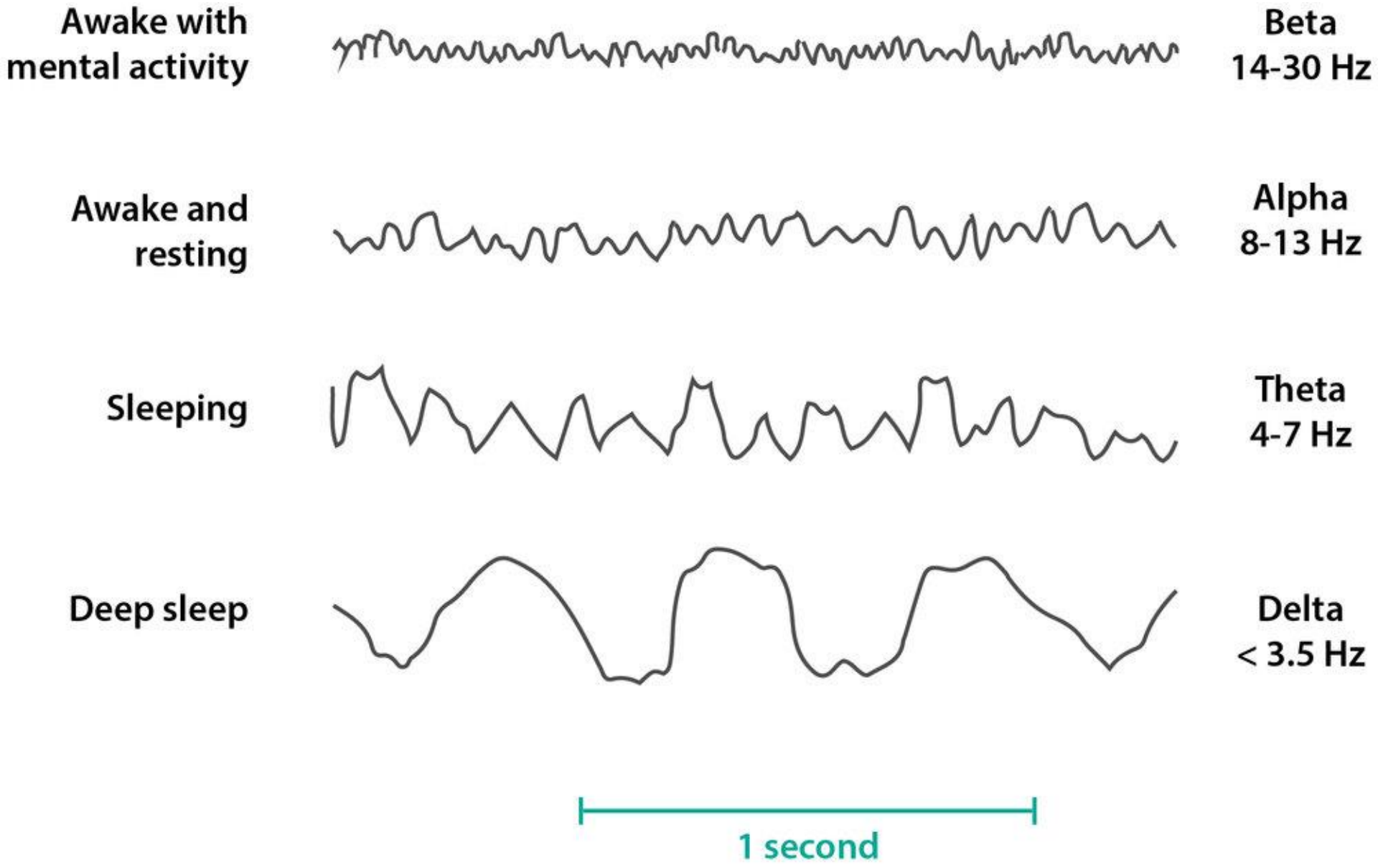
Topic 4
Sensation and perception: Vision


Awake with mental activity
Beta 14-30 Hz
Awake and resting
Alpha 8-13 Hz
Sleeping
Theta 4-7 Hz
Deep sleep
Delta < 3.5 Hz
1 second

Overview

- The senses
- Vision – the retina
- Vision – beyond the retina
- Visual perception
- Perceptual organization
- Perception of depth
- Perception of size
- Perceptual constancies

Sandro Del-Prete

Sensation ≠ Perception

- The underside of our brain's right hemisphere → helps us recognize a familiar human face as soon as we detect it

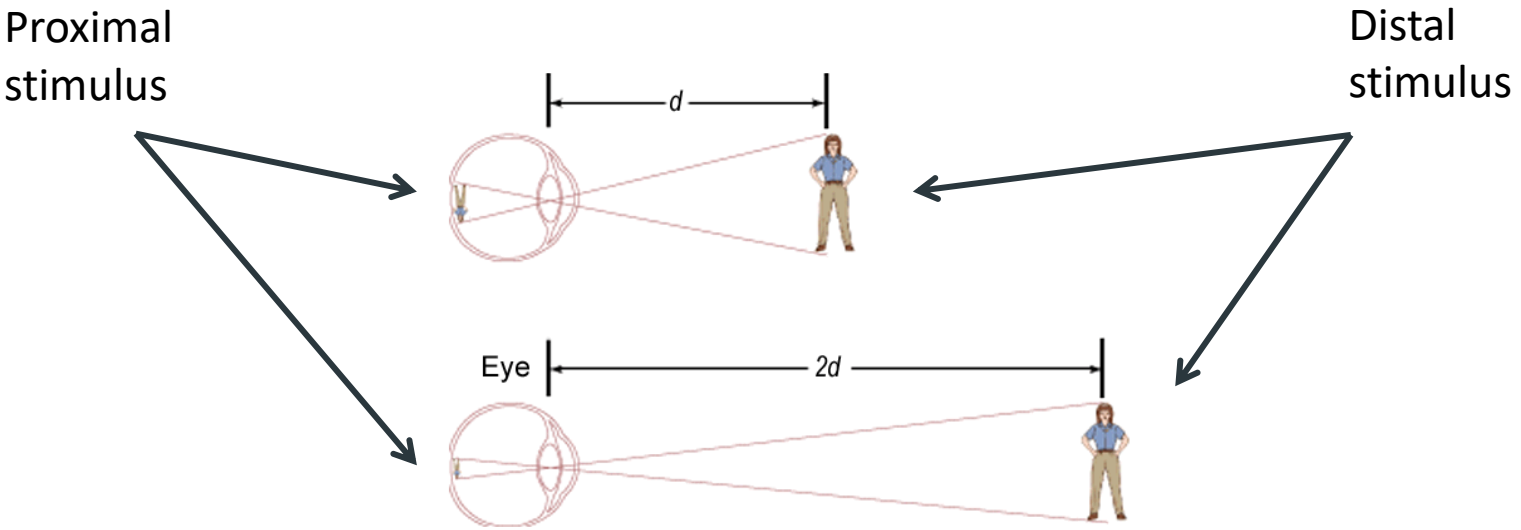
The senses

- **Sensation** - the detection of external stimuli and the transmission of this information to the brain
- **Perception** - the processing, organization, and interpretation of sensory signals

Distal Stimulus → Proximal Stimulus → Transduction → Sensation → Perception

The senses

Are our perceptions a true reflection of reality or do they represent an interpretation of reality?



Thresholds

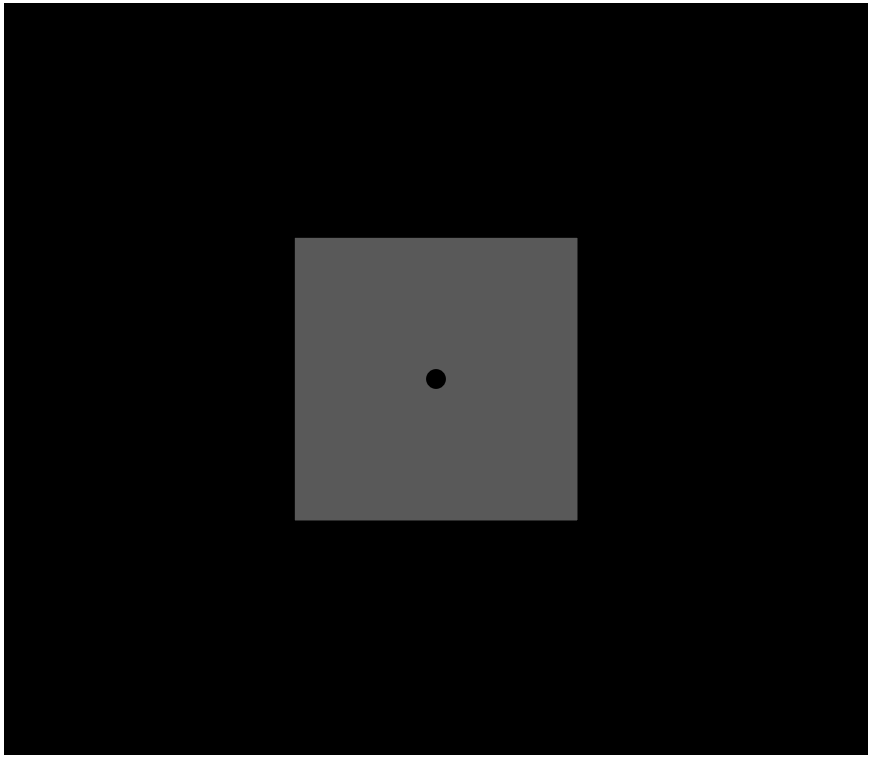
- We have very restricted awareness:
  - **Absolute threshold**
    - The minimum stimulus energy needed to detect a particular stimulus 50 percent of the time.
      - Can I detect this sound?
    - **Subliminal**
      - Below absolute threshold
      - If you cannot detect it ***consciously*** at least 50% of the time, it is subliminal for you
  - **Difference threshold**
    - Detecting small differences between stimuli
    - The minimum difference between two stimuli required for detection 50 % of the time.
    - We experience the difference threshold as a just noticeable difference

The senses

- Vision
- Hearing
- Taste
- Smell
- Skin senses (pressure, temperature, pain)
- Vestibular sense
- Kinesthesis
- Proprioception
- Interoception

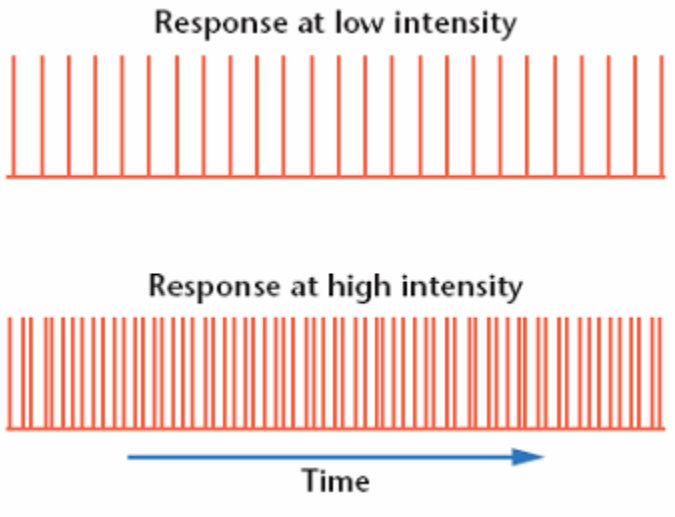
The senses

- Quantitative variations (intensity)



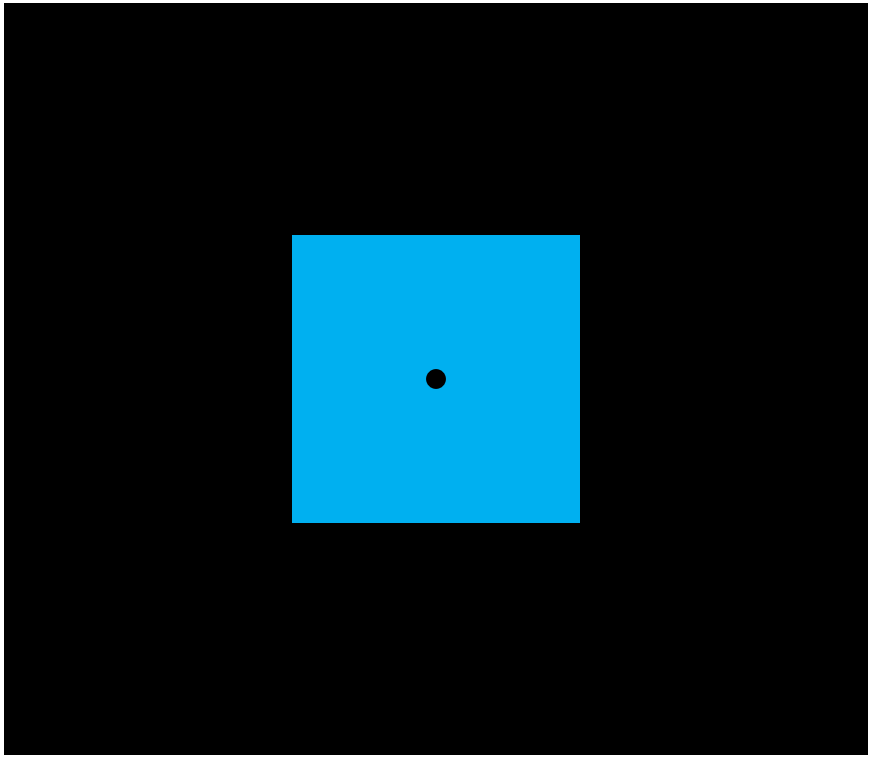
The senses

- Quantitative variations (intensity)
  - Rates of neuron firing
  - Total number of neurons triggered



