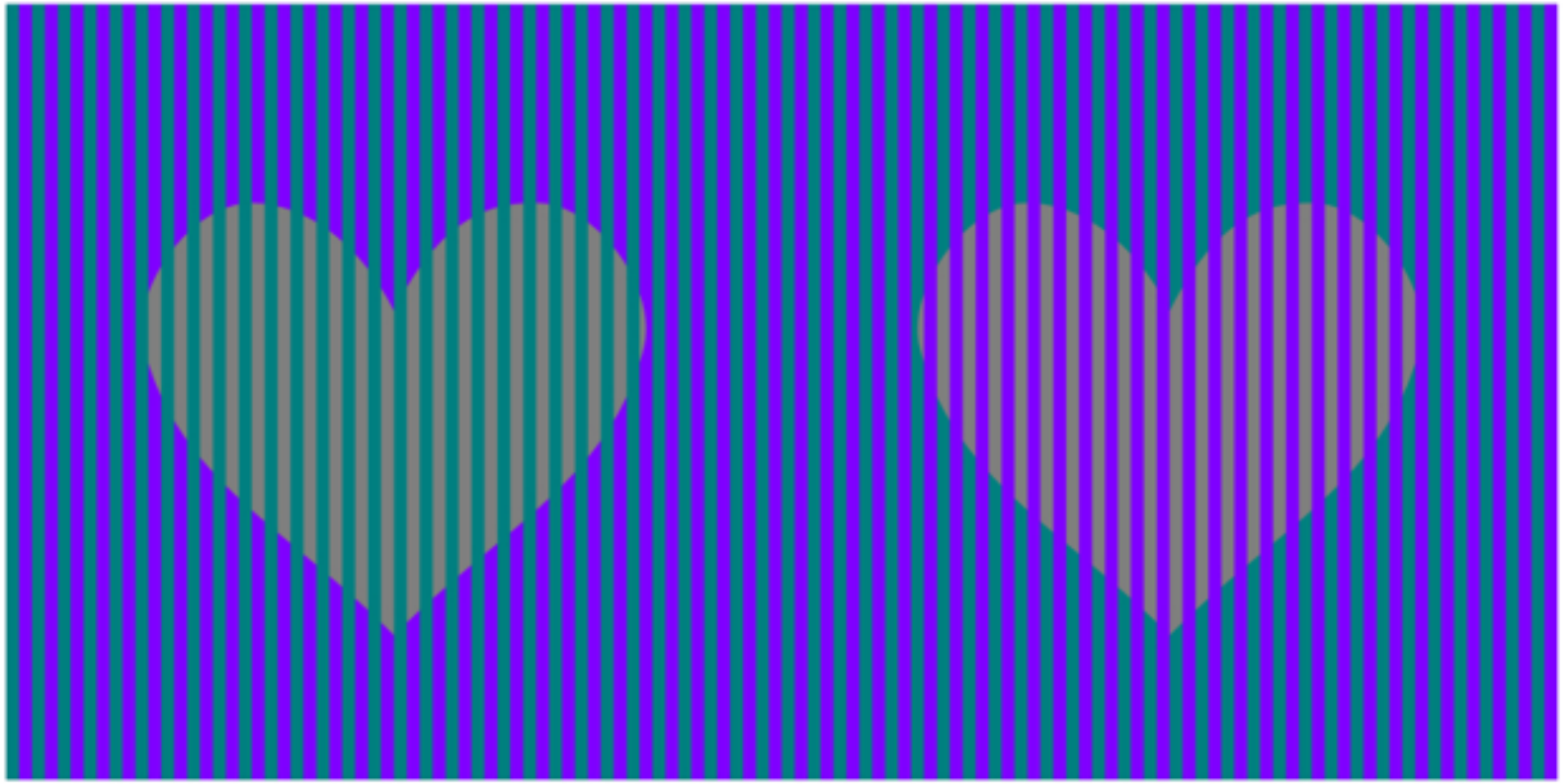
Color Vision is in Two Steps



- Step One
  - Retina's R, G, B cones and rods are activated to varying degrees (trichromatic theory)
- Step Two
  - Signals are processed by the nervous system's opponent cells while heading to the visual cortex (opponent-process theory)

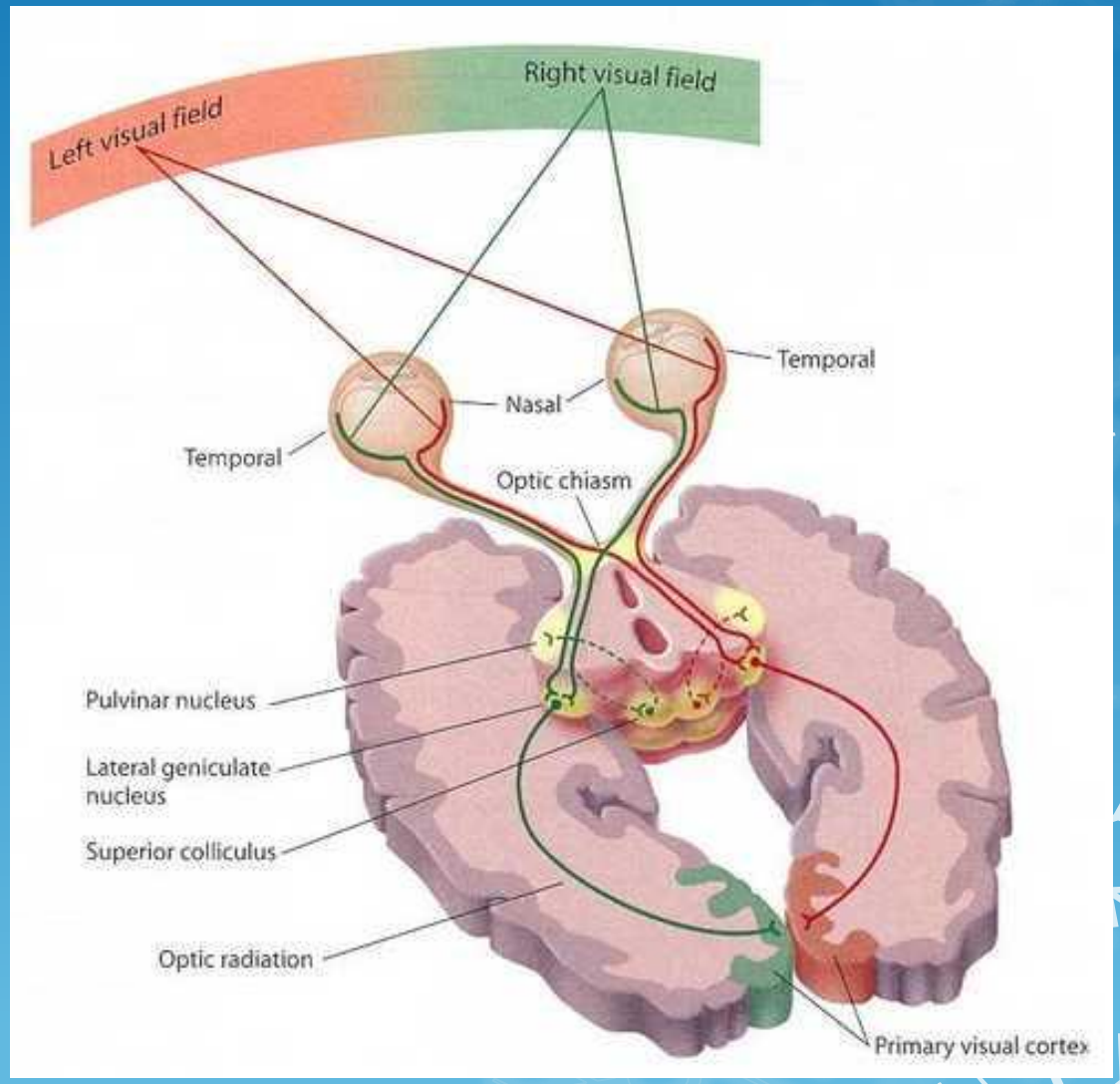
Color Constancy

- Question: if light is changing, why does color not change?
- Answer: Color constancy
  - We use context clues to figure out what color something is “supposed to be” even if lighting changes
  - Brain interprets light as relative to the objects around it
  - That red looks different on a paint chip at the store than at your house.



A little more on processing

- Info from the retina is transmitted from rods and cones to the ganglion cells then to the occipital lobe/visual cortex
- Sometimes eye misfires
  - Pressure can stimulate "false light"
    - Look left, close your eyes, gently touch the right side of your lid
    - See light on the left?