The senses

- Qualitative variations (sensory quality)



The senses

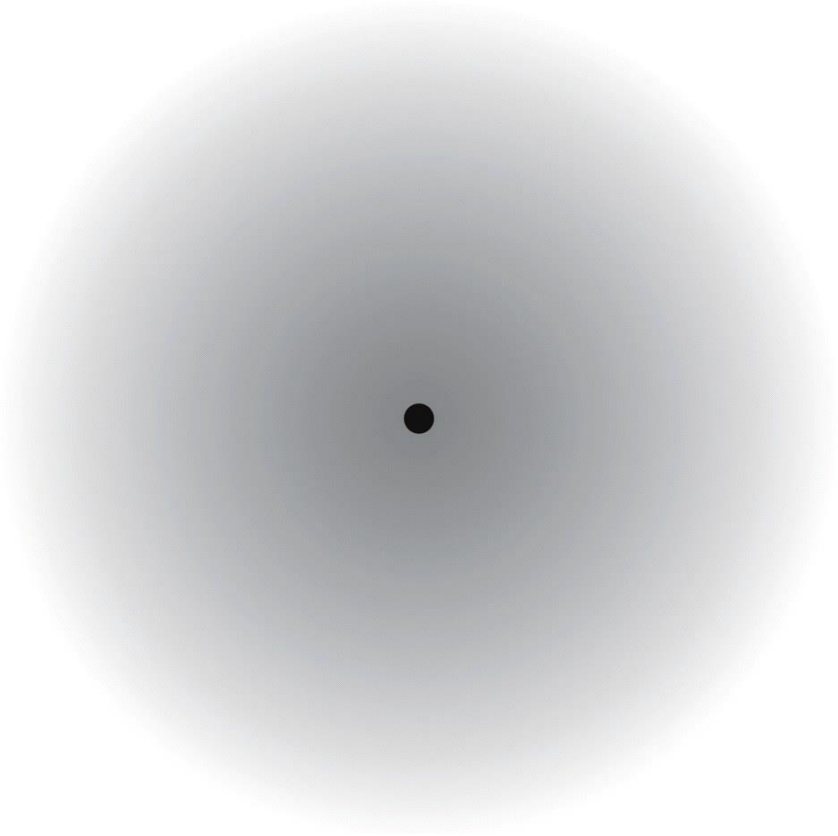
- Qualitative variations (sensory quality)
  - Different sensory qualities are signaled by different neurons
  - Certain sensory qualities arise because of different patterns of activation across a whole set of neurons

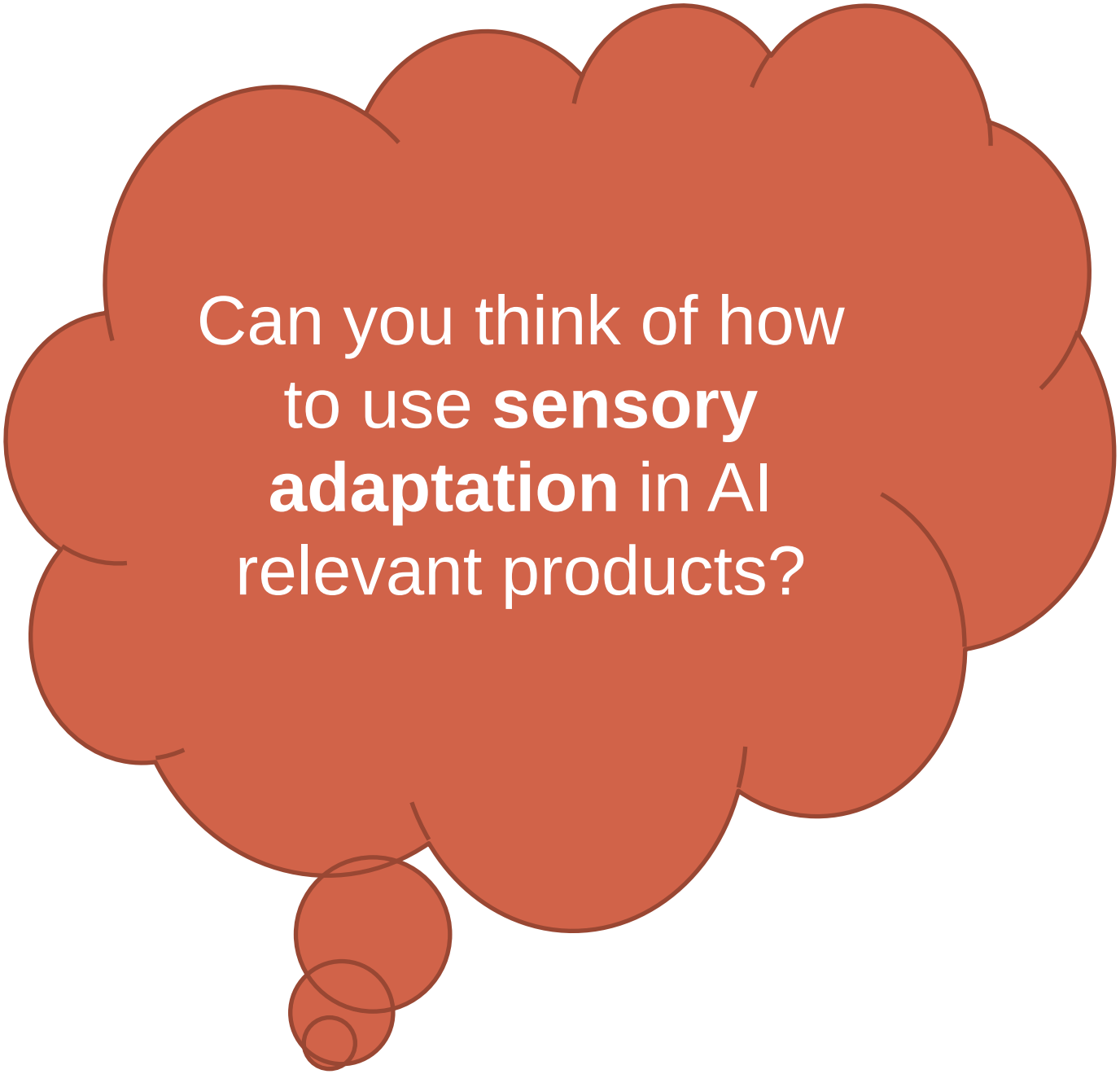
The senses

- Sensory Adaptation
  - the tendency to respond less to a stimulus that has been present and unchanging for some time
  - Benefit:
    - Freedom to focus on informative changes in our environment

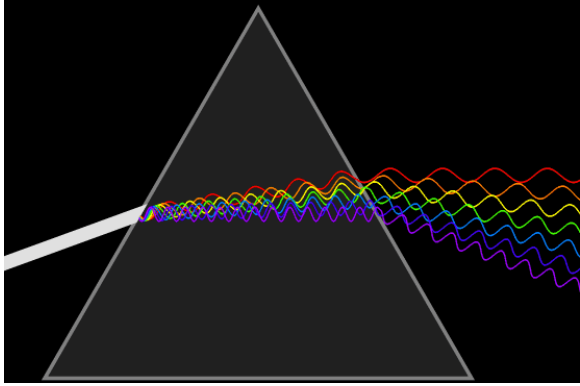
The senses

- Adaptation

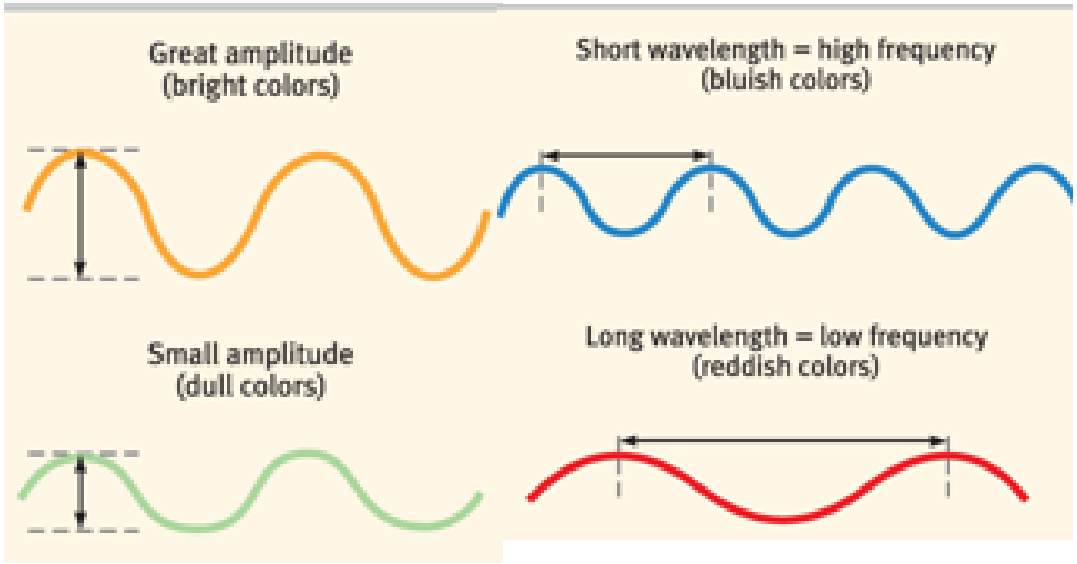



Can you think of how to use **sensory adaptation** in AI relevant products?