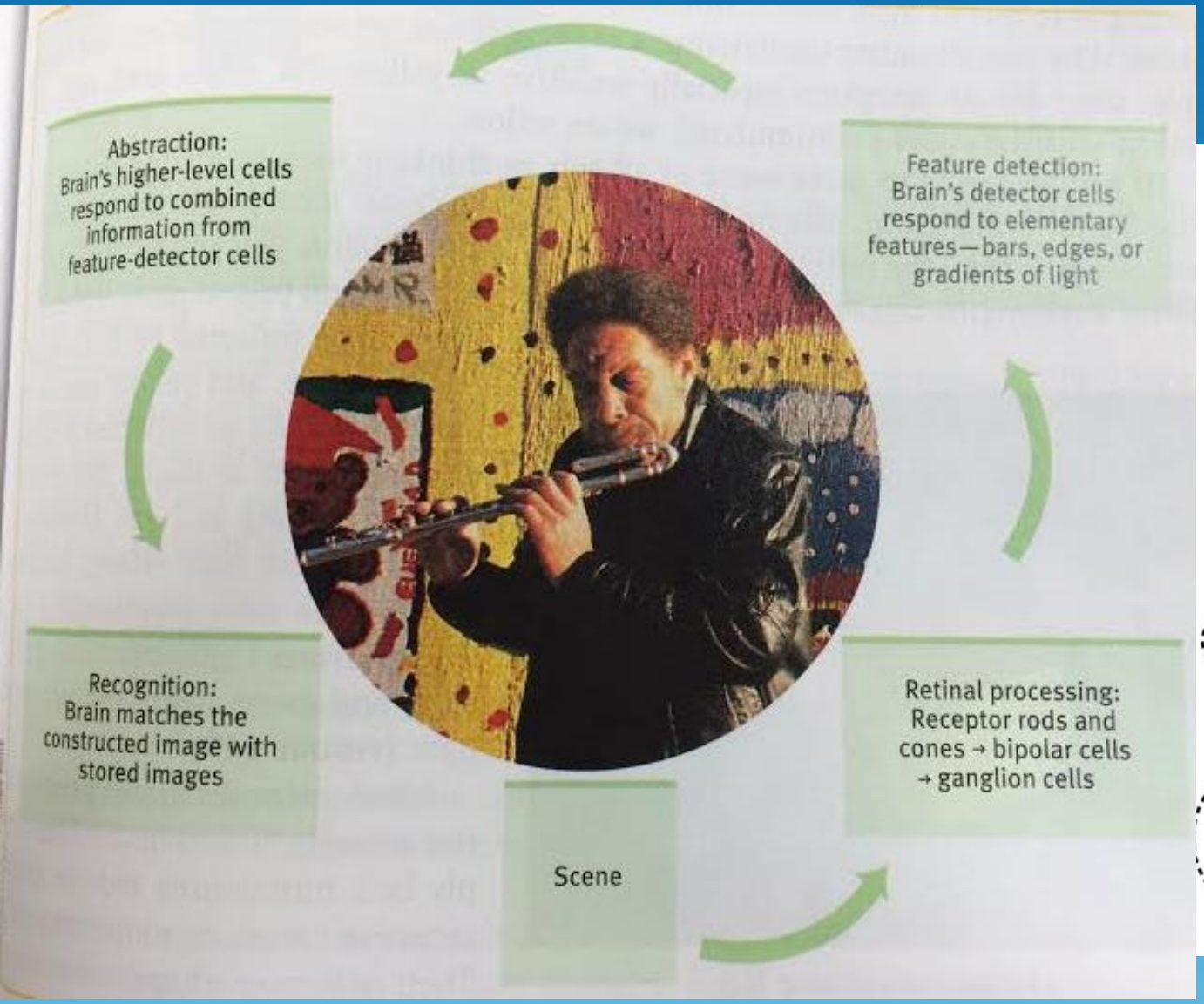


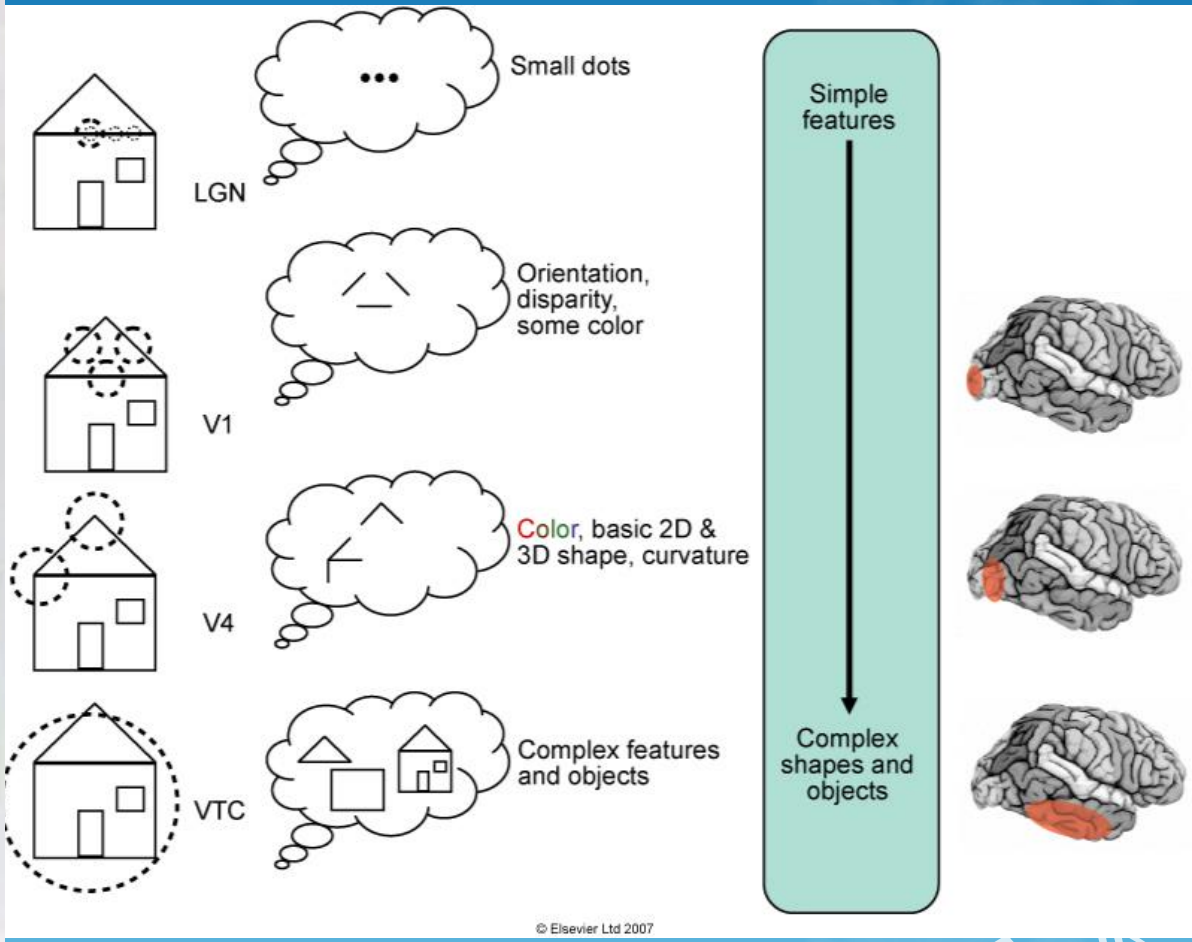
Feature Detection

- Most cells in the visual cortex are particularly sensitive to certain features
- Cells in other parts of the cortex are sensitive to more complex things
  - E.g. Spot on the temporal lobe right behind right ear helps you perceive faces
  - Scientists are able to determine what we are looking at by what part of our brain is active
- Some cells respond to entire scenes and specific gestures
- Moral of the story: our sensation and perception cells are highly sensitive

Parallel Processing

- Computers: serial processing—Step one, then step two, then step three
- Brains: parallel processing—Multiple steps at once
  - We deal with different aspects of input, separately but simultaneously
  - Then we add it altogether (synthesize) (which is super crazy and powerful)
- Brain damage in one area can disrupt entire perception
  - Mrs. M.: can't detect movement
  - Visual cortex injury: blindsight (blind in a certain spot), but can still perceive whether items in that spot are vertical or horizontal
  - Can see details, but not entire objects


Abstraction:
Brain's higher-level cells respond to combined information from feature-detector cells
Feature detection:
Brain's detector cells respond to elementary features—bars, edges, or gradients of light
Recognition:
Brain matches the constructed image with stored images
Retinal processing:
Receptor rods and cones → bipolar cells → ganglion cells
Scene


LGN
Small dots
V1
Orientation, disparity, some color
V4
Color, basic 2D & 3D shape, curvature
VTC
Complex features and objects
Simple features
Complex shapes and objects
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Hearing

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Perception

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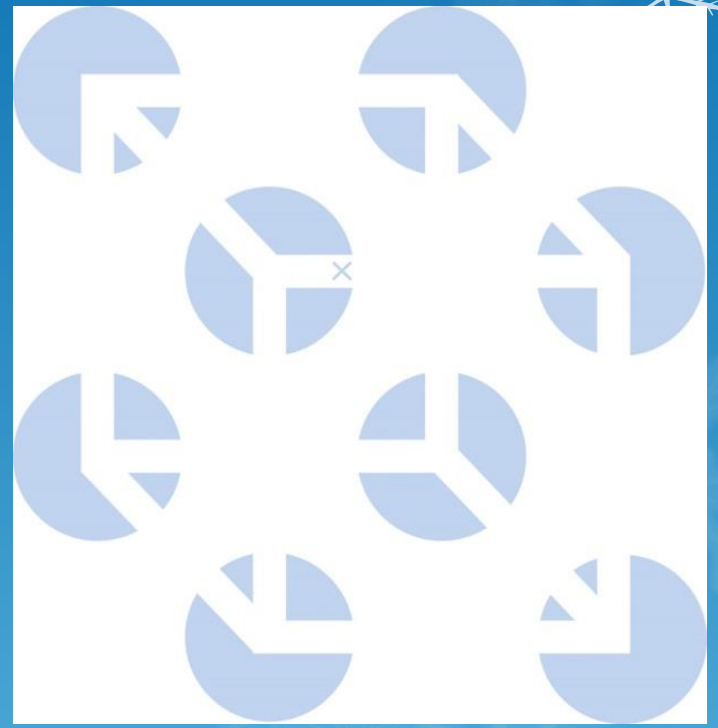
Perception

- Is the process of **selecting**, **organizing**, and **interpreting** sensory information
- Enables us to recognize meaningful objects and events.

Selective Attention

- Perceptions about objects change from moment to moment
  - (Think about all the waves changing!)
  - We perceive what we focus on!
- We can perceive different forms of the Necker cube
  - However, we can only pay attention to one aspect of the object at a time.



Necker Cube

Inattentional Blindness

- Inattentional blindness: the inability to see an object or a person in our midst.
- Do you see the gorilla?
  - Simmons & Chabris (1999) showed that half of the observers failed to see the gorilla-suited assistant in a ball passing game.

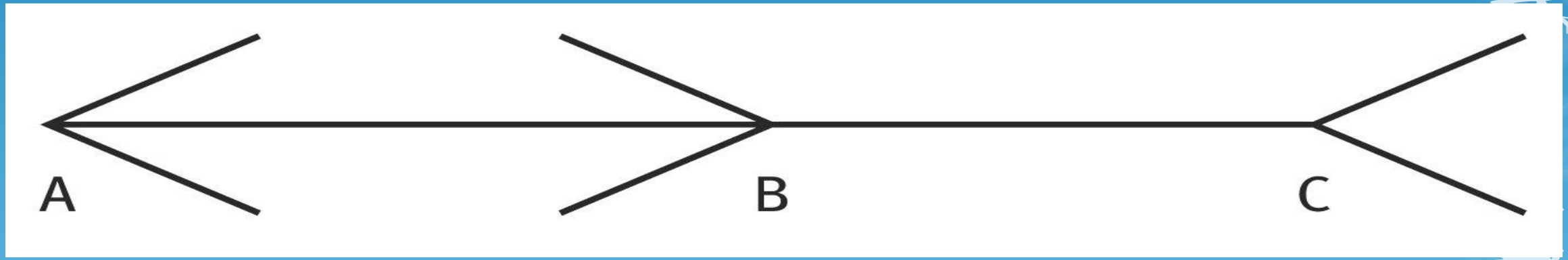
http://www.youtube.com/watch?v=vJG698U2Mvo

Change Blindness

- A type of inattentional blindness where one fails to notice change
- Experiment: Two-thirds of individuals giving directions failed to notice a change in the individual asking for directions.
- Why??

Perceptual Illusions

- Illusions illustrate how perception is organized.



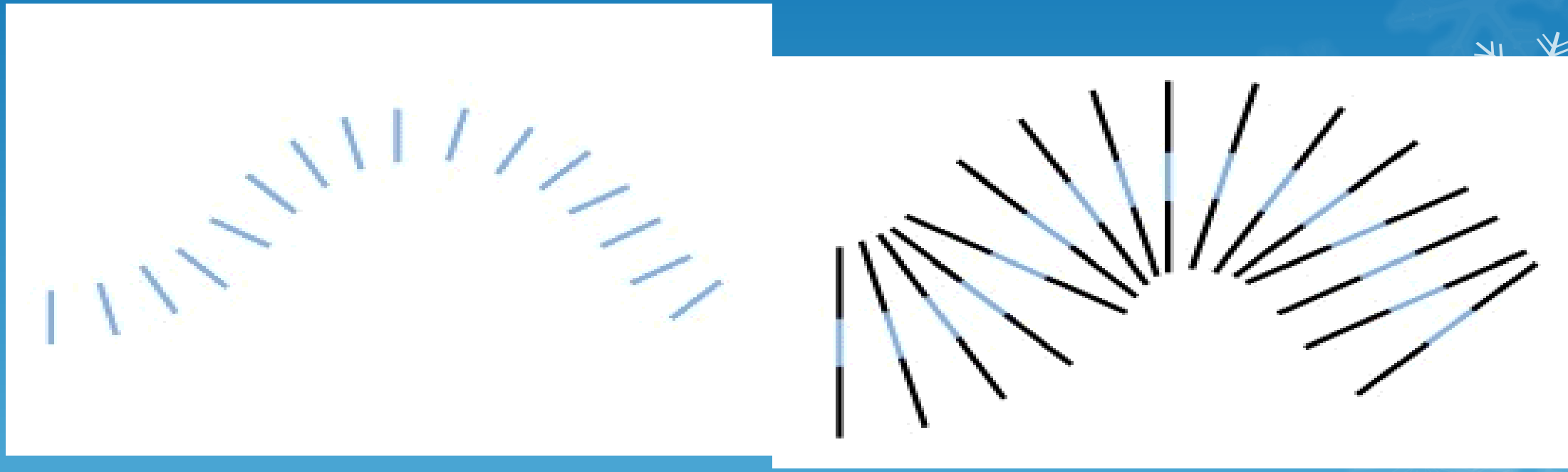
Line AB is longer than line BC.

Tall Arch

- The vertical dimension of the arch look longer than the horizontal dimension.
- In fact! both are equal.

Rick Friedman/ Black Star

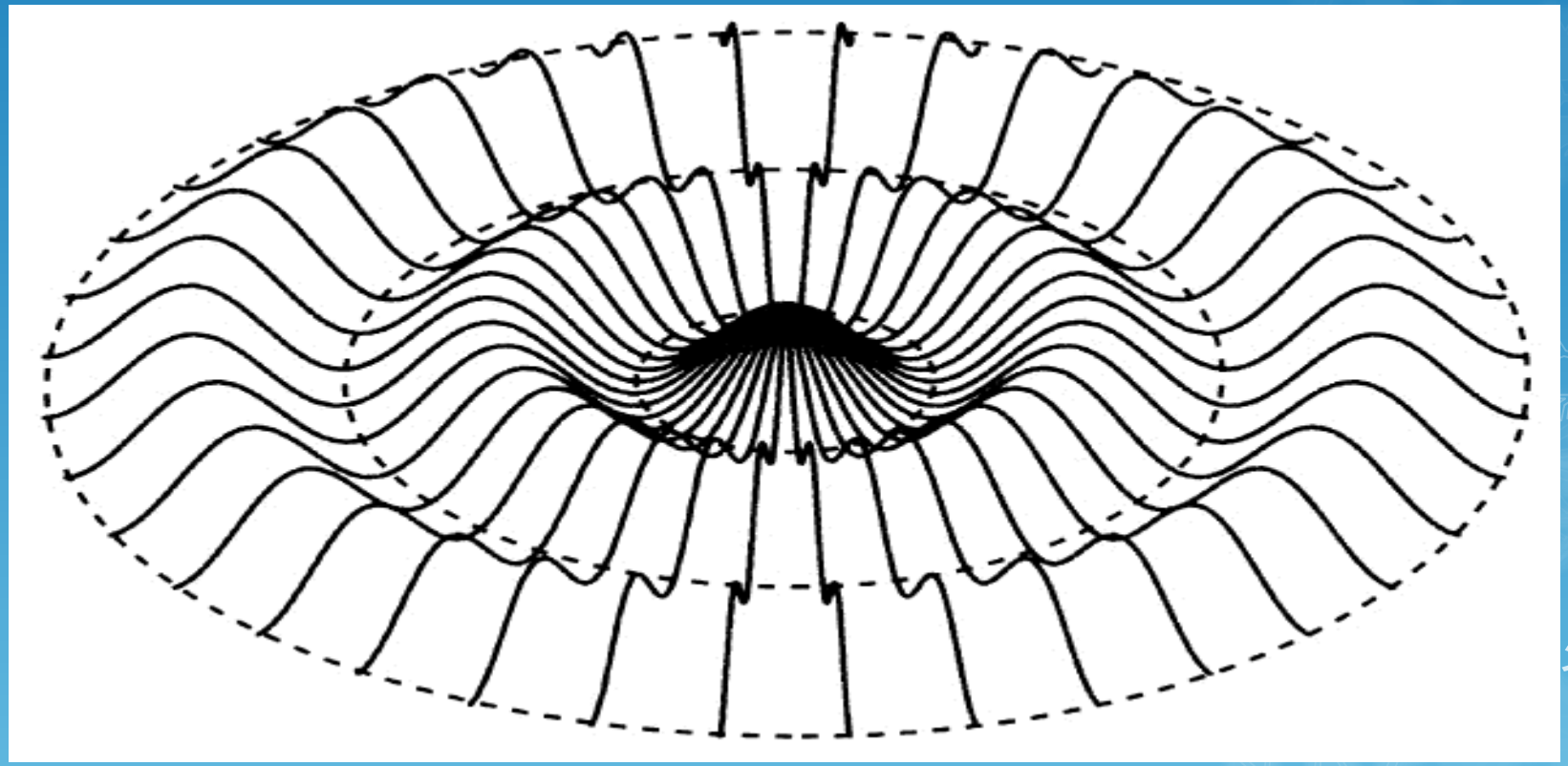
Worm Illusion



- How is the left different from the right?
- Which is the foreground, which is the background?

3-D Illusion

- 3-D??
- 2-D??
- 3/2-D??

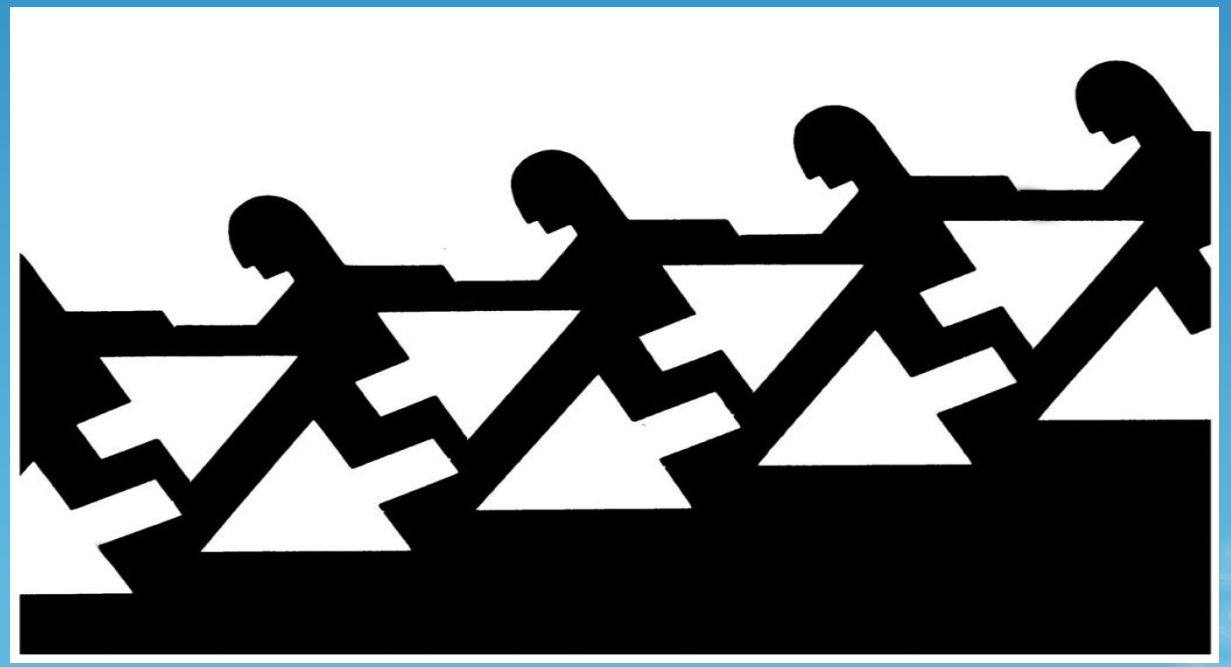


Perceptual Organization

- Visual capture
  - When vision competes with our other senses, vision usually wins
- How do we form meaningful perceptions from sensory information?
  - We organize it
  - Gestalt psychologists show that a figure formed a "whole," which is different than its surroundings.

Step One: Form Perception

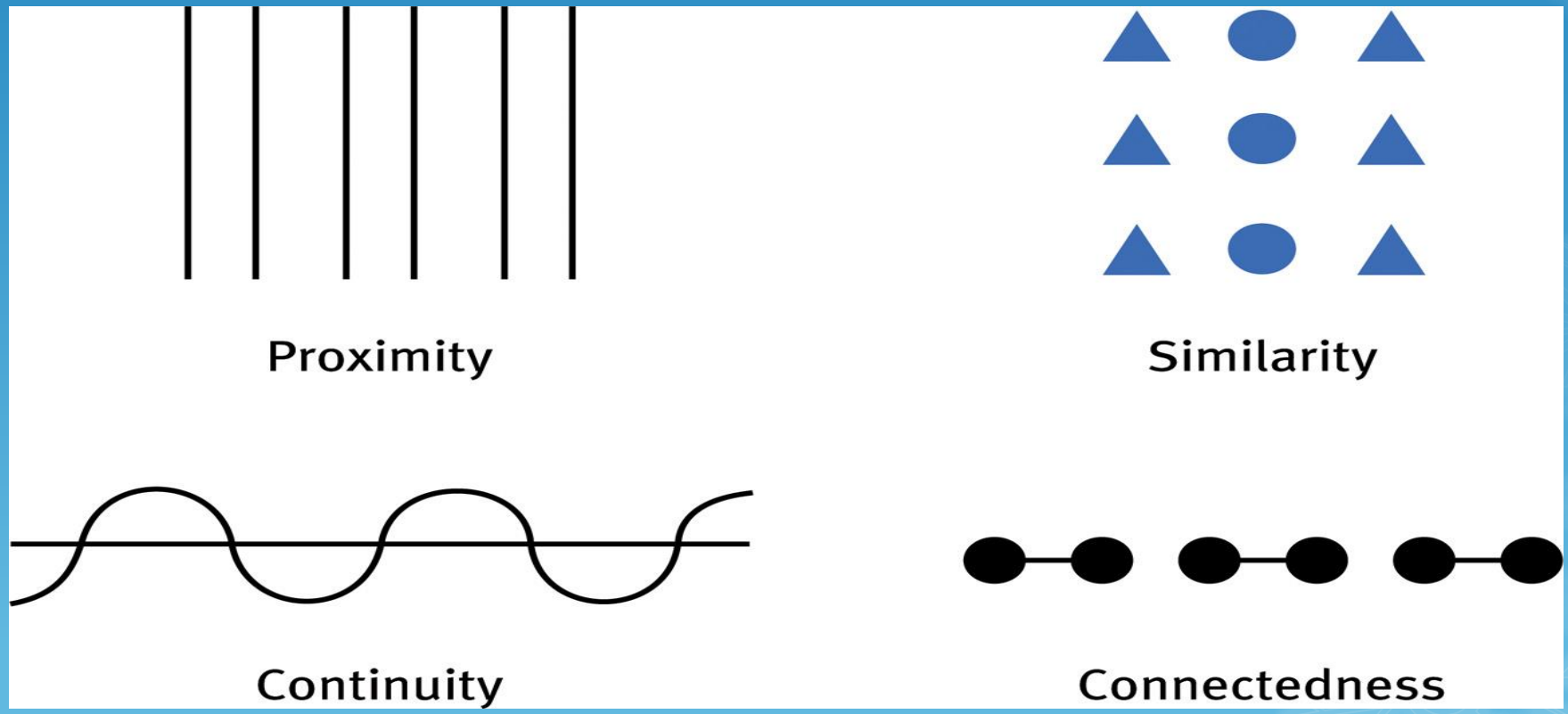
- Figure-Ground
  - Organization of the visual field into objects (figures) that stand out from their surroundings (ground).



Time Savings Suggestion, © 2003 Roger Sheperd.

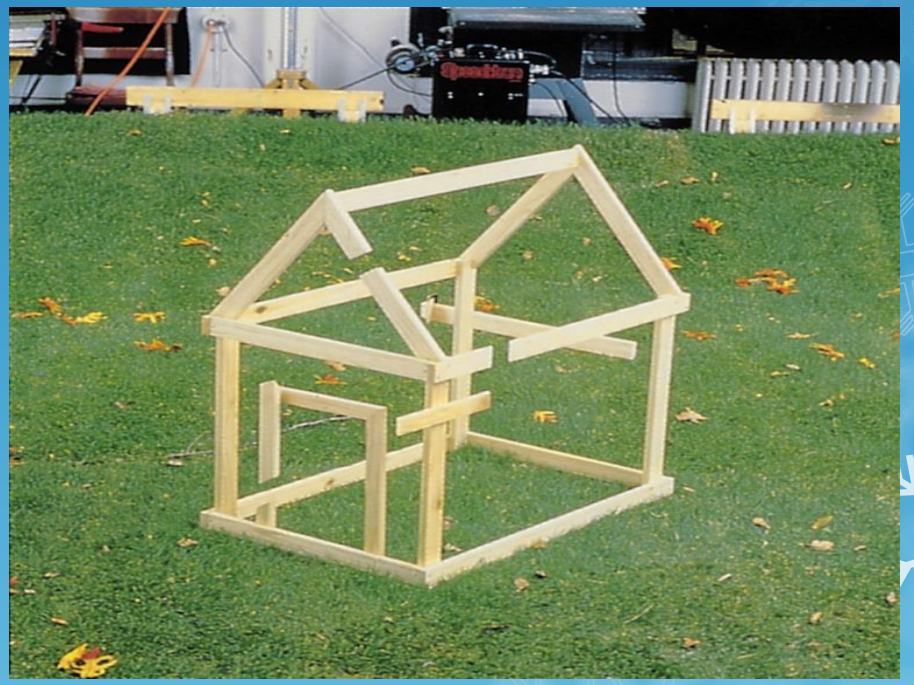
Step Two: Grouping

- Organize the figure into a meaningful form using grouping rules.



Grouping & Reality

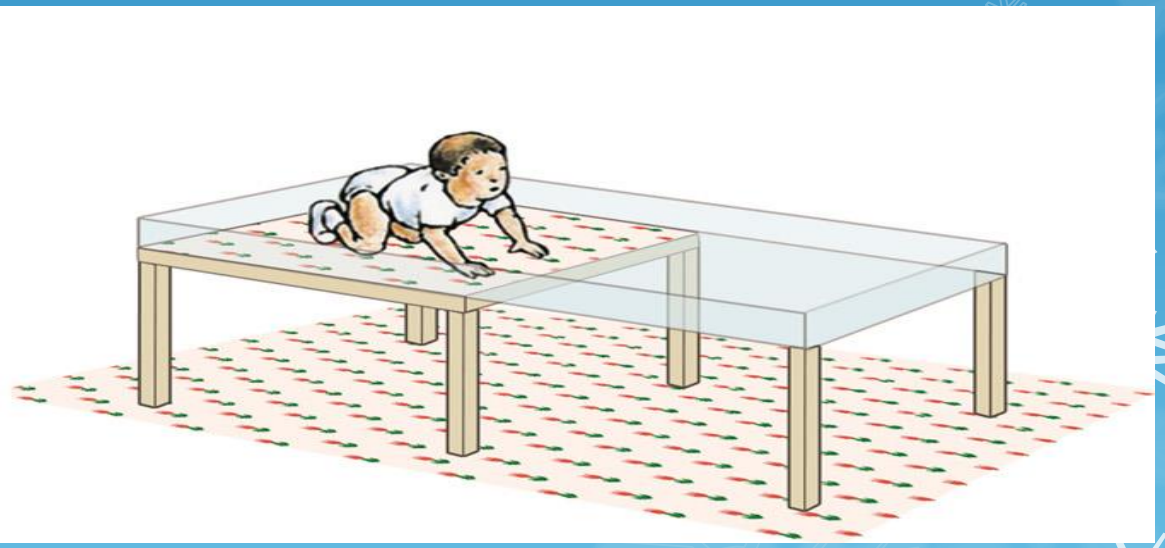
- Grouping principles usually help us construct reality, they may occasionally lead us astray.



Both photos by Walter Wick. Reprinted from GAMES Magazine. © 1983 PCS Games Limited Partnership

Step Three: Distance

- Depth perception
  - Enables us to judge distances.
  - Human infants (crawling age) have depth perception (Gibson and Walk)
  - Even newborn animals show depth perception.



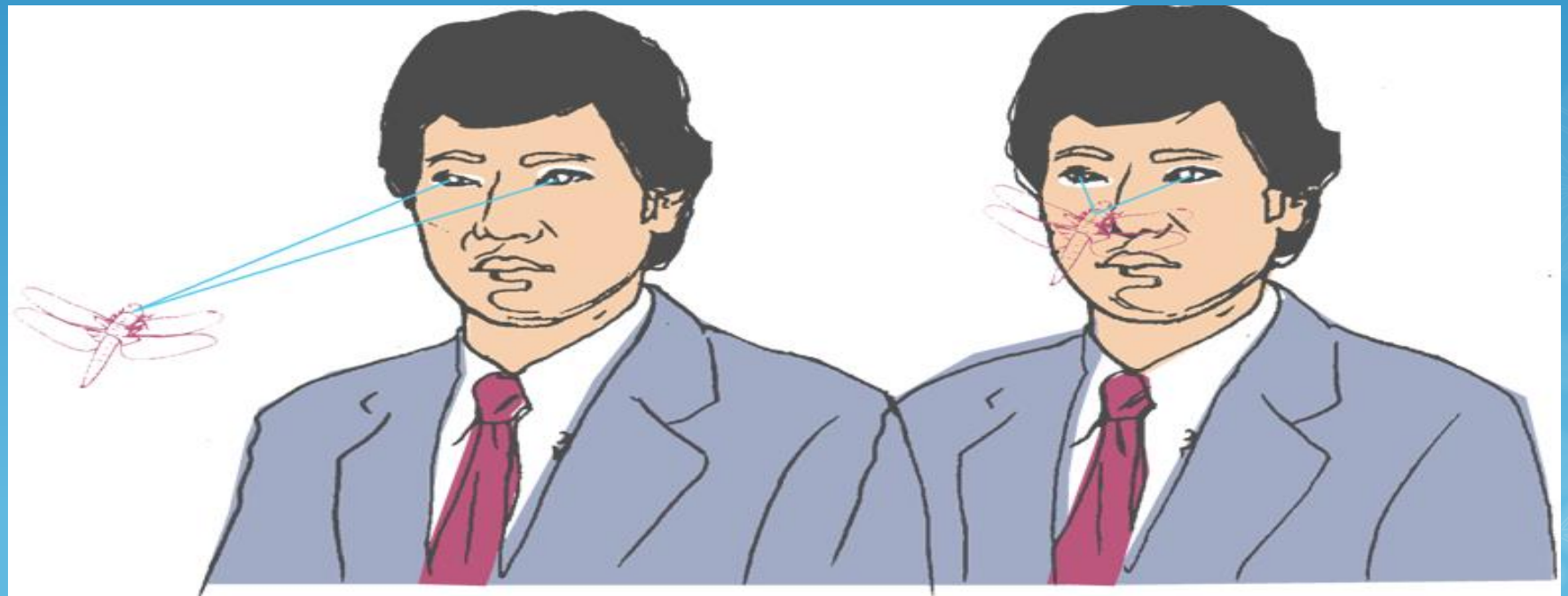
Visual Cliff

Binocular Cues

- Retinal disparity
  - Images from the two eyes differ, which helps us perceive depth
  - It is the difference between the visual images that each eye perceives because of the different angles each eye sees from
  - Try looking at your two index fingers when pointing them towards each other half an inch apart and about 5 inches directly in front of your eyes. You will see a “finger sausage” as shown in the inset.
  - If they don’t integrate seamlessly→double vision