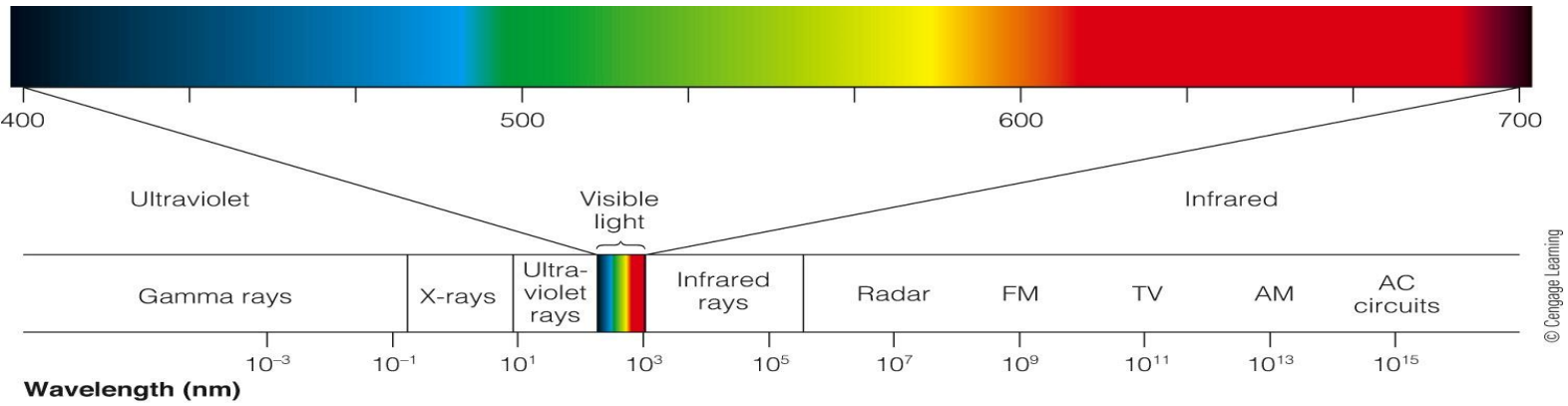
Vision – the retina



- Light (direct or reflected)
  - can vary in intensity



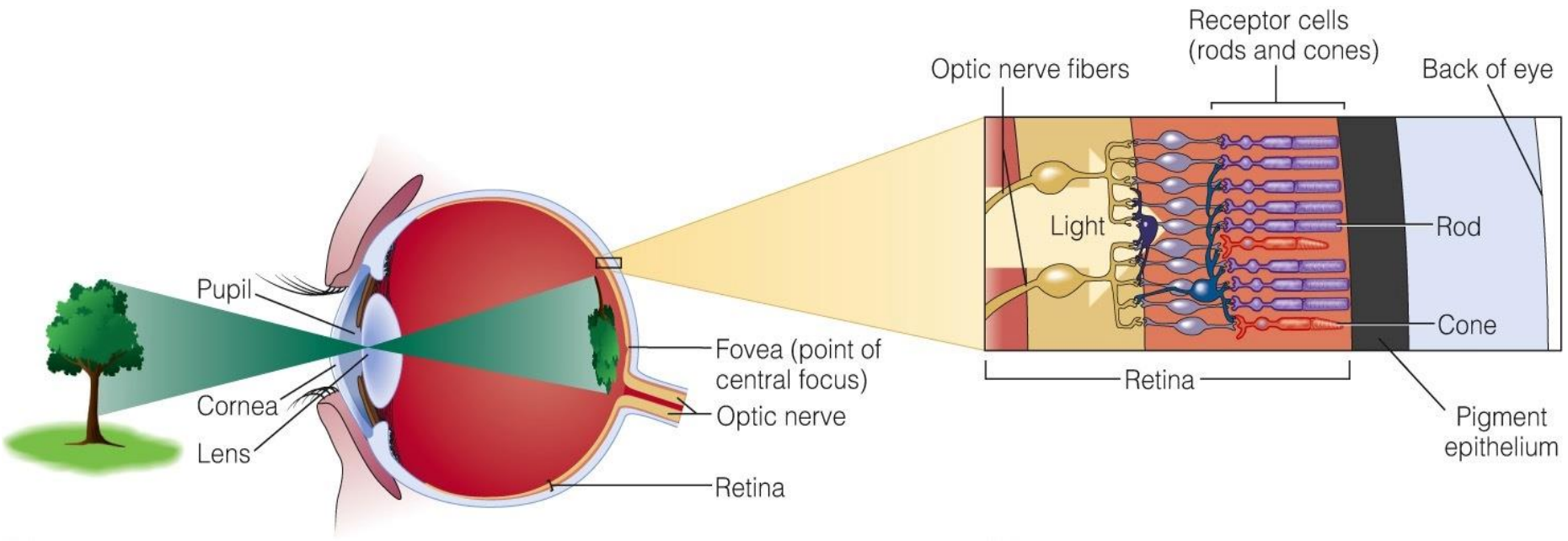
  - can vary in wavelength



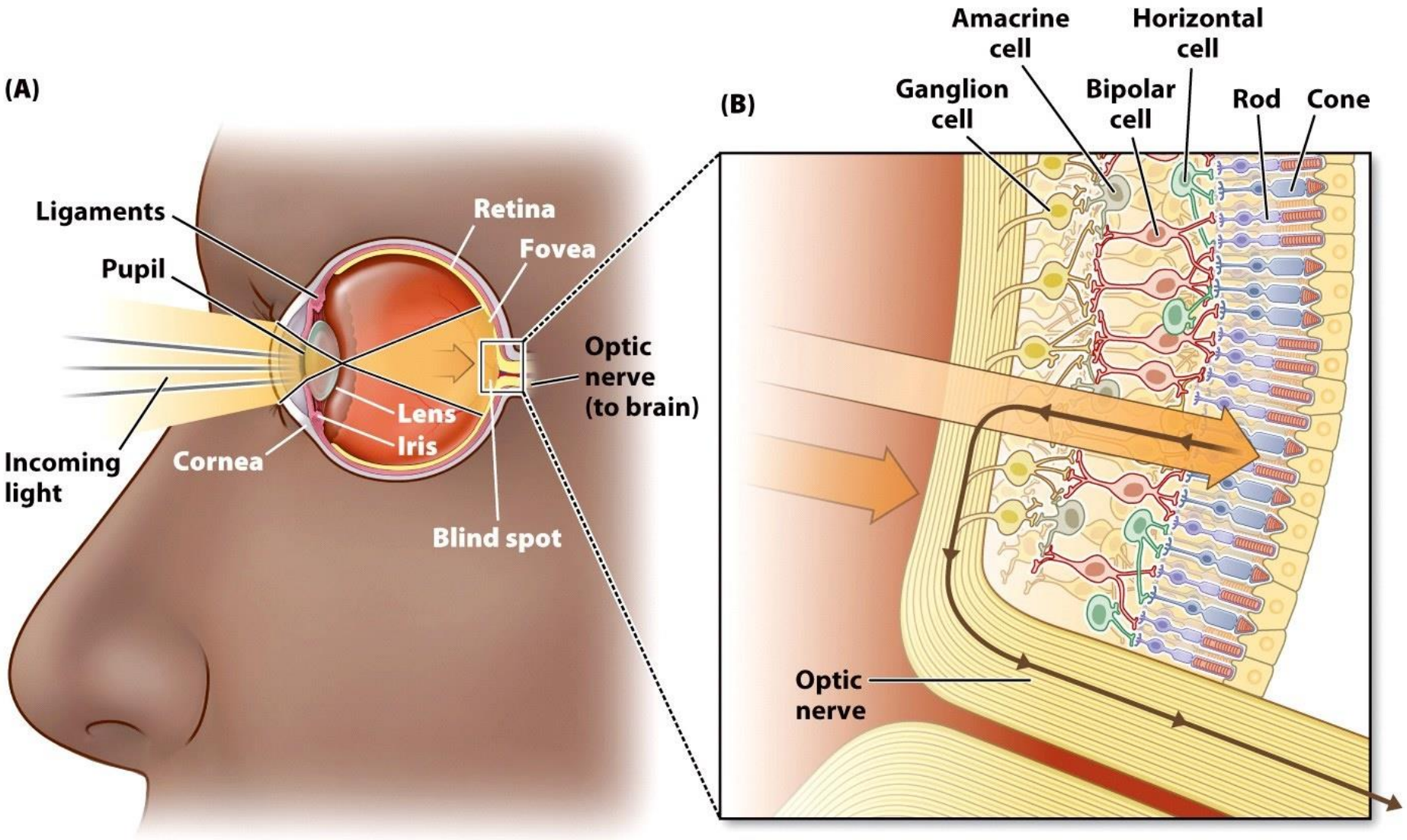
Vision – the retina

Light → Cornea →Pupil, Iris → Lens→Retina→Optic nerve→Brain's visual cortex

Bottom-up processing



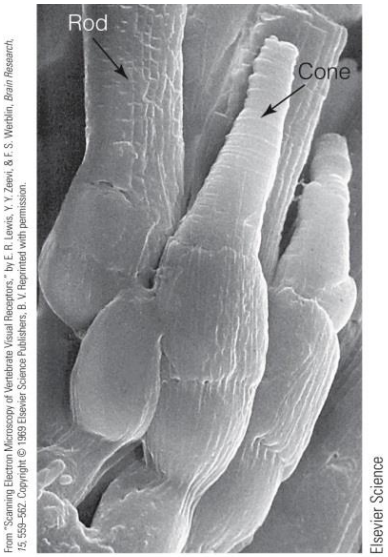
Vision – the retina



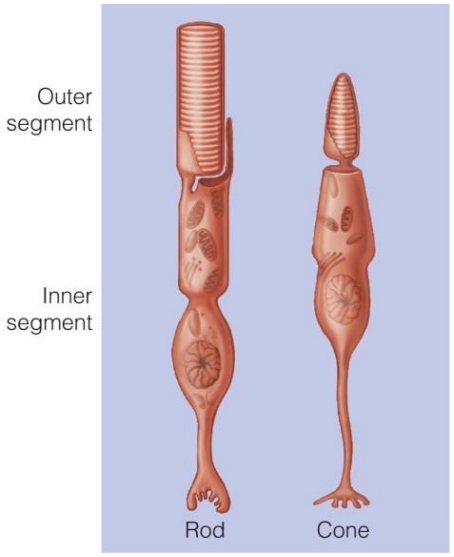
Vision – the retina

- Light (direct or reflected)
  - can vary in intensity and wavelength
  - is absorbed by pigments in the receptors (rods and cones) which transduce light energy into electric energy ⇒
  - electric signal is carried to the brain via ganglion cells

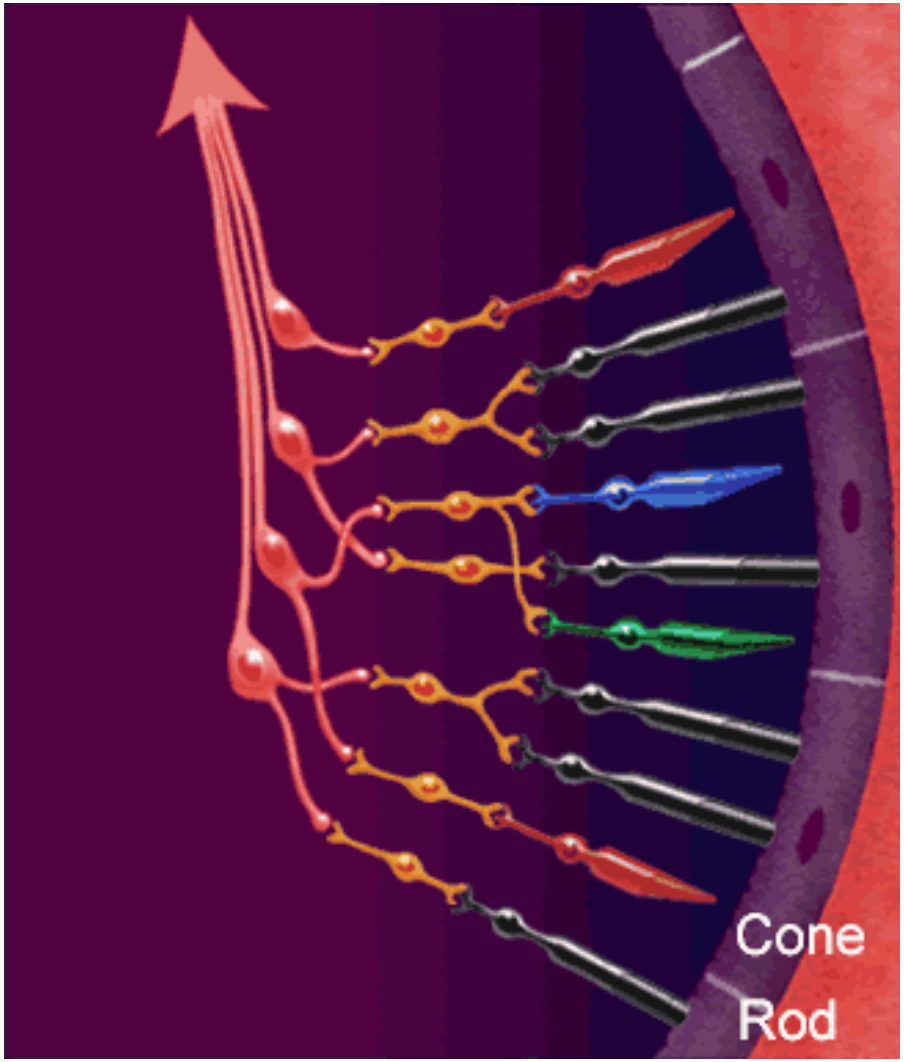
Vision – the retina



(a)

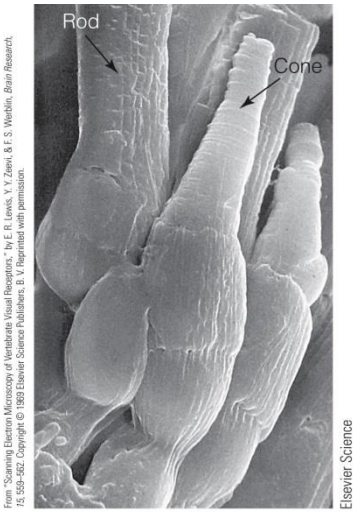


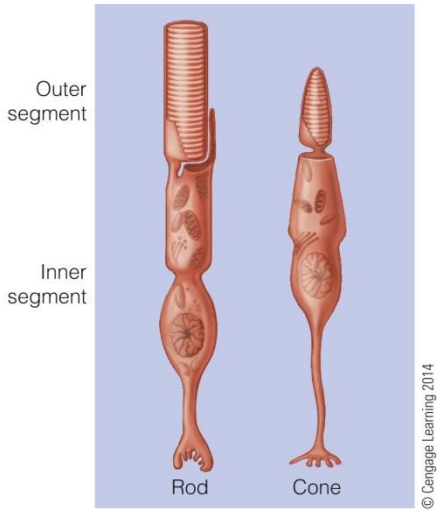
(b)