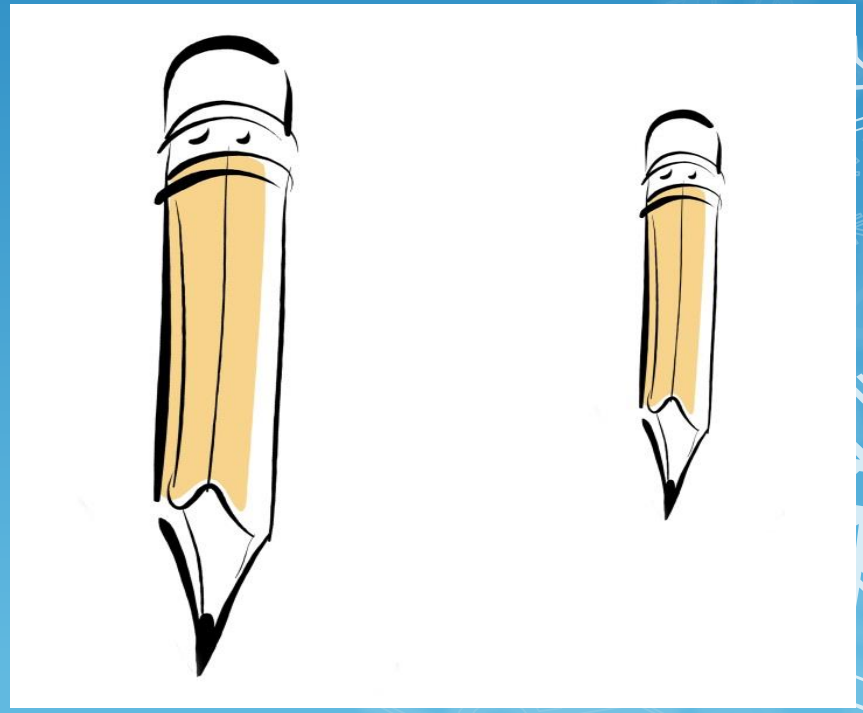
Binocular Cues

- Convergence
  - A neuromuscular cues.
  - Eyes move inward (towards the nose) to see near objects and outward (away from the nose) to see faraway objects.



Monocular Cues

- Relative Size: If two objects are similar in size, we perceive the one that casts a smaller retinal image to be farther away.



Monocular Cues

- Interposition: Objects that block other objects tend to be perceived as closer

Rene Magritte, *The Blank Signature*, oil on canvas, National Gallery of Art, Washington. Collection of Mr. and Mrs. Paul Mellon. Photo by Richard Carafelli.

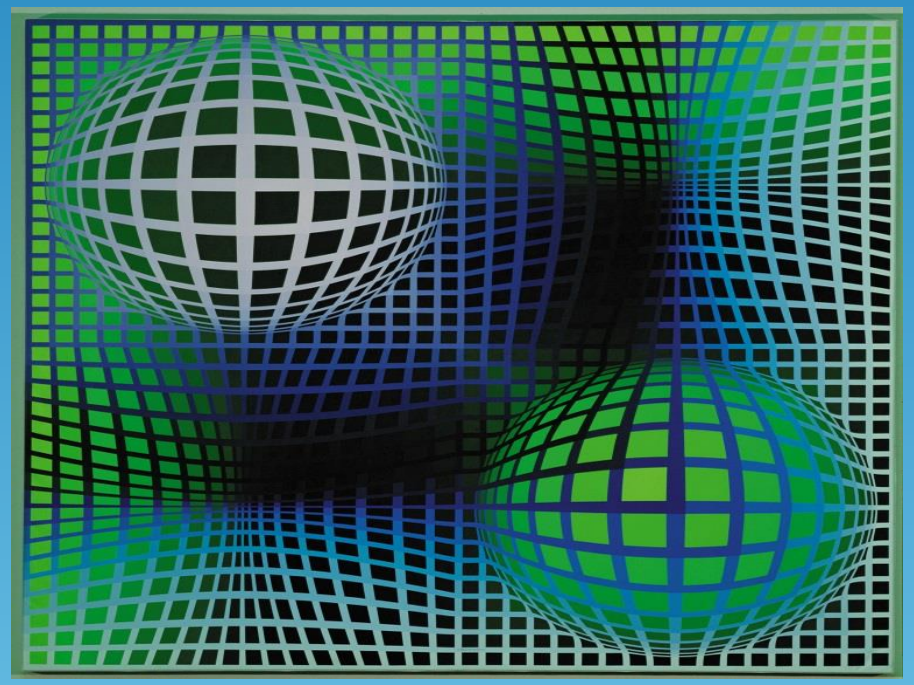
Monocular Cues

- Relative Clarity
  - Light from distant objects passes through more light than closer objects
  - We perceive hazy objects to be farther away than objects that appear sharp and clear.

Morning Fog

Monocular Cues

- Texture Gradient: Fine texture indicates increasing distance



Monocular Cues

- Relative Height: We perceive objects that are higher in our field of vision to be farther away than those that are lower.

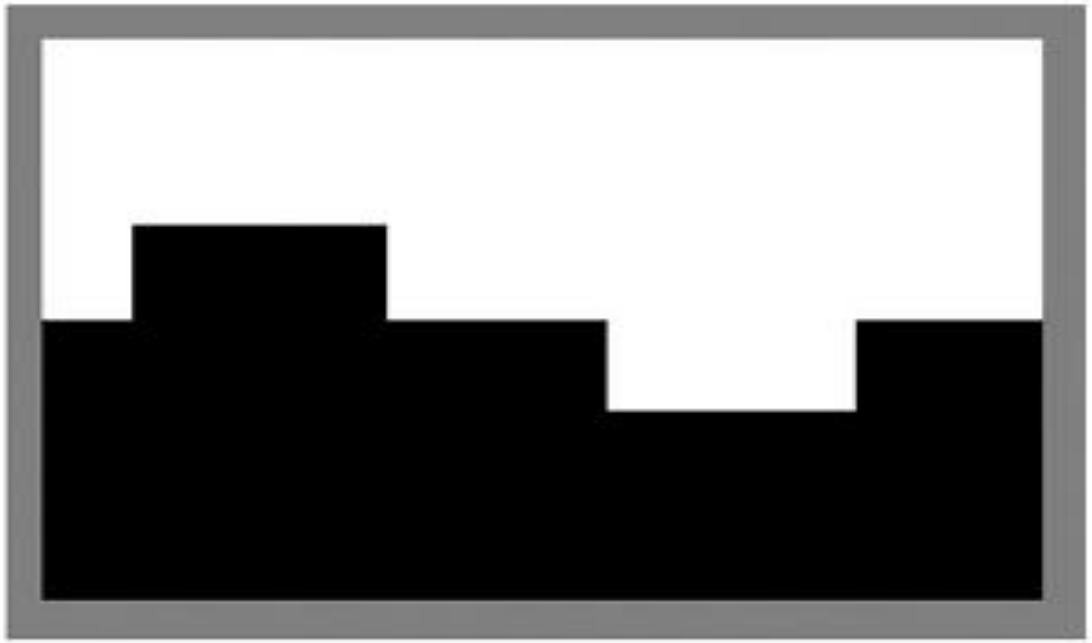
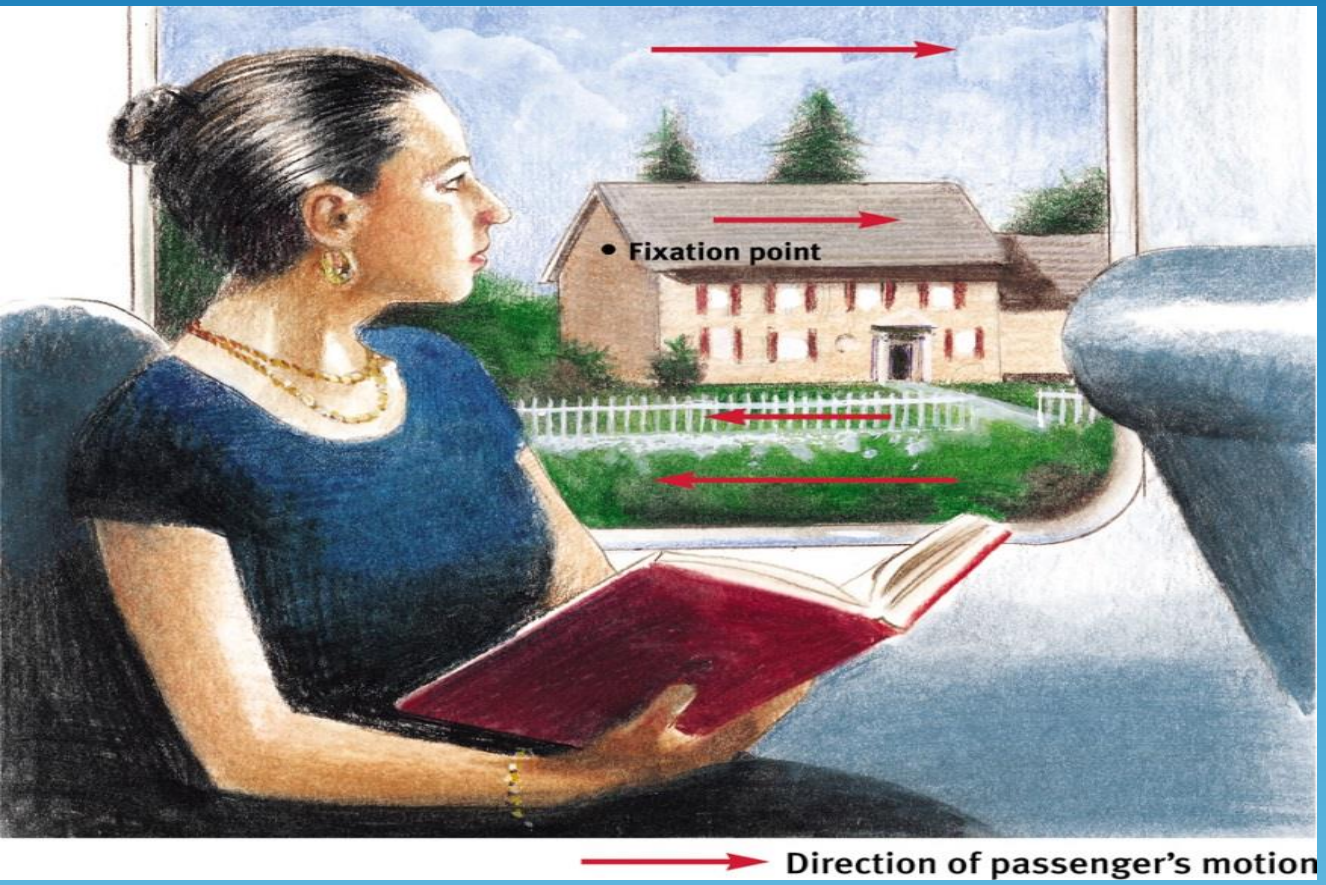


Image courtesy of Shaun P. Vecera, Ph. D., adapted from stimuli that appeared in Vecera et al., 2002

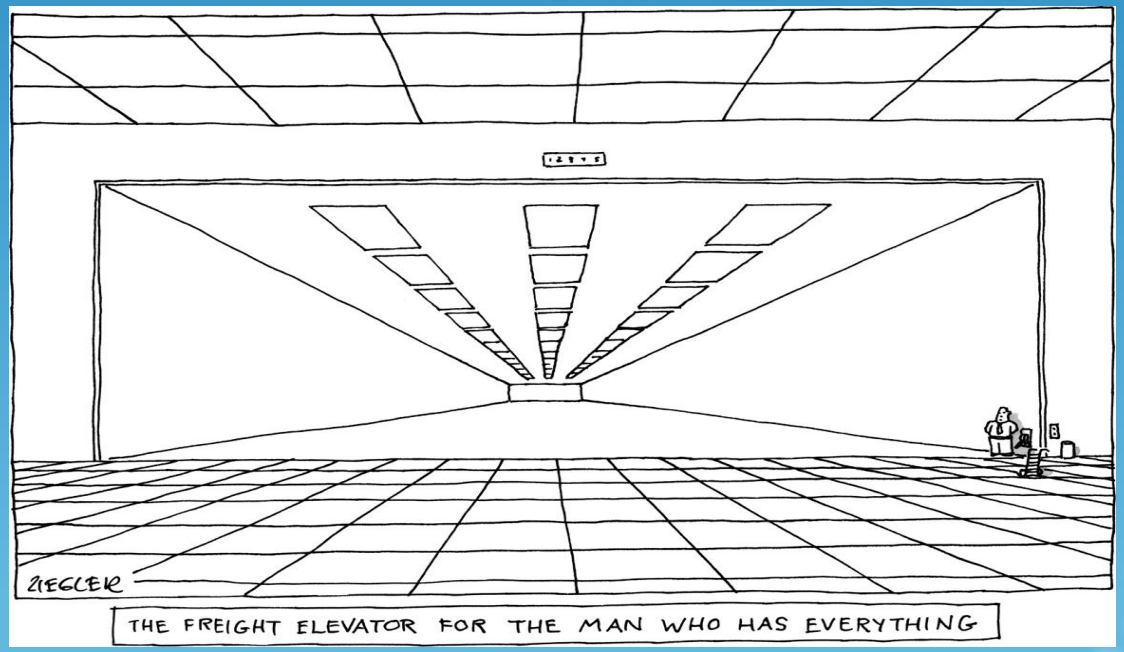
Monocular Cues



- Relative motion
  - Closer objects to a fixation point: move faster and in opposite direction
  - Farther objects from a fixation point: move slower and in the same direction.

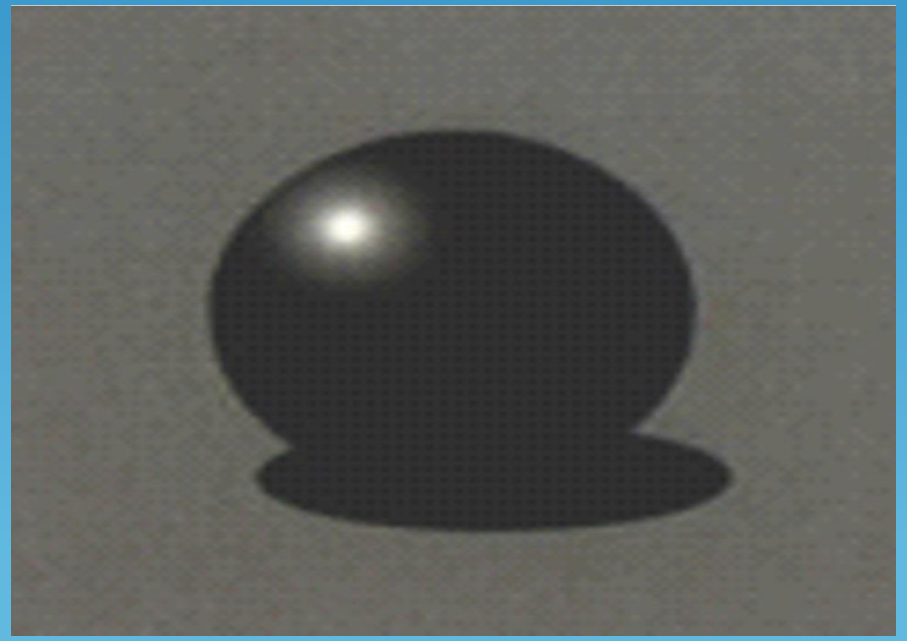
Monocular Cues

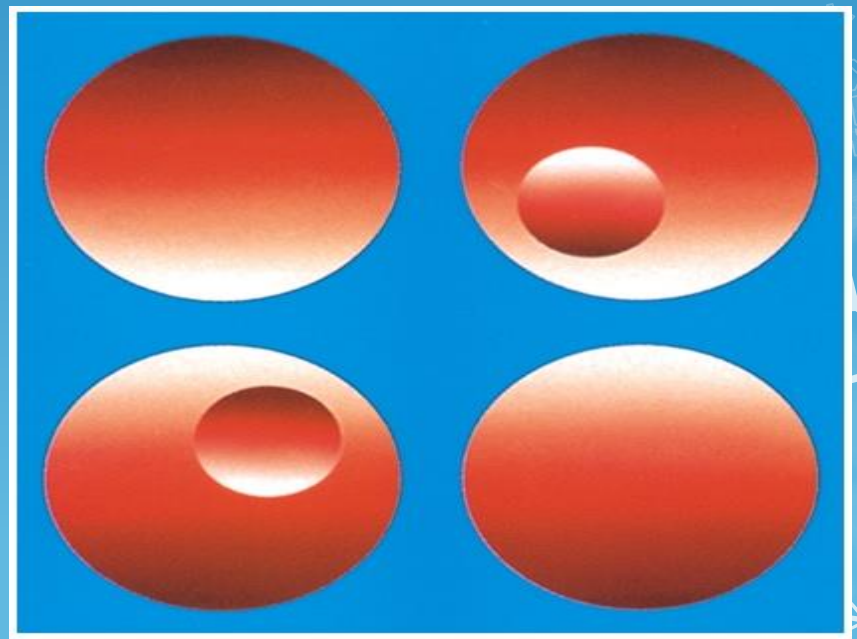
- Linear Perspective: Parallel lines, such as railroad tracks, appear to converge in the distance. The more the lines converge, the greater their perceived distance.



Monocular Cues

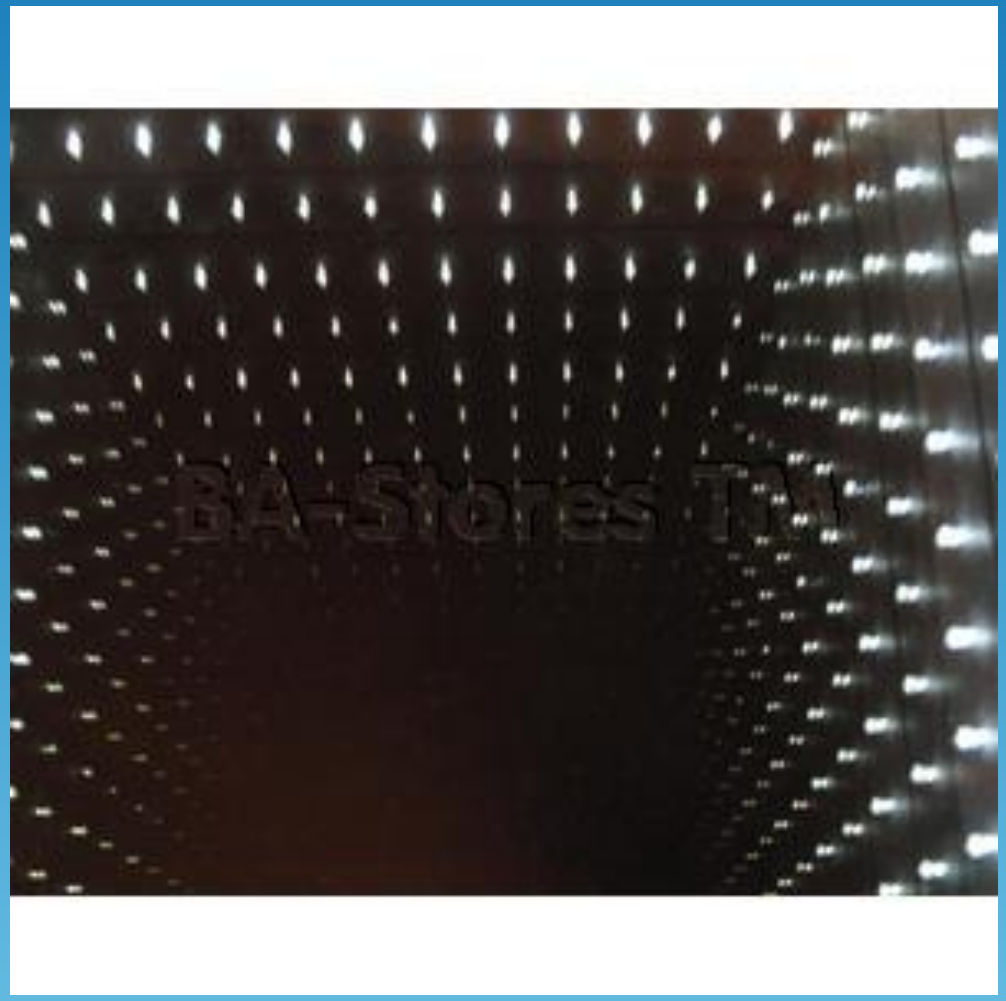
- Light and Shadow: Nearby objects reflect more light into our eyes than more distant objects.
- Given two identical objects, the dimmer one appears to be farther away.

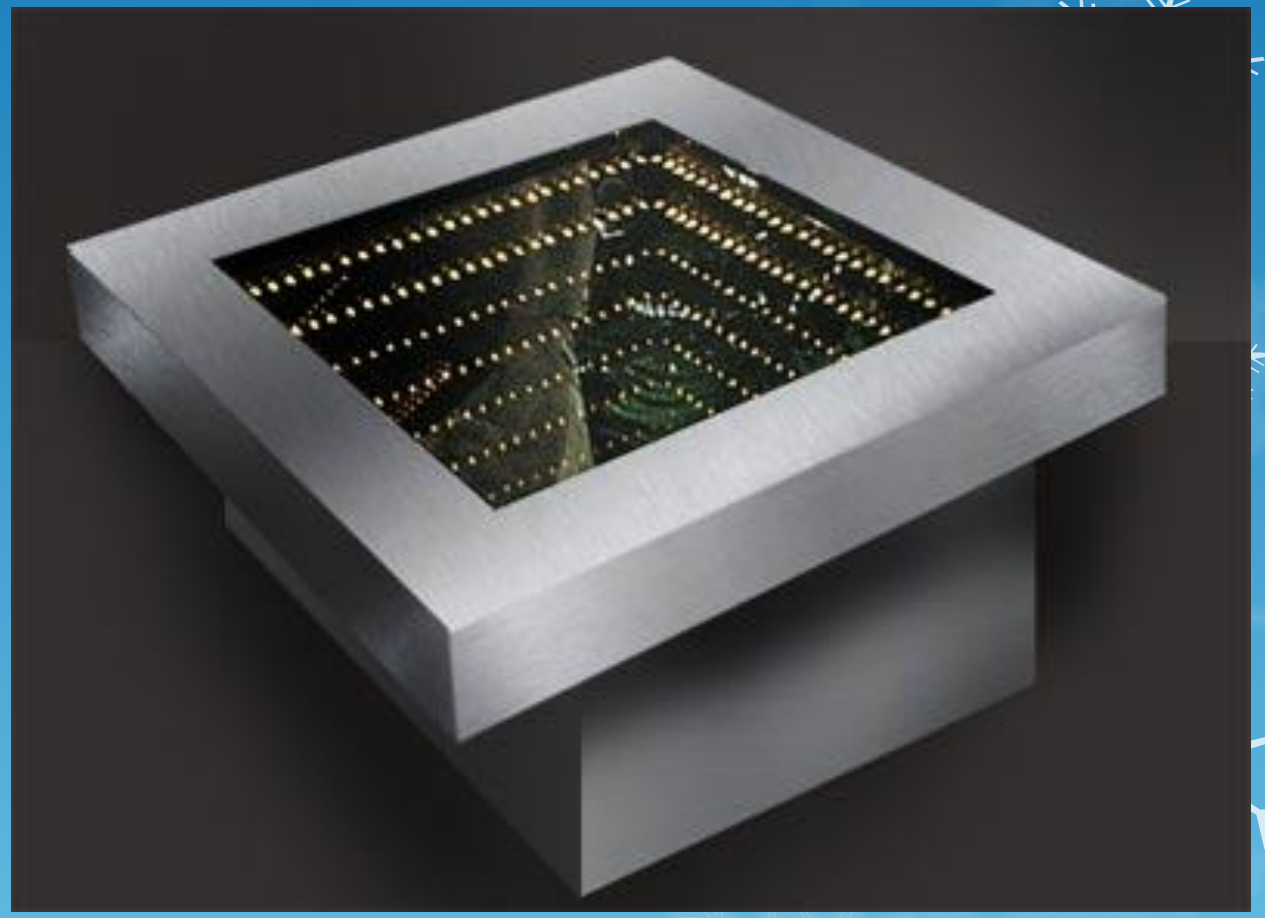




From "Perceiving Shape From Shading," by V.S. Ramachandran. © 1988 by Scientific American, Inc. All rights reserved.

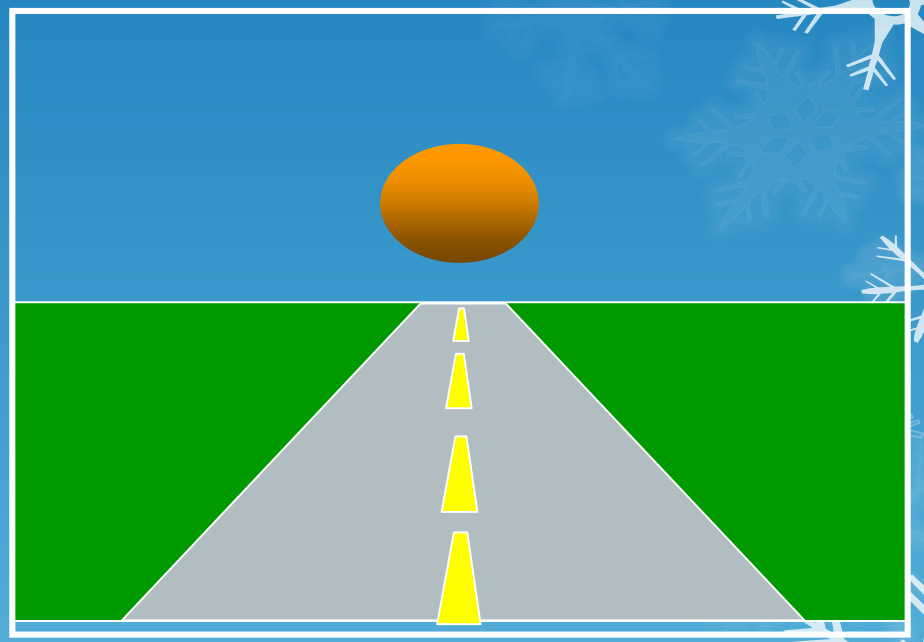
Infinity Tables





Motion Perception

- Motion Perception: Objects traveling towards us grow in size and those moving away shrink in size
- The same is true when the observer moves to or from an object.