https://storify.com/MariaVita1/opponent-process-theory

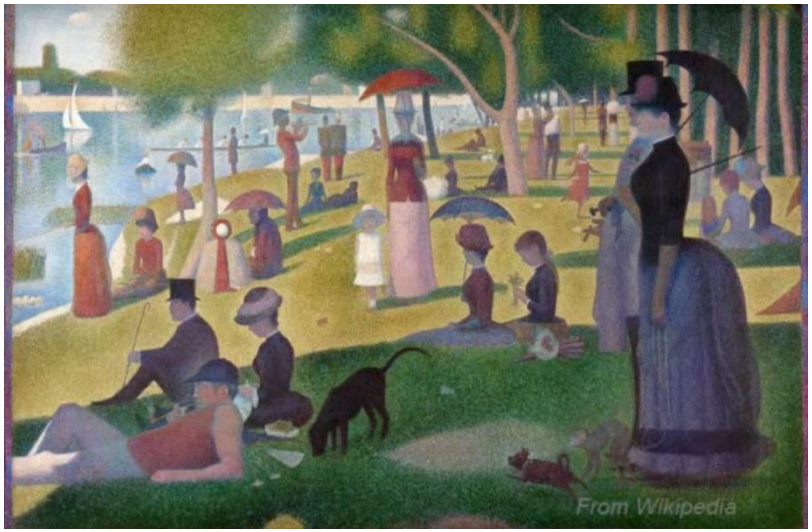
Vision – the retina



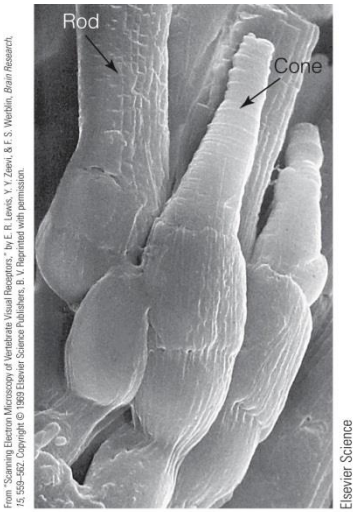


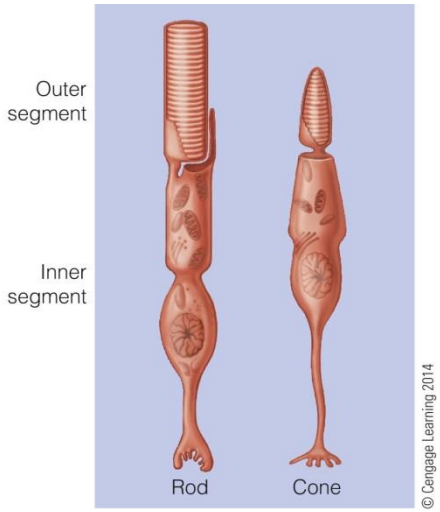
Rods → night vision

Cones → day vision



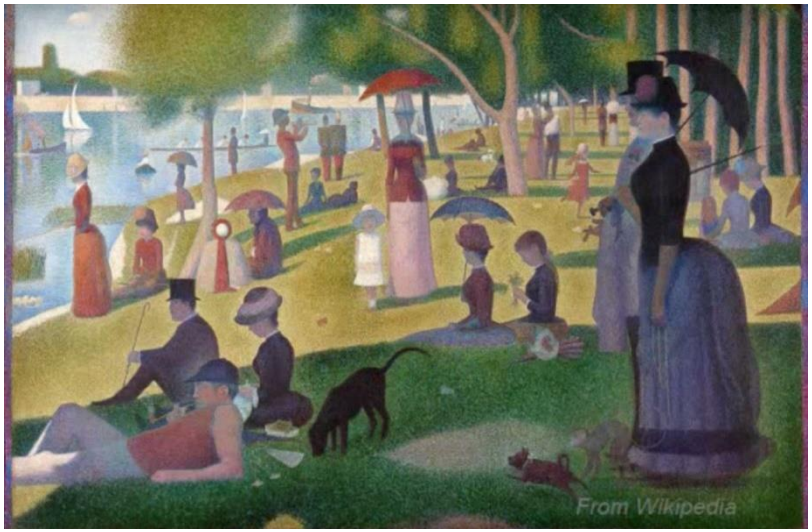
Vision – the retina



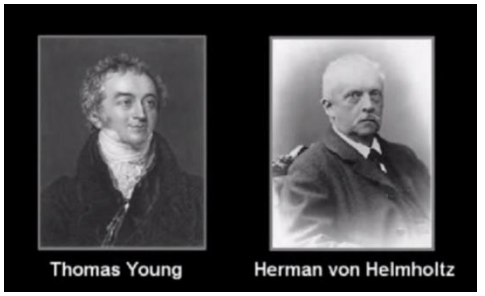


Rods → no color vision

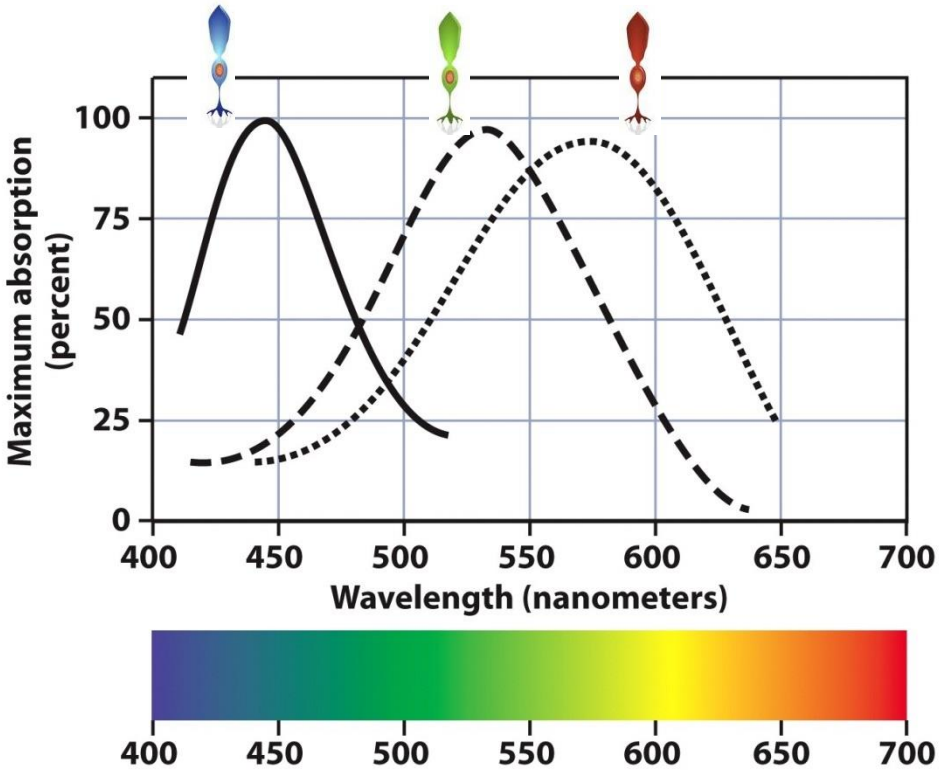
Cones → color vision

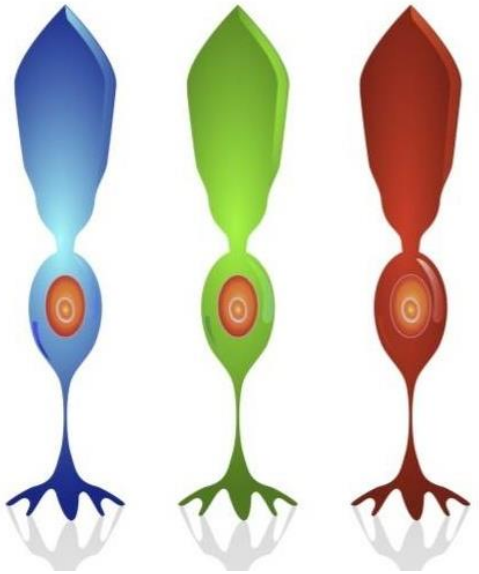


Vision – the retina

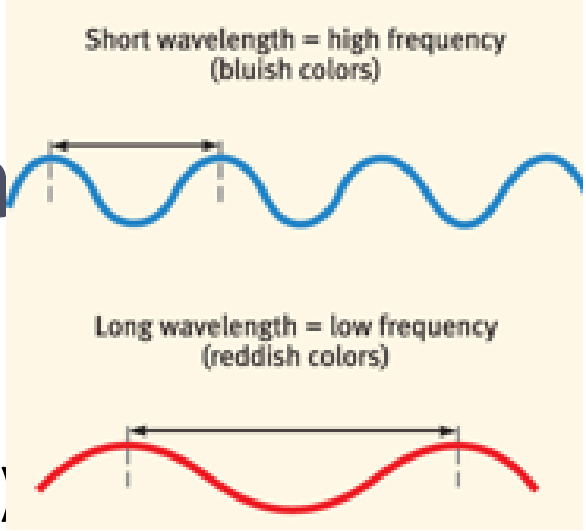


- Color vision
  - Trichromatic Theory (Young-Helmholz)

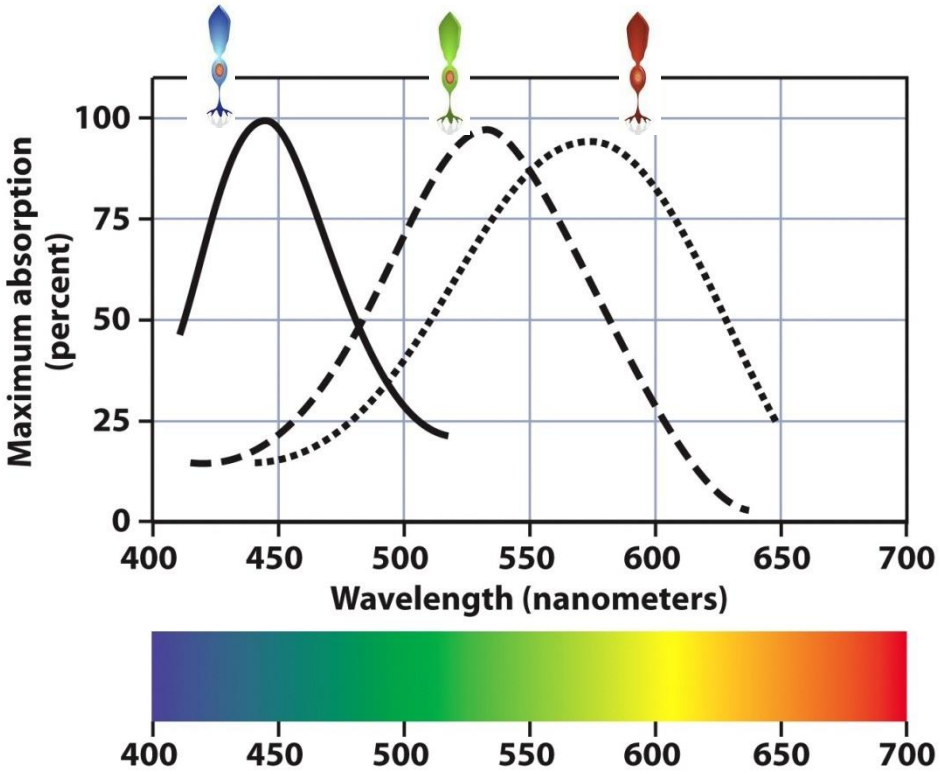


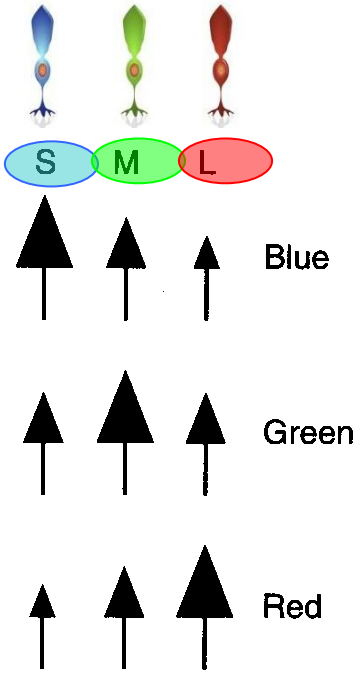


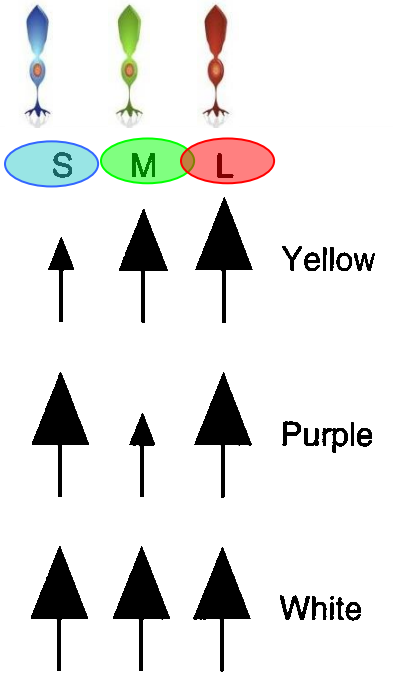
Vision – the retin



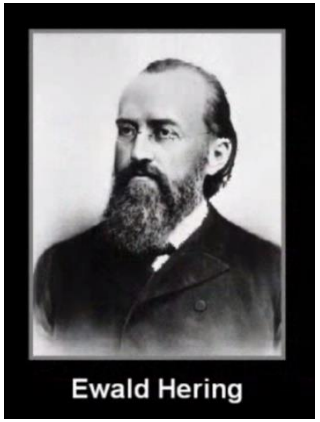
- Color vision
  - Trichromatic Theory (Young-Helmholz)



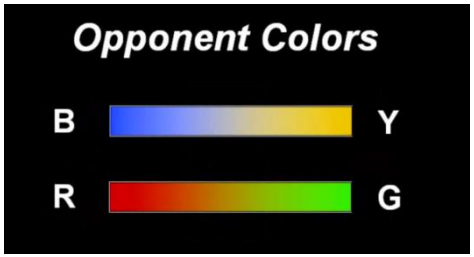




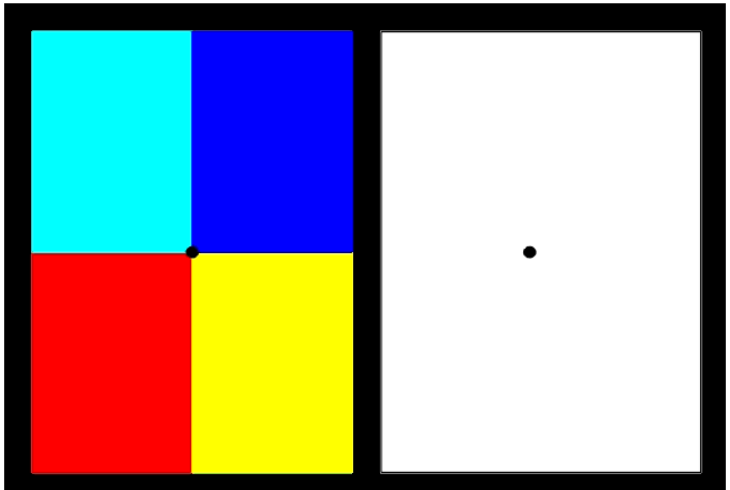
Vision – the retina



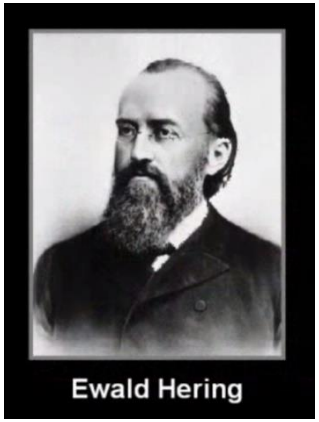
- Color vision
  - Opponent-process theory (Hering)
    - There is no such thing as “blue-yellow” or “red-green”