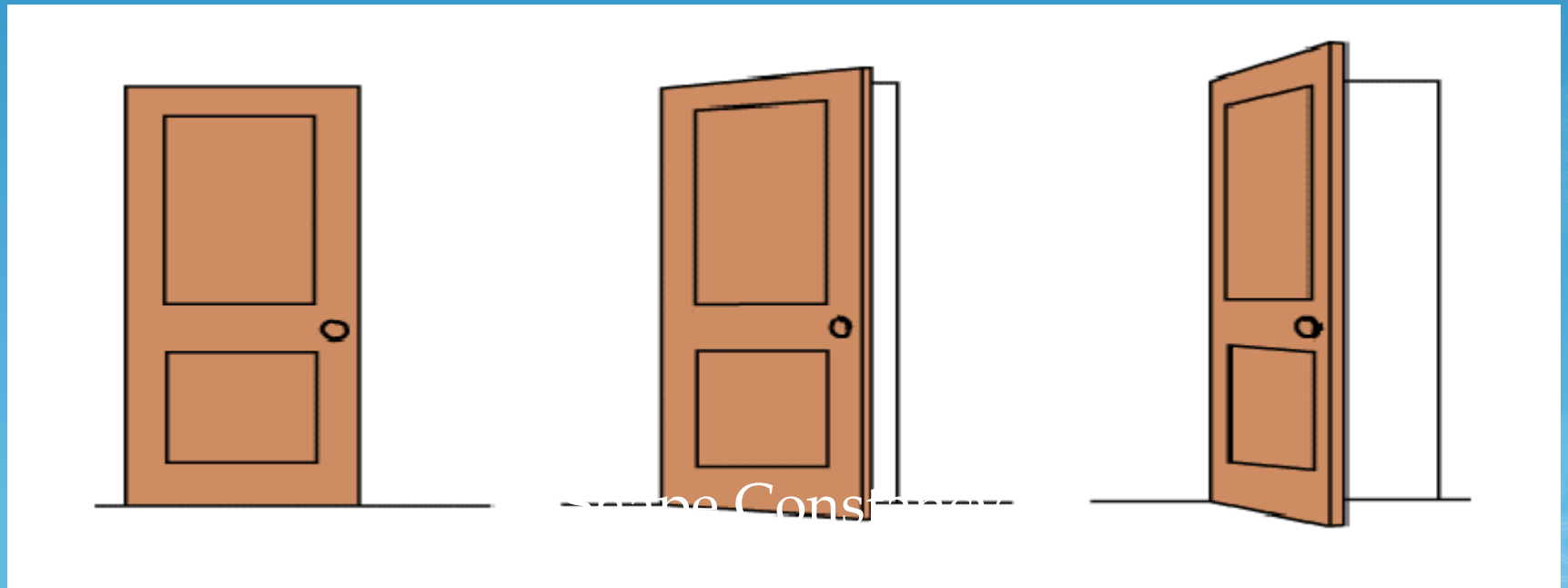
Apparent Motion

- Phi Phenomenon: When lights flash at a certain speed they tend to present illusions of motion
  - Neon signs use this principle to create motion perception.

One light jumping from one point to another: Illusion of motion.

Perceptual Constancy

- Perceiving objects as unchanging even as illumination and retinal images change.
- Perceptual constancies include constancies of shape and size.

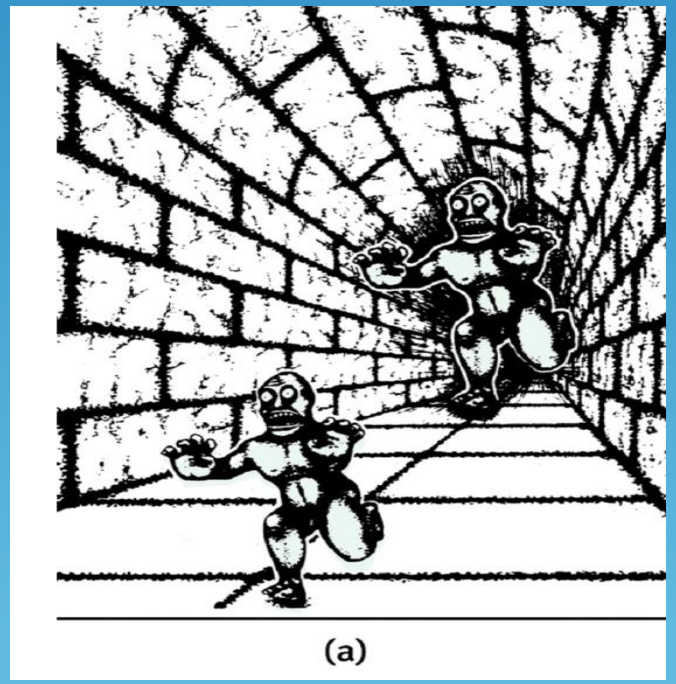


Size Constancy

- Stable size perception even when the stimuli change size

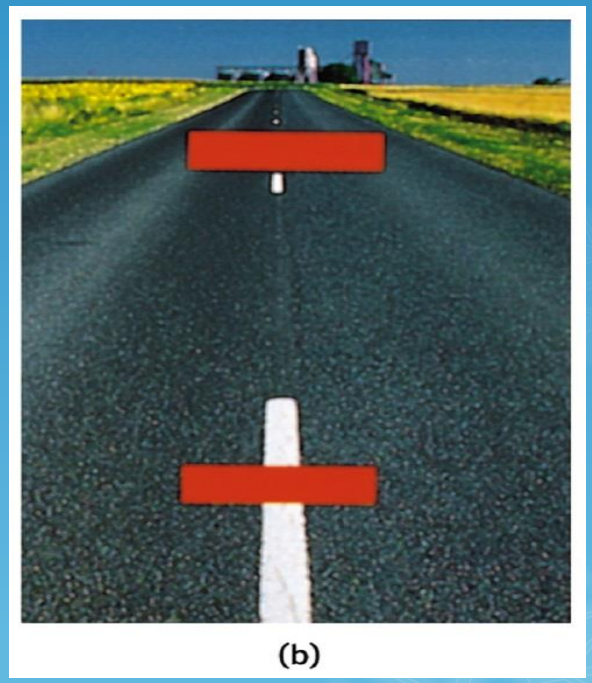
Size-Distance Relationship

- The distant monster (below, left) and the top red bar (below, right) appear bigger because of distance cues.



(a)

From Shepard, 1990



(b)

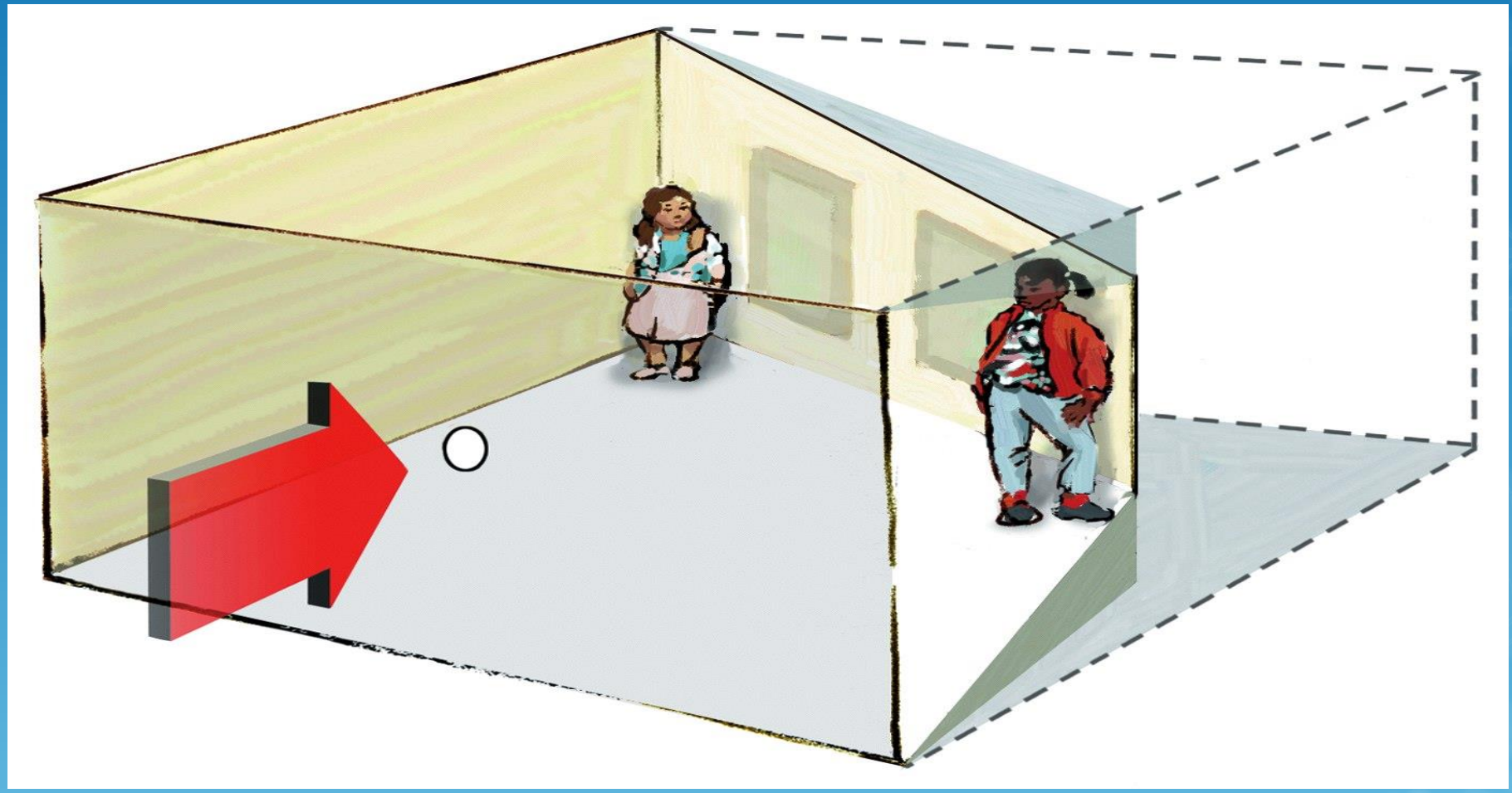
Alan Choisnet/ The Image Bank

Size-Distance Relationship

- Both girls in the room are of similar height. However, we perceive them to be of different heights as they stand in the two corners of the room.

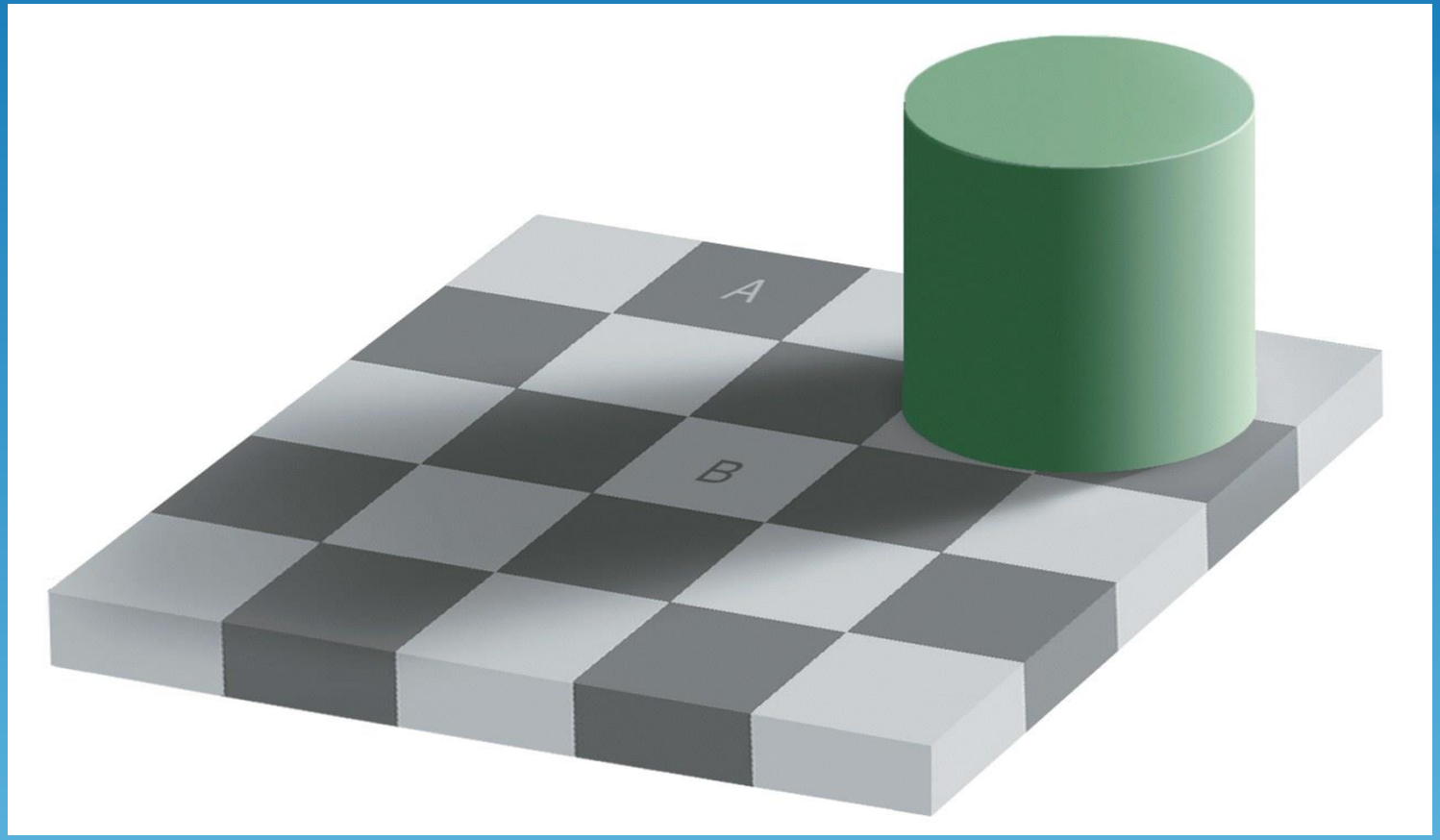
Both photos from S. Schwartzenberg/ The Exploratorium

Ames Room



- The Ames room is designed to demonstrate the size-distance illusion

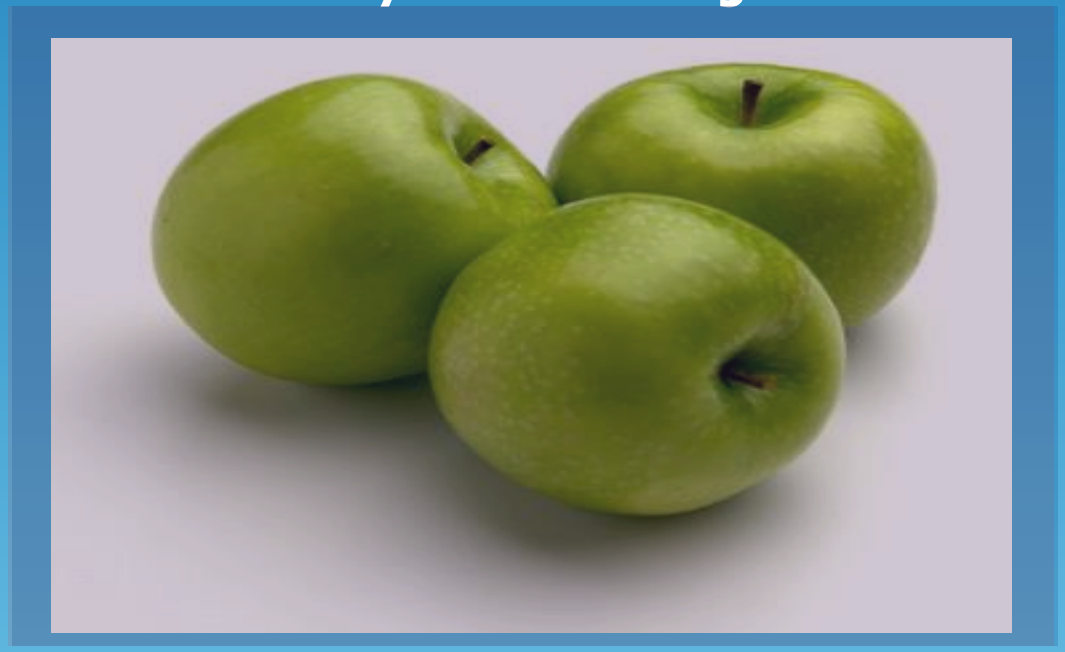
Lightness Constancy



- The color and brightness of square A and B are the sa

Color Constancy

- Perceiving familiar objects as having consistent color even when changing illumination filters the light reflected by the object.