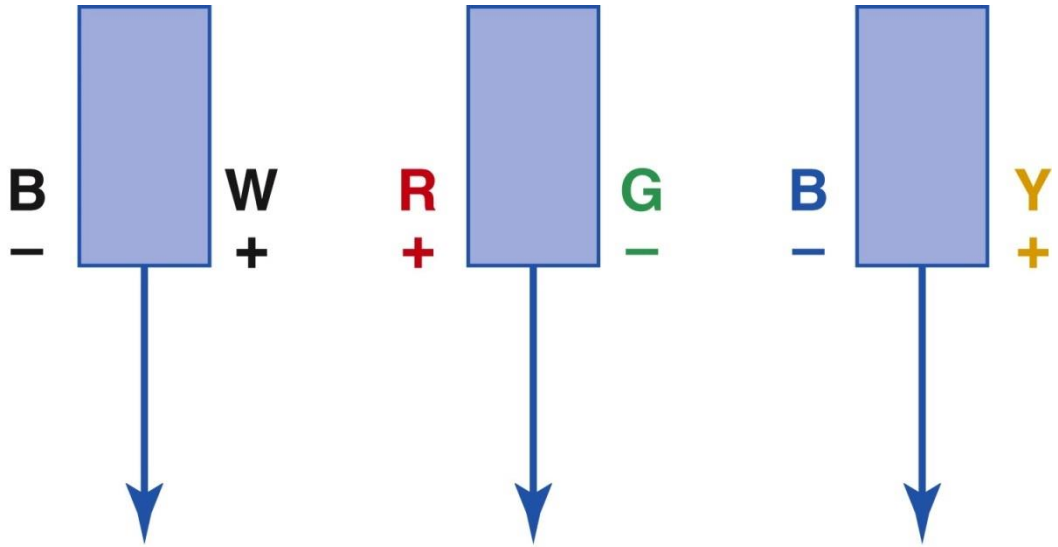
    - Afterimages



Vision – the retina

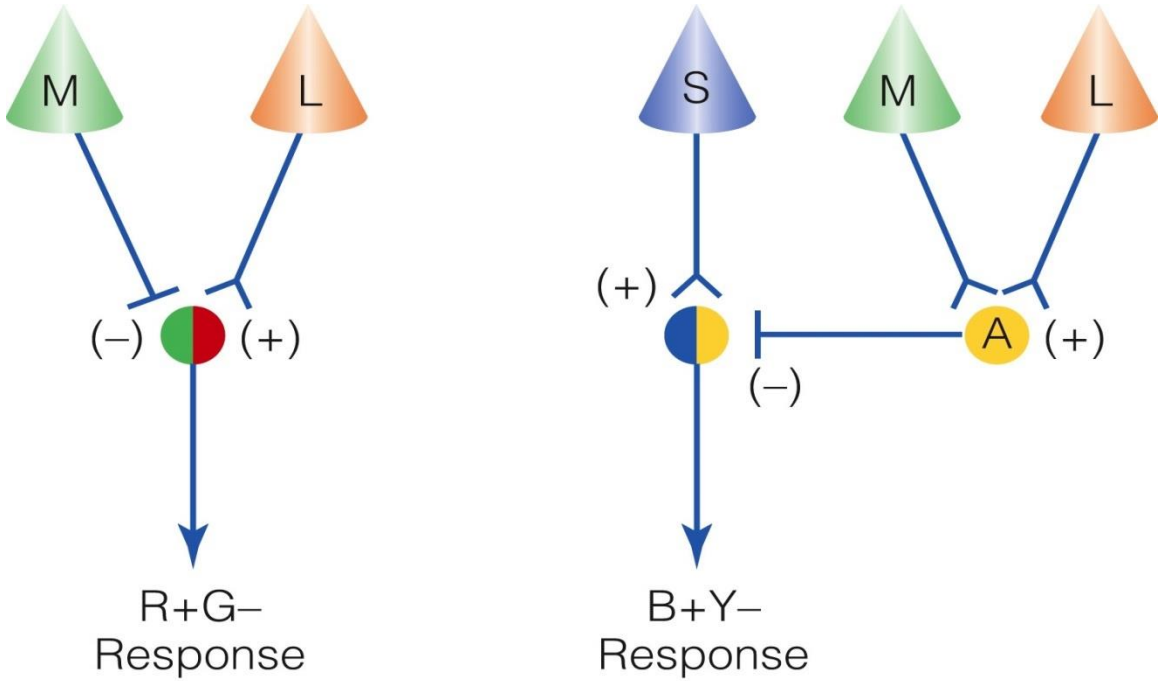


- Color vision
  - Opponent-process theory (Hering)
    - Black-white
    - Red-green
    - Blue-yellow



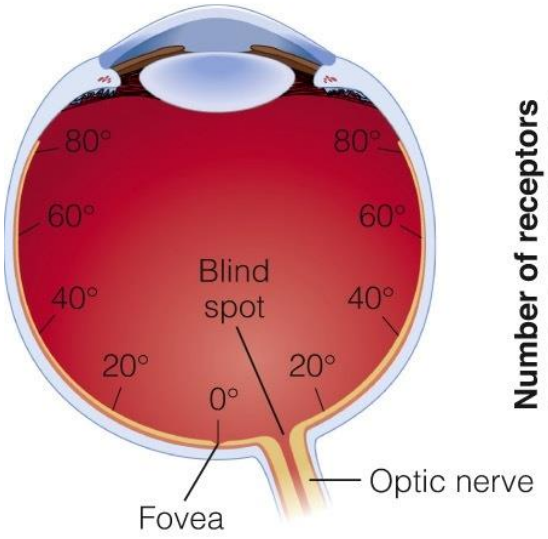
Vision – the retina

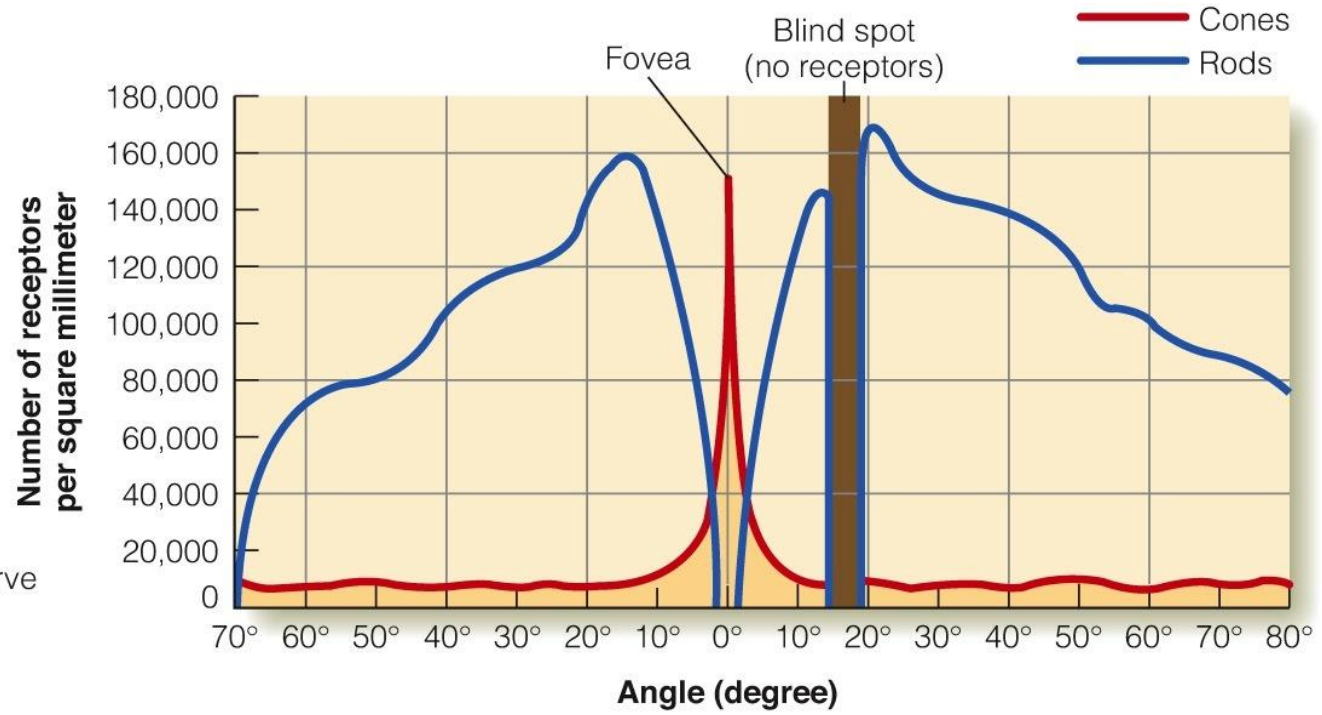
- Color vision
  - Trichromatic theory (Young-Helmholtz) and the opponent-process theory (Hering) represent different stages of visual processing



Vision – the retina

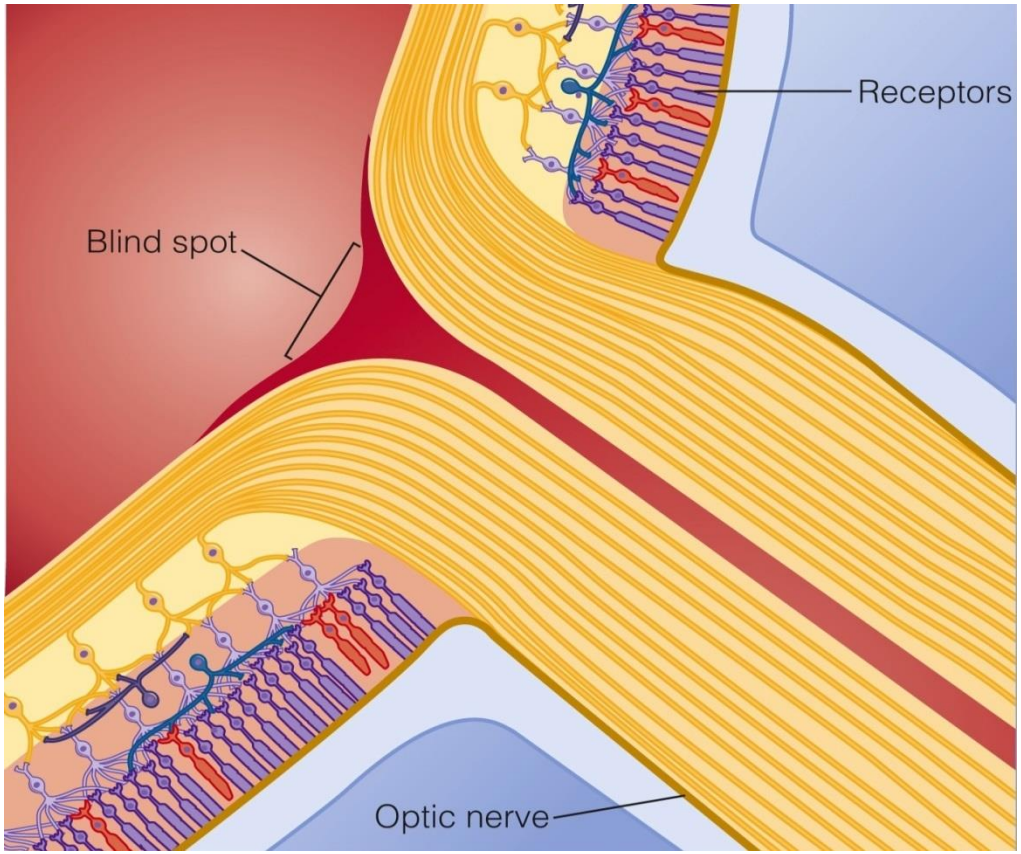
- Distribution of rods and cones across the retina