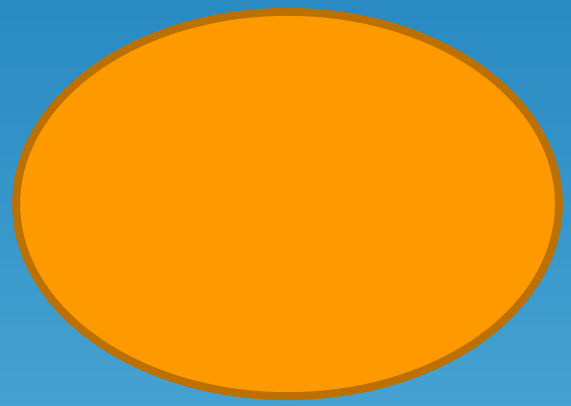


Perceptual Interpretation

- Immanuel Kant (1724-1804) maintained that knowledge comes from our inborn ways of organizing sensory experiences.
-
- John Locke (1632-1704) argued that we learn to perceive the world through our experiences.
  - How important is experience in shaping our
  - perceptual interpretation?

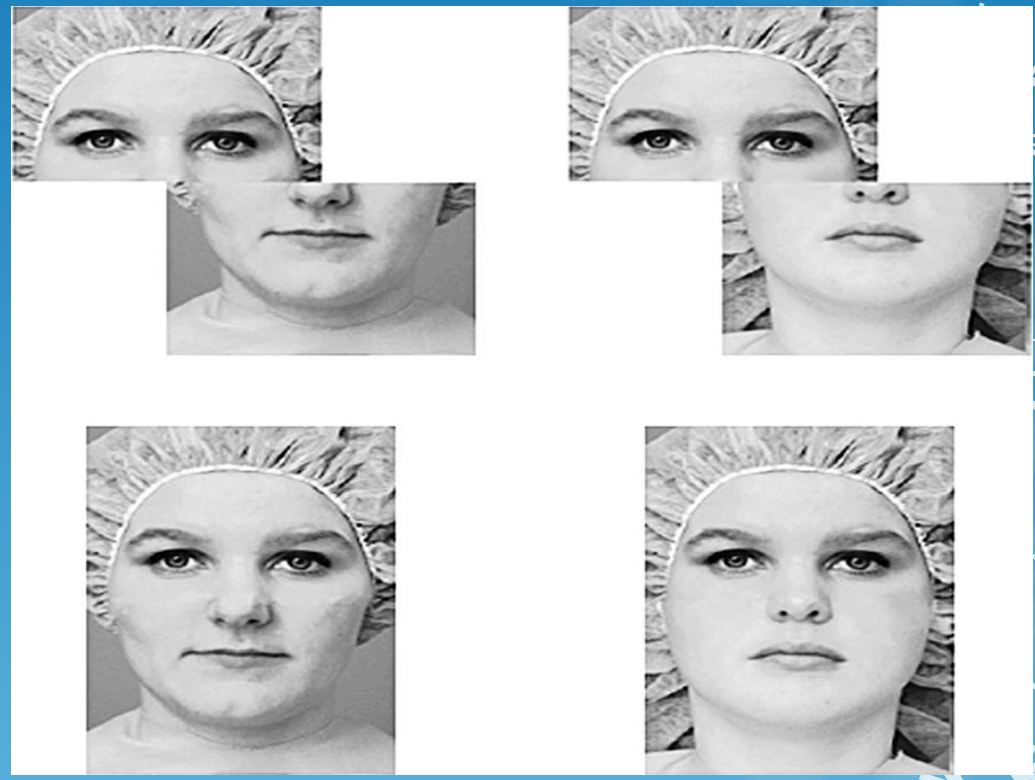
Restored Vision

- After cataract surgery, blind adults were able to regain sight. These individuals could differentiate figure and ground relationships, yet they had difficulty distinguishing a circle and a triangle (Von Senden, 1932).



Facial Recognition

- After blind adults regained sight, they were able to recognize distinct features, but were unable to recognize faces. Normal observers also show difficulty in facial recognition when the lower half of the pictures are changed.



Courtesy of Richard LeGrand

Sensory Deprivation

- Kittens raised without exposure to horizontal lines later had difficulty perceiving horizontal bars.

 Blakemore & Cooper (1970)

Perceptual Adaptation

- Visual ability to adjust to an artificially displaced visual field, e.g., prism glasses.

Courtesy of Hubert Dolezal

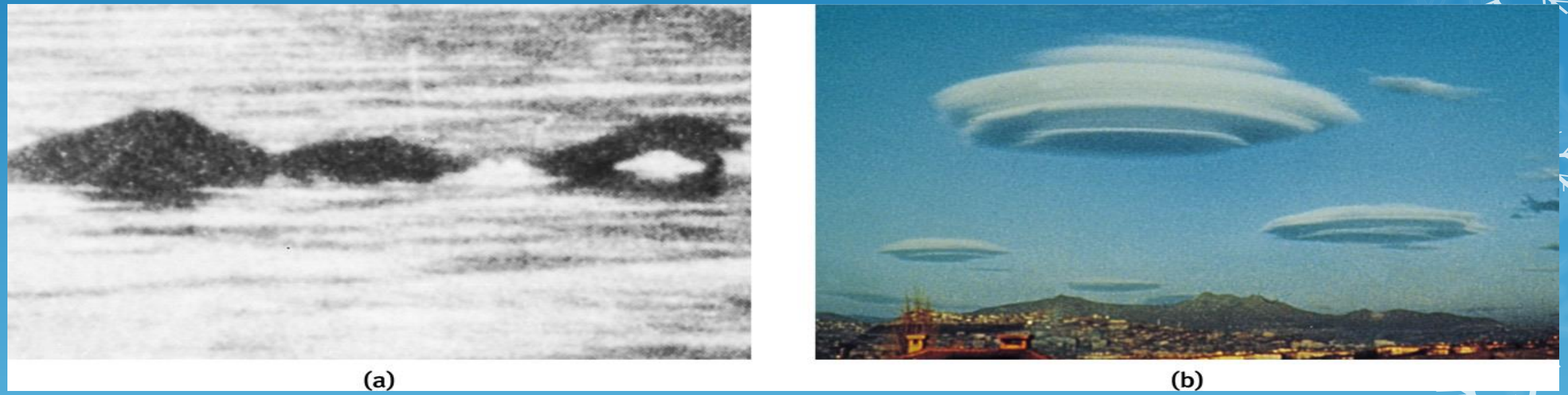
Perceptual Set

- A mental predisposition to perceive one thing and not another. What you see in the center picture is influenced by flanking pictures.

From Shepard, 1990

Perceptual Set

Other examples of perceptual set.



- (a) Loch ness monster or a tree trunk;
  (b) Flying saucers or clouds?

Schemas

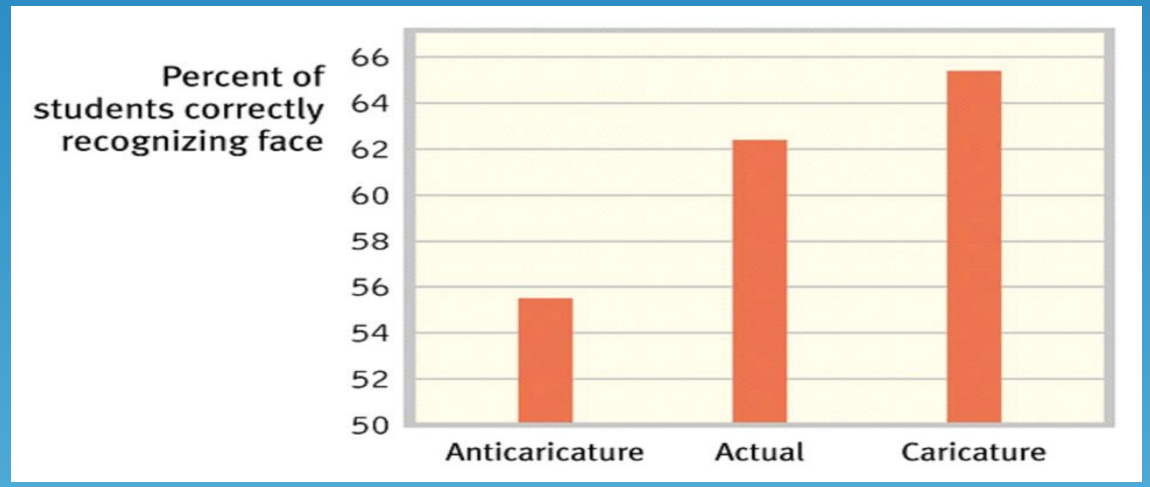
- Schemas are concepts that organize and interpret unfamiliar information.

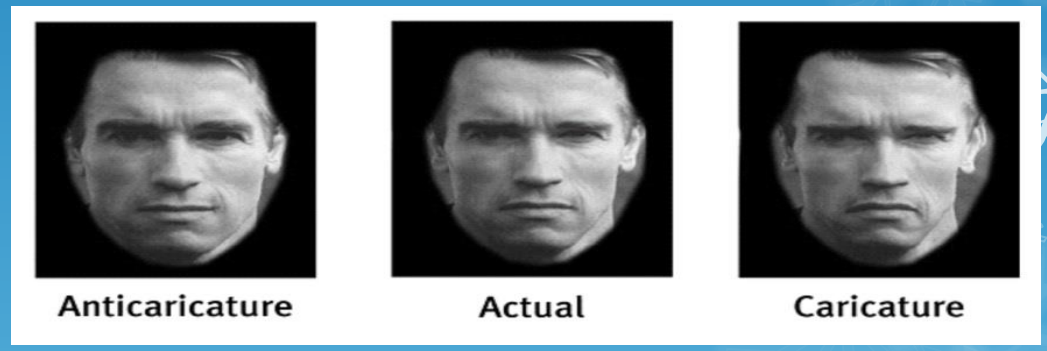
Courtesy of Anna Elizabeth Voskuil

- Children's schemas represent reality as well as their abilities to represent what they see.

Features on a Face

- Face schemas are accentuated by specific features on the face.





Kieran Lee, FaceLab, Department of Psychology, University of Western Australia

- Students recognized a caricature of Arnold Schwarzenegger faster than his actual photo.

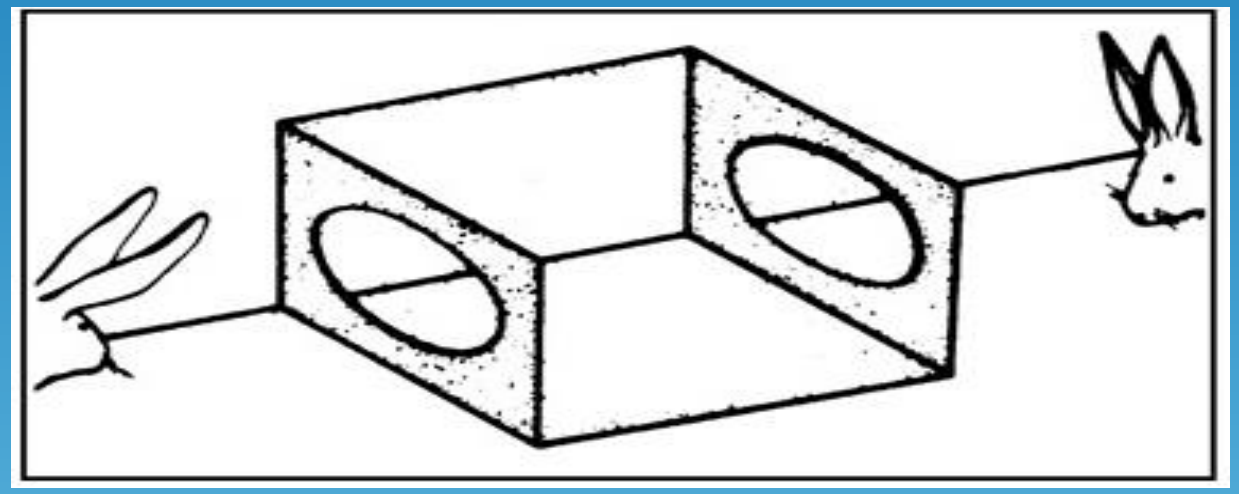
Eye & Mouth

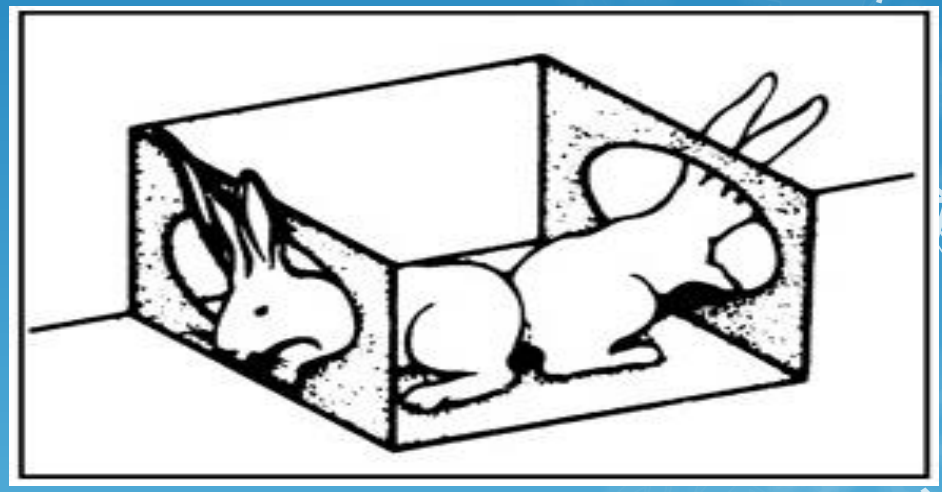
- Eyes and mouth play a dominant role in face recognition.