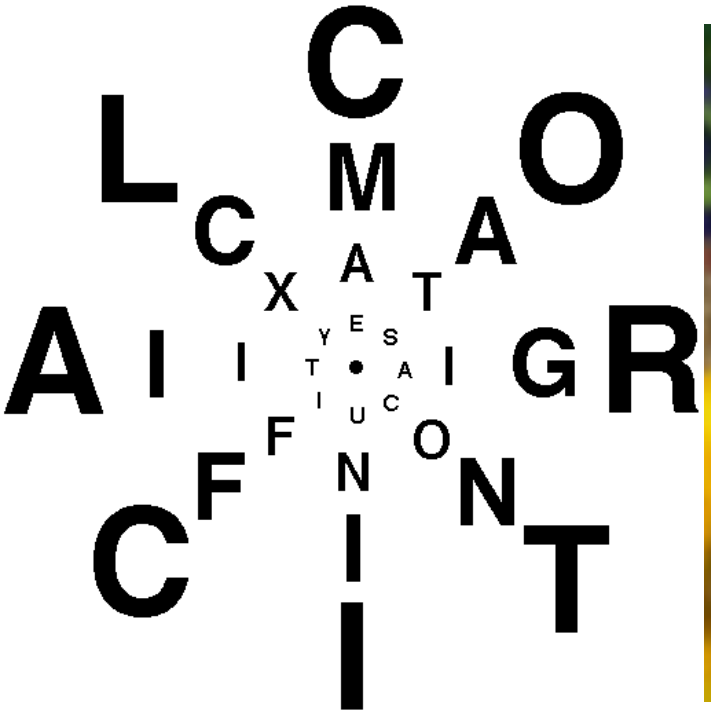
Vision – the retina

- Distribution of rods and cones across the retina



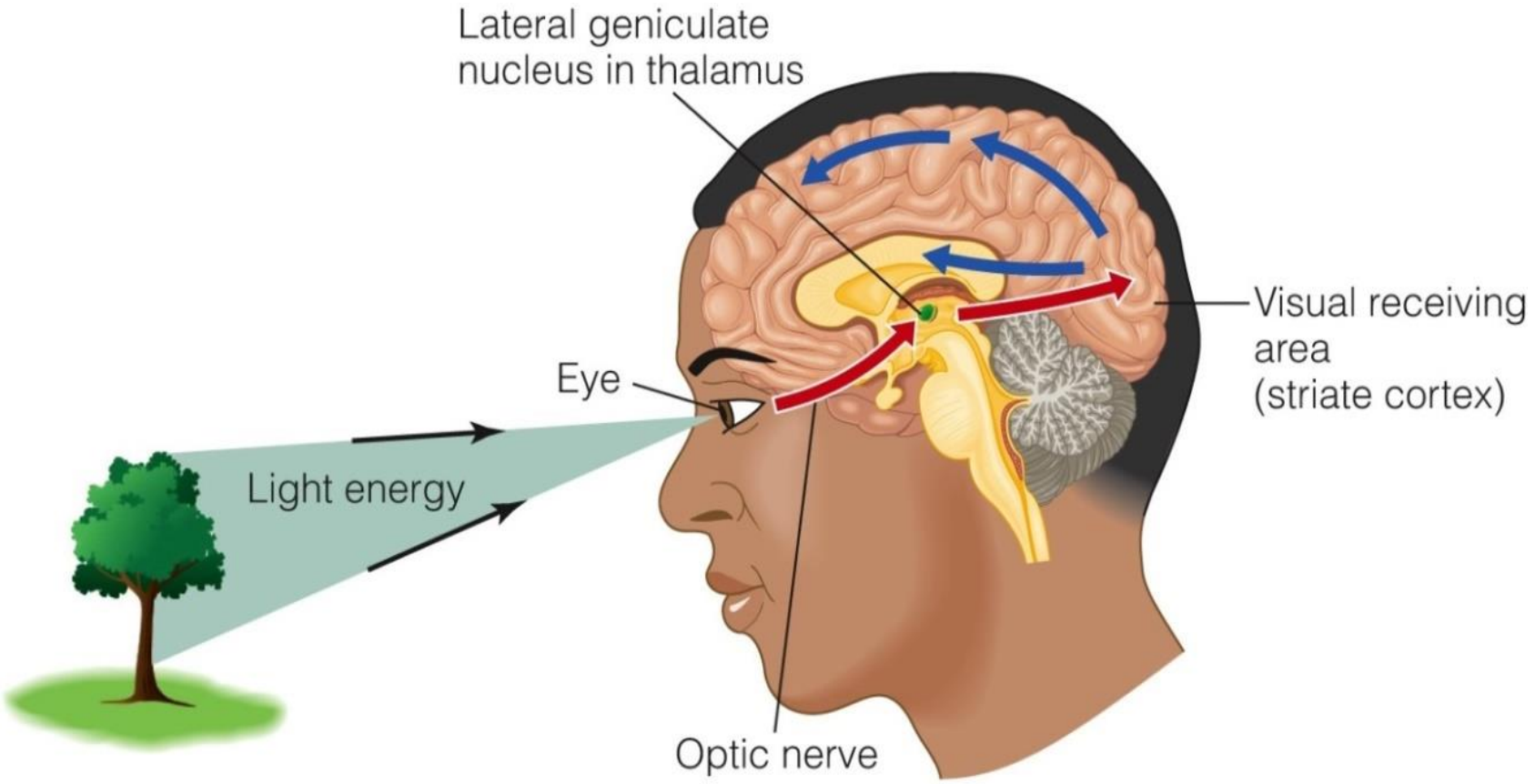
Vision – the retina

- Distribution of rods and cones across the retina
  - -> Higher resolution in the fovea



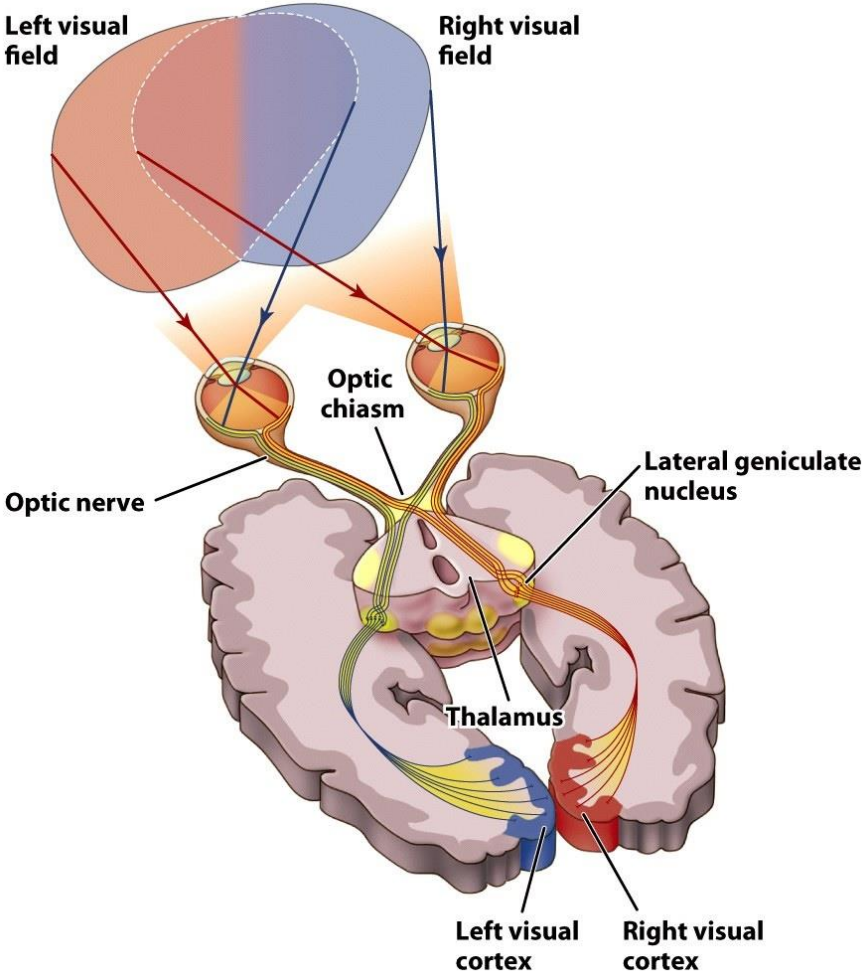
Vision – beyond the retina

- What happens after the retina?

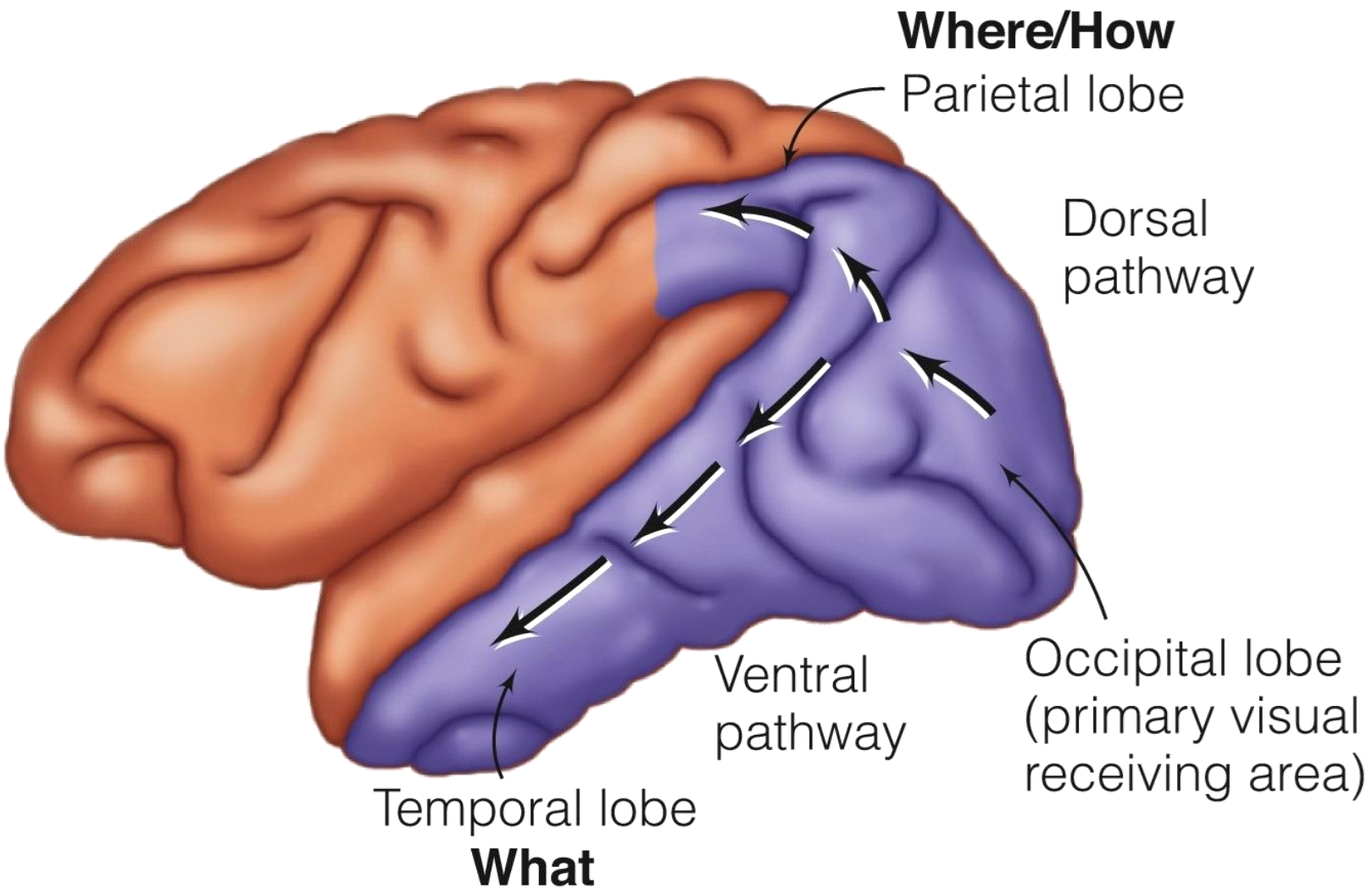


Vision – beyond the retina

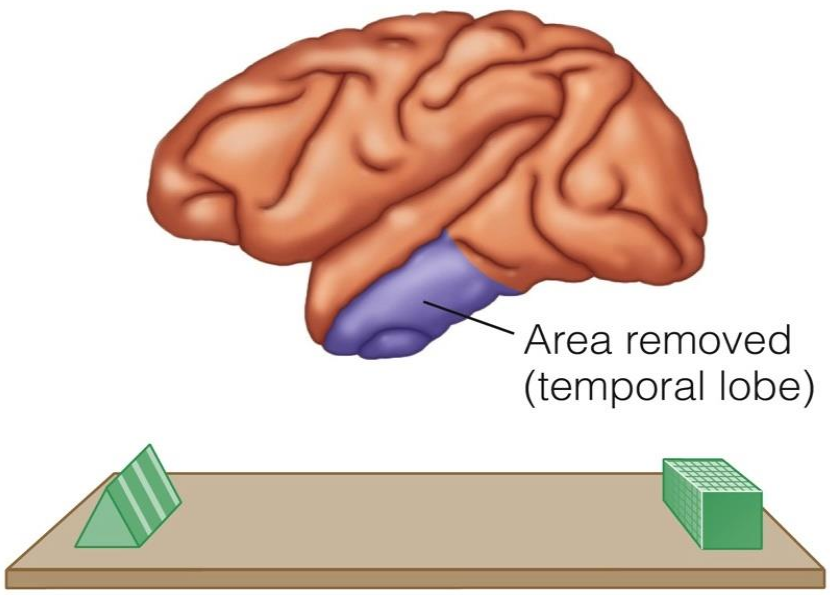
- What happens after the retina?



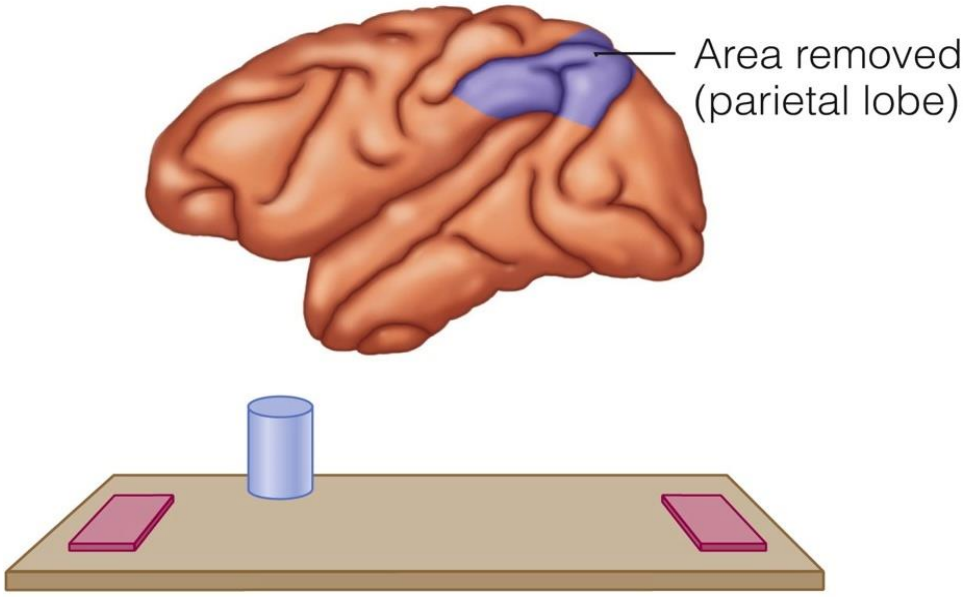
Vision – beyond the retina



Vision – beyond the retina



(a) Object discrimination



(b) Landmark discrimination

Vision – beyond the retina

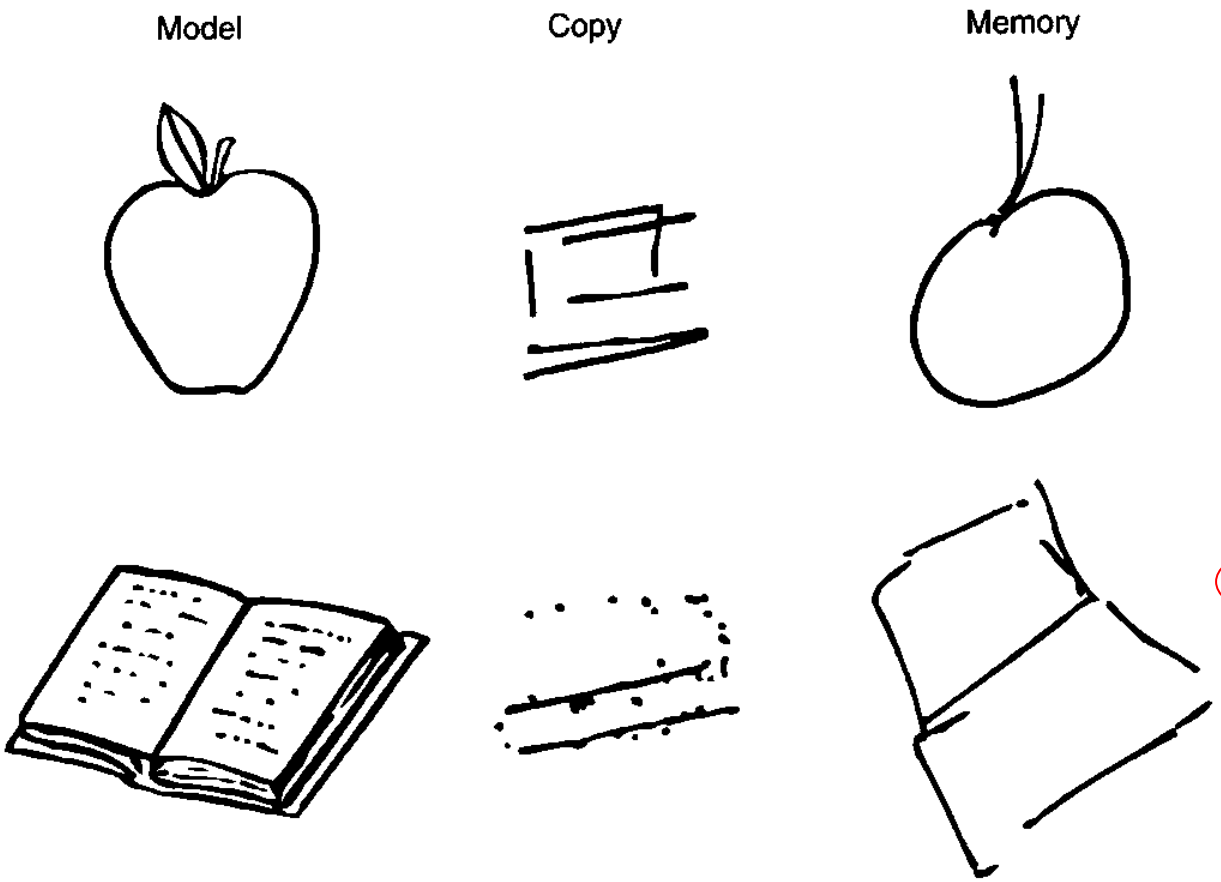
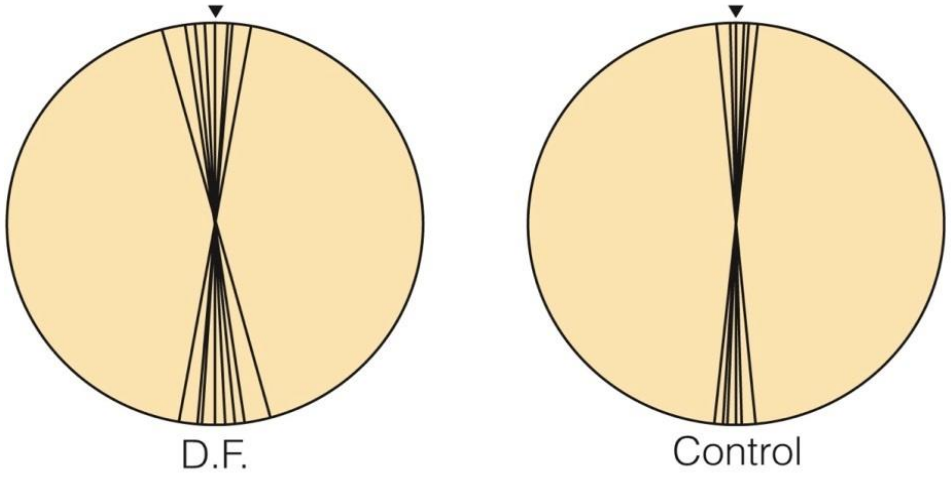


Figure 4.6
Patient D.F. could not recognize the apple or book drawings on the left and could not copy the drawings, as shown by her attempts in the middle column. The drawings on the right are ones she produced from memory. (From Milner & Goodale, 1995.)

Vision – beyond the retina

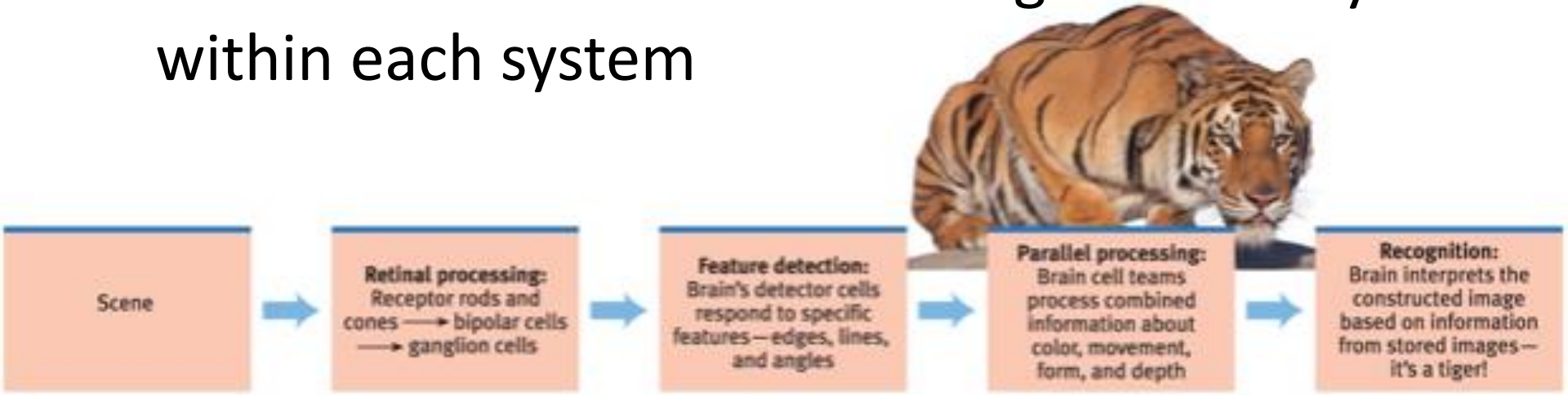


(b) Active “posting”

Vision – beyond the retina

- Two systems
  - "where" (path to parietal cortex, dorsal)
  - "what" (path to temporal cortex, ventral)

- There is without doubt a strong modularity within each system



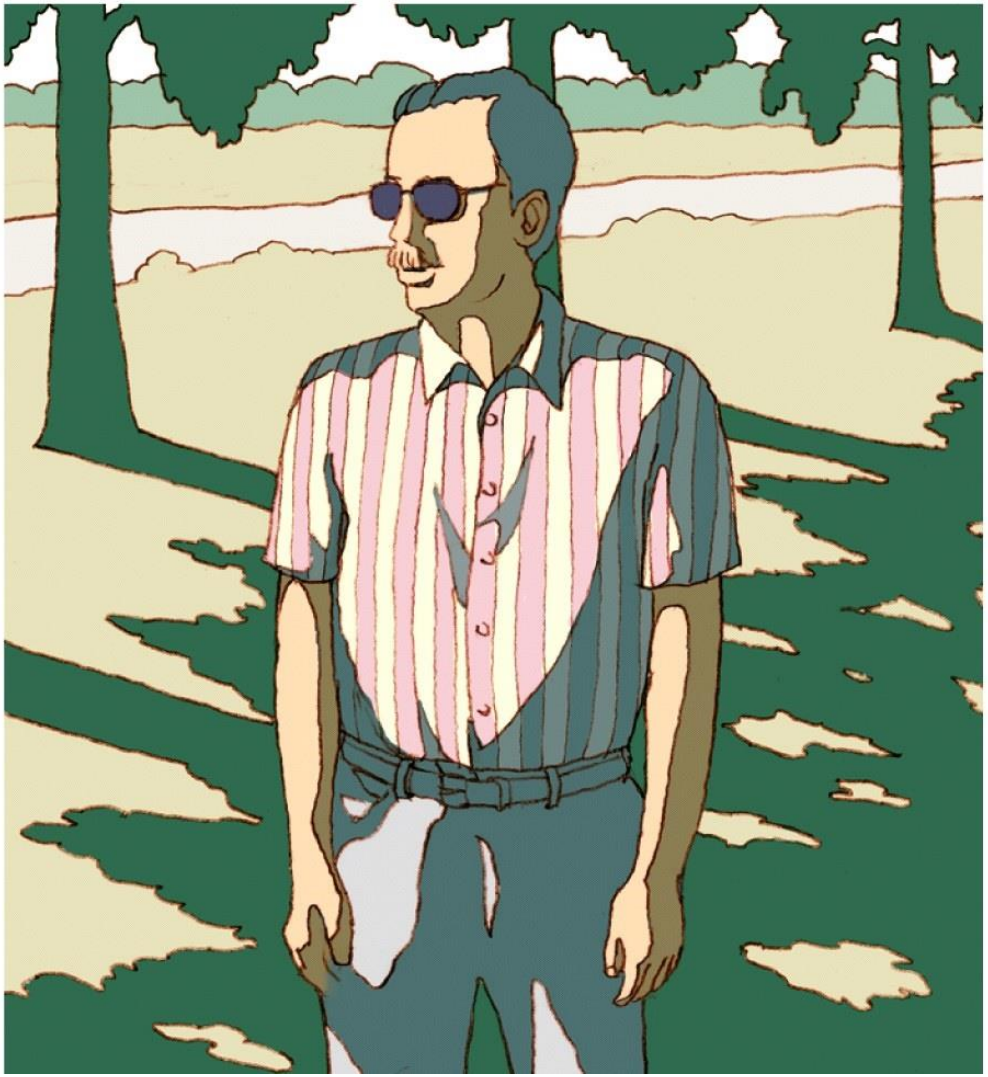
Myers/DeWall, *Psychology*, 13e, © 2021 Worth Publishers
Tom Walker/Getty Images

FIGURE 6.20 A simplified summary of visual information processing

Visual perception

The visual system is not a passive receiver of visual information but modulates, organizes, and interprets this information!

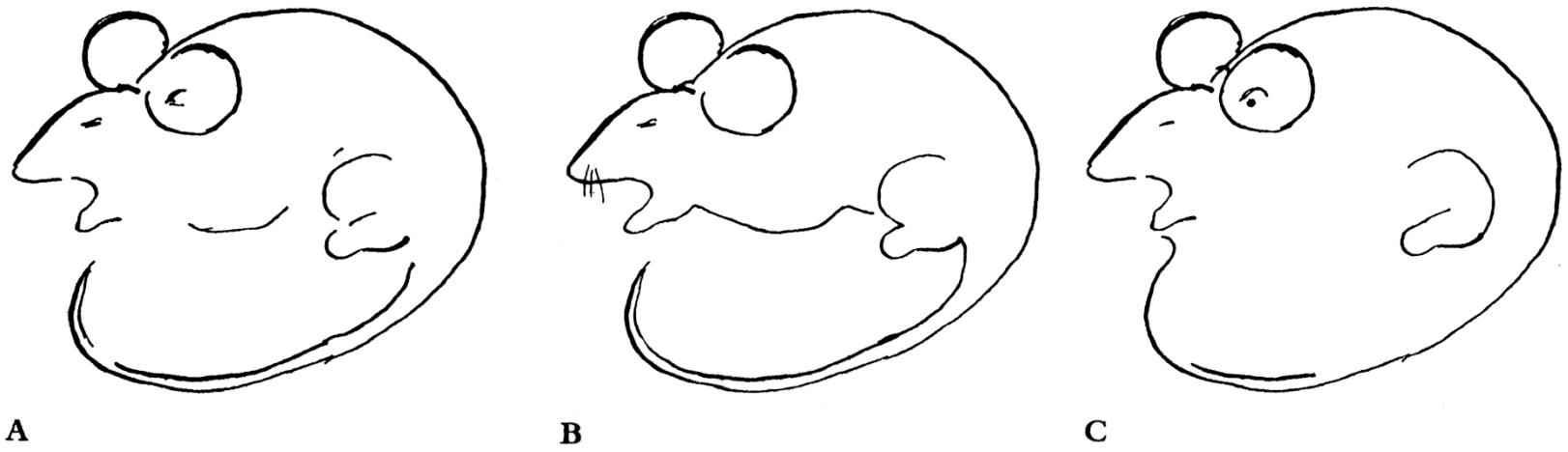
Visual perception



Visual perception

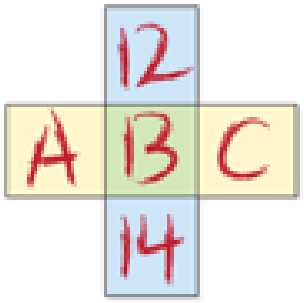
Visual perception

- Perception occurs on the basis of
  - Bottom-up (data-driven) processes
    - Starts at your sensory receptors and works up to higher levels of processing.
  - Top-down (knowledge-driven) processes
    - e.g., **priming**



Visual perception

- Perception occurs on the basis of
  - Bottom-up (data-driven) processes
    - Starts at your sensory receptors and works up to higher levels of processing.
  - Top-down (knowledge-driven) processes
    - e.g., priming
    - e.g., context



THE CAT

T E C T

H H

Context

- Our immediate context, and the motivation and emotion we bring to a situation, also affect our interpretations.