Courtesy of Christopher Tyler

Context Effects

- Context can radically alter perception.

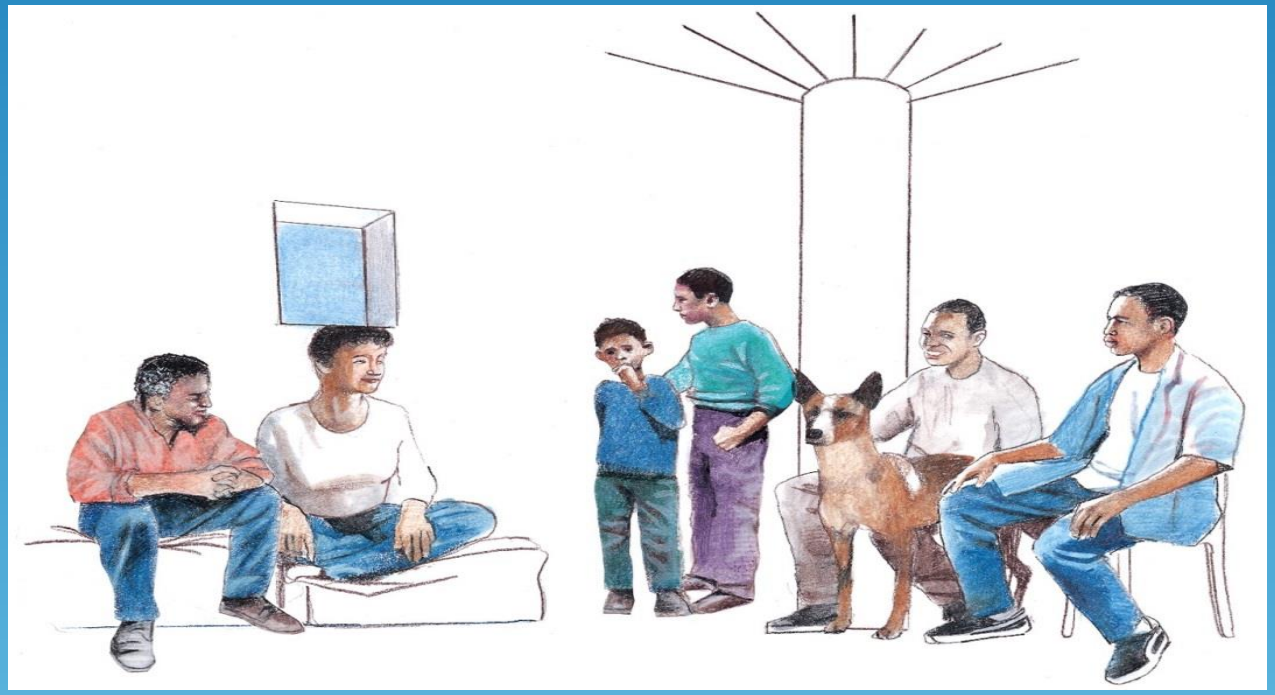




- Is the "magician cabinet" on the floor or hanging from the ceiling?

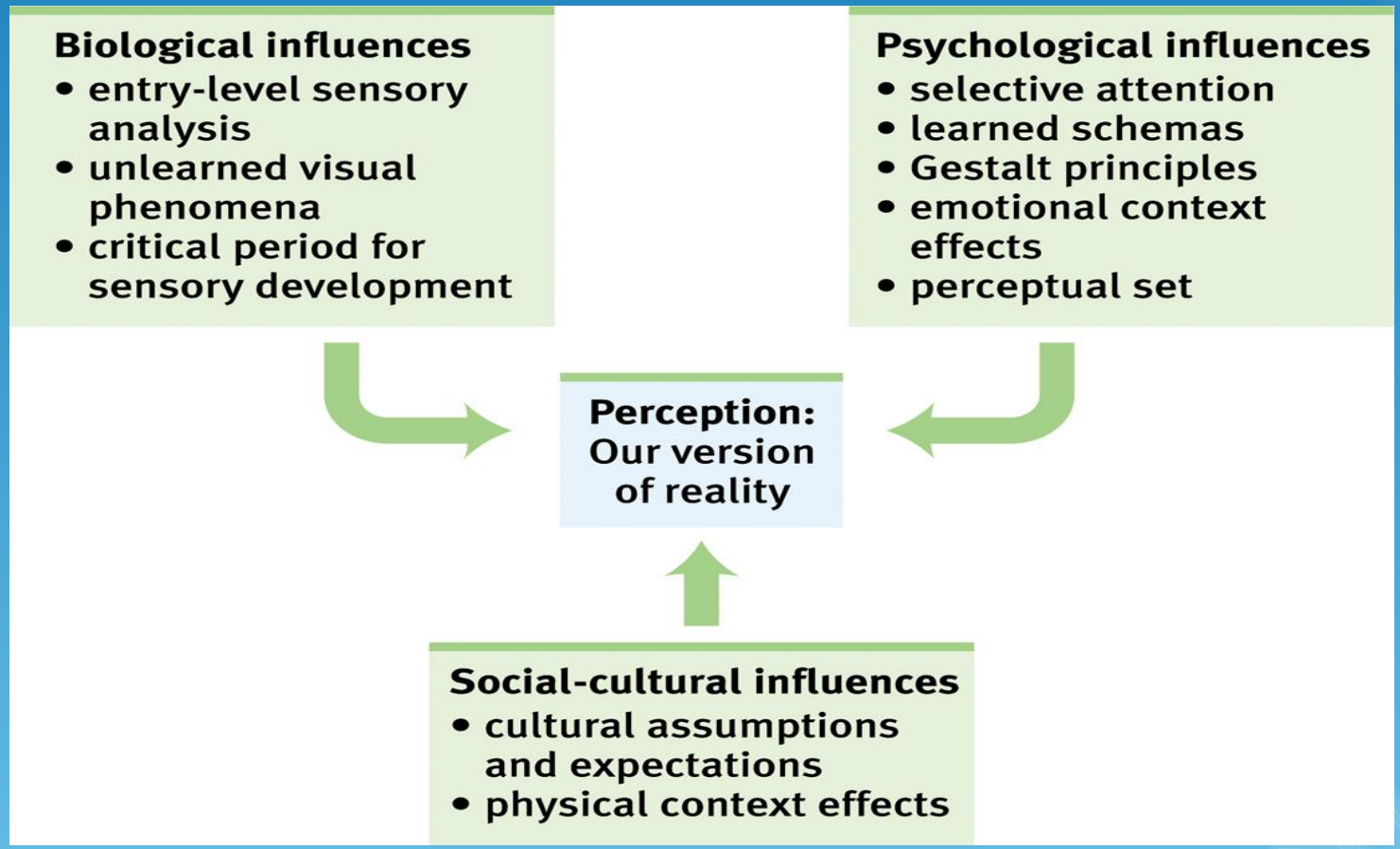
Cultural Context

- Context instilled by culture also alters perception.



- To an East African, the woman sitting is balancing a metal box on her head, while the family is sitting under a tree.

- Is perception innate or acquired?



Perception & Human Factors

- Human Factor Psychologists design machines that assist our natural perceptions.

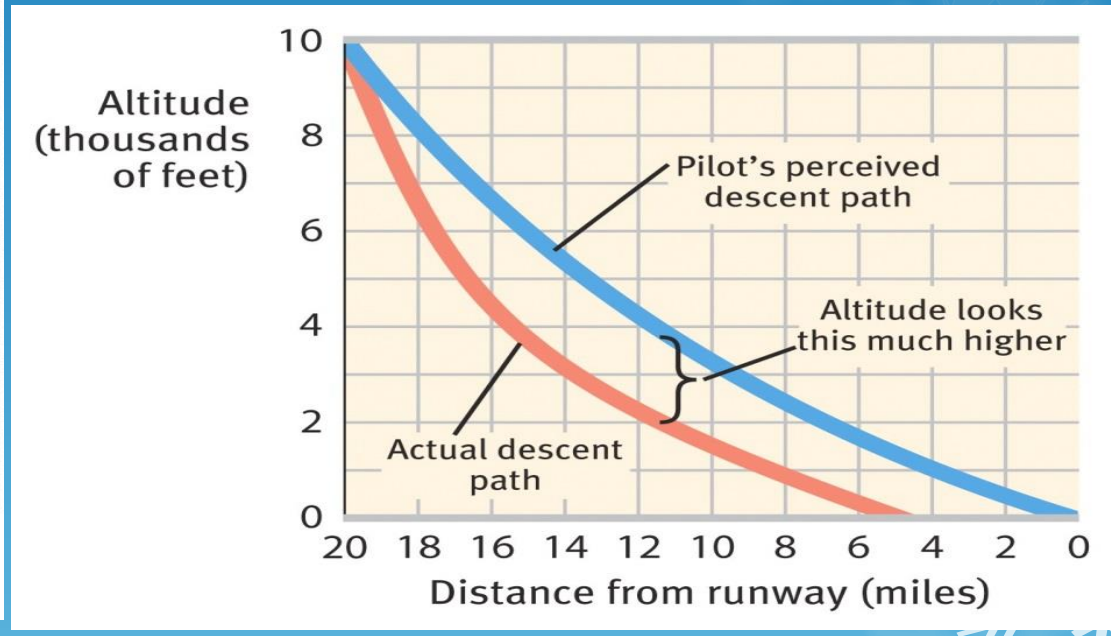
Photodisc/ Punchstock

Courtesy of General Electric

- The knobs for the stove burners on the right are easier to understand than those on the left.

Human Factors & Misperceptions

- Understanding human factors enables us to design equipment to prevent disasters.



- Two-thirds of airline crashes caused by human error are largely due to errors of perception.

Human Factors in Space

- To combat conditions of monotony, stress, and weightlessness when traveling to Mars, NASA engages Human Factor Psychologists.

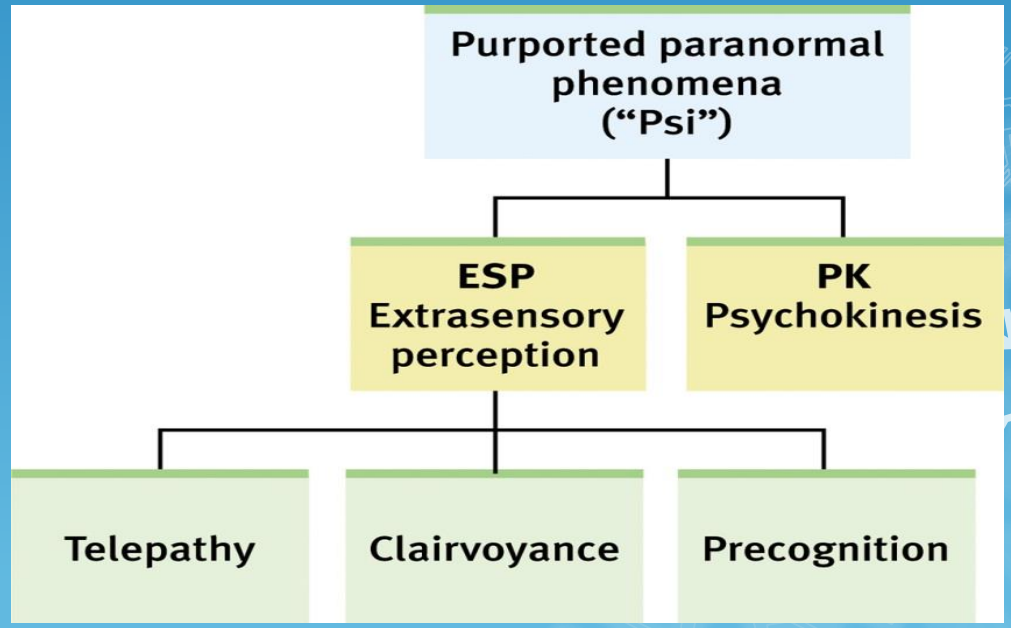
Transit Habituation (Transhab), NASA

Is There Extrasensory Perception?

- Perception without sensory input is called extrasensory perception (ESP). A large percentage of scientists do not believe in ESP.

Claims of ESP

- Paranormal phenomena include astrological predictions, psychic healing, communication with the dead, and out-of-body experiences, but most relevant are telepathy, clairvoyance, and precognition.



Claims of ESP

1. Telepathy: Mind-to-mind communication. One person sending thoughts and the other receiving them.
2. Clairvoyance: Perception of remote events, such as sensing a friend's house on fire.
3. Precognition: Perceiving future events, such as a political leader's death.

Premonitions or Pretensions?

- Can psychics see the future? Can psychics aid police in identifying locations of dead bodies? What about psychic predictions of the famous Nostradamus?

- The answers to these questions are NO! Nostradamus' predictions are "retrofitted" to events that took place after his predictions.

Putting ESP to Experimental Test

- In an experiment with 28,000 individuals, Wiseman attempted to prove whether or not one can psychically influence or predict a coin toss. People were able to correctly influence or predict a coin toss 49.8% of the time.