- People's expectations influence their perceptions constantly, whether about an angry man
  - Is he reaching for his keys or a weapon?

- "__eel is on the wagon."
  - Wheel
- "__eel is on the orange"
  - Peel

Visual perception

Visual perception

- Perception occurs on the basis of
  - Bottom-up (data-driven) processes
    - Starts at your sensory receptors and works up to higher levels of processing.
  - Top-down (knowledge-driven) processes
    - e.g., priming
    - e.g., context
    - BUT: the orientation of an individual part is sometimes crucial for the perception of the whole.
    - Constructs perceptions from this sensory input by drawing on your experience and expectations.

- How is the woman in the picture feeling?

Craig Klomparens/Hope College

FIGURE 6.9 Context makes clearer The Hope College volleyball team celebrates its national championship winning moment.

- Emotions can shove our perceptions in one direction or another
  - Hearing sad music can predispose people to perceive a sad meaning in spoken homophonic word
    - mourning – morning
    - die - dye
    - pain – pane

https://en.wikipedia.org/wiki/French_fries

https://www.mcdonalds.com/us/en-us/product/small-french-fries.html

(Robinson et al., 2007)

(Lee et al., 2006)

What determines our perceptual set?

- Experience →concepts, schemas
  - Helps organize and interpret unfamiliar information
  - Apply top-down processing to interpret ambiguous sensations

David

Diana

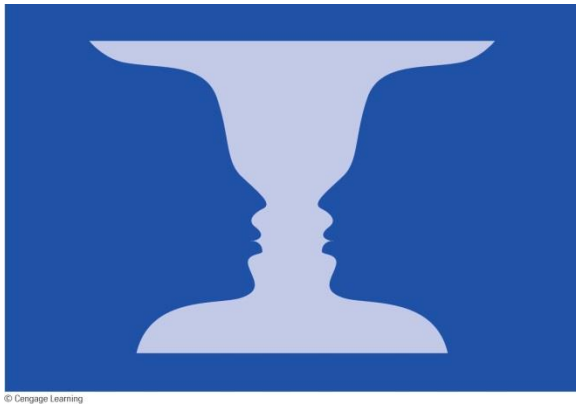
(Stern & Karraker, 1989)

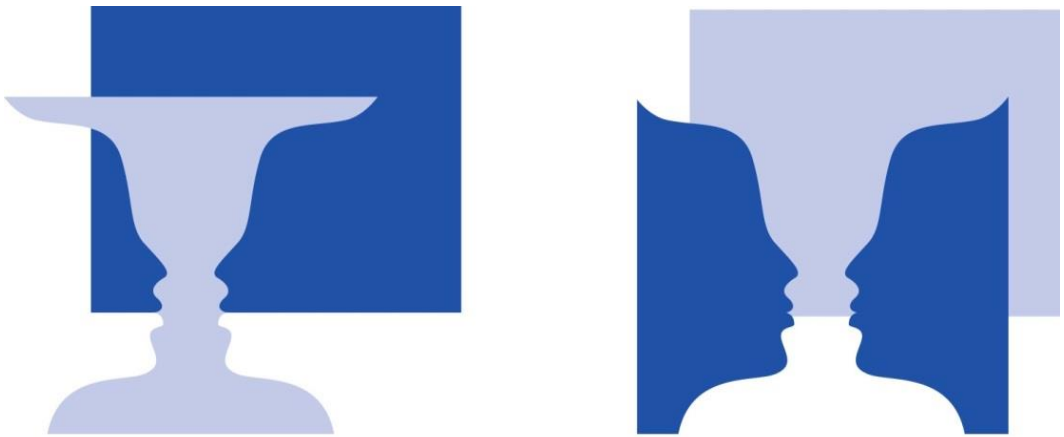
- Perception is influenced by culture.

(Gregory & Gombrich, 1973)

Perceptual organization

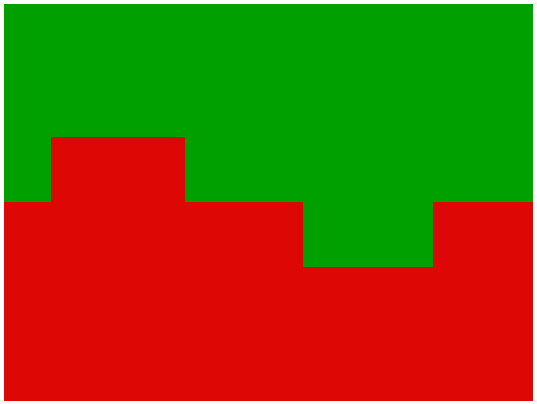
- Segregation of figure and ground





Perceptual organization

- Principles of figure-ground segregation
  - Lower areas are more often perceived as figure than higher areas

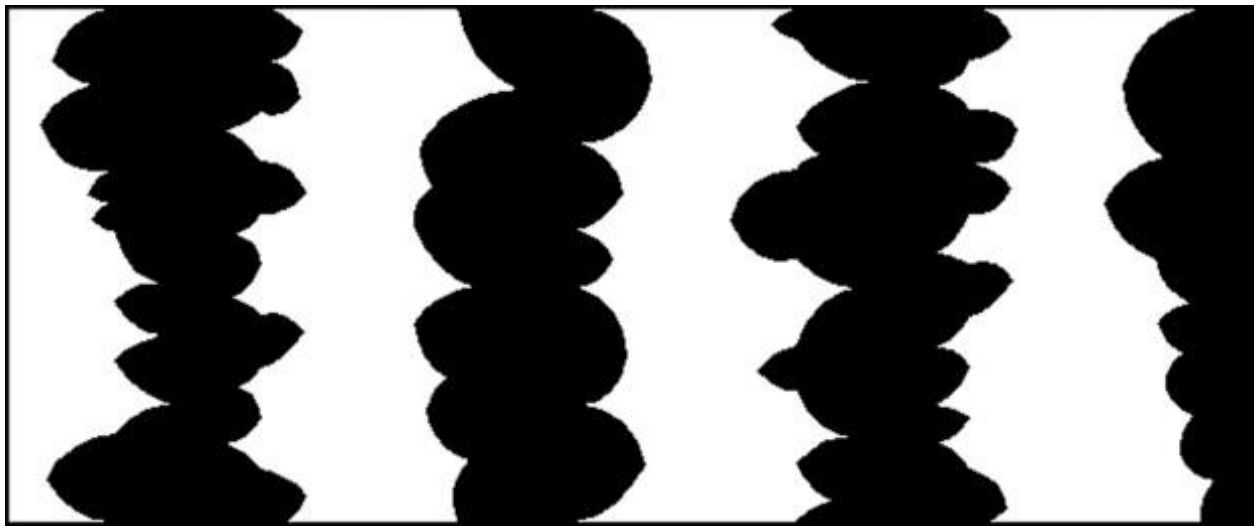


Perceptual organization

- Principles of figure-ground segregation
  - Lower areas are more often perceived as figure than higher areas

Perceptual organization

- Principles of figure-ground segregation
  - Lower areas are more often perceived as figure than higher areas
  - Convex forms are more often perceived as figure whereas concave forms are more often perceived as background

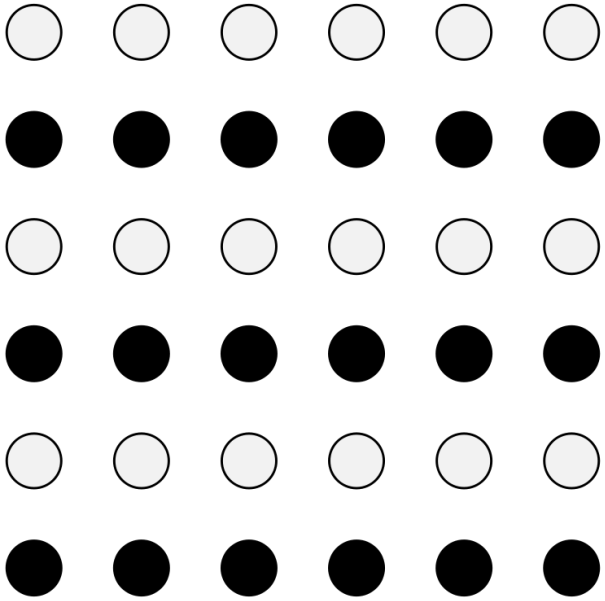


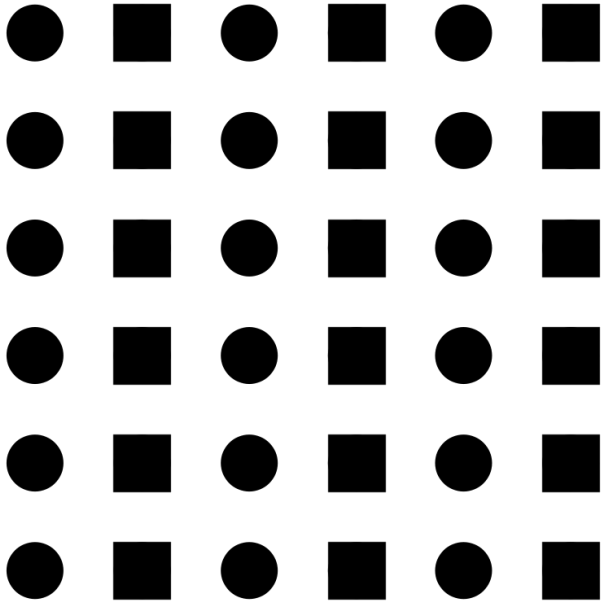
Perceptual organization

- Perceptual interpretation on the basis of organizing principles (Gestalt principles)
  - e.g., proximity

Perceptual organization

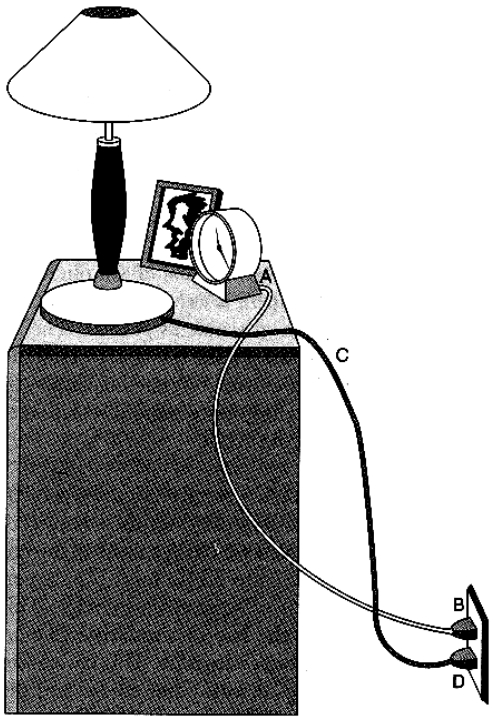
- Perceptual interpretation on the basis of organizing principles (Gestalt principles)
  - e.g., similarity





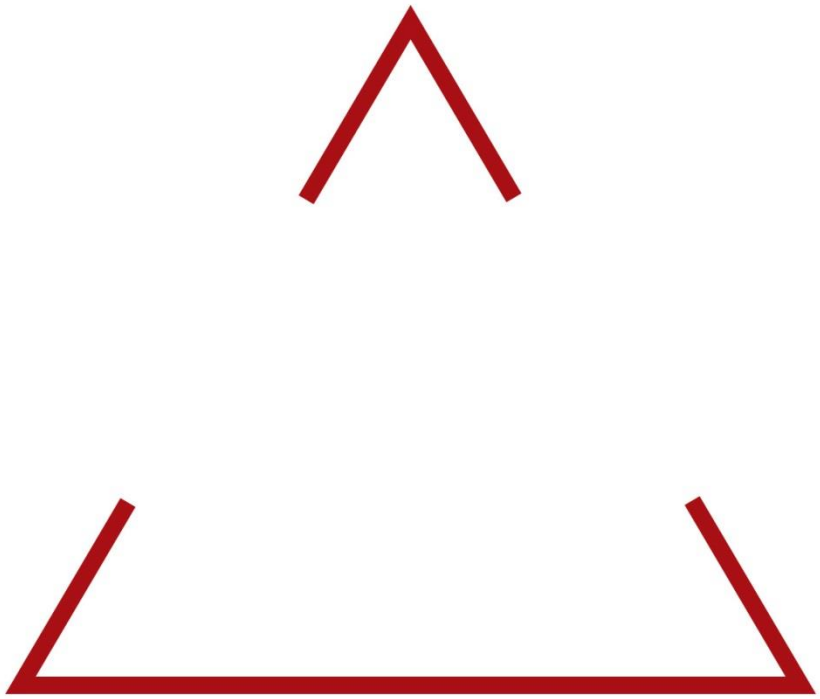
Perceptual organization

- Perceptual interpretation on the basis of organizing principles (Gestalt principles)
  - e.g., continuity



Perceptual organization

- Perceptual interpretation on the basis of organizing principles (Gestalt principles)
  - e.g., closure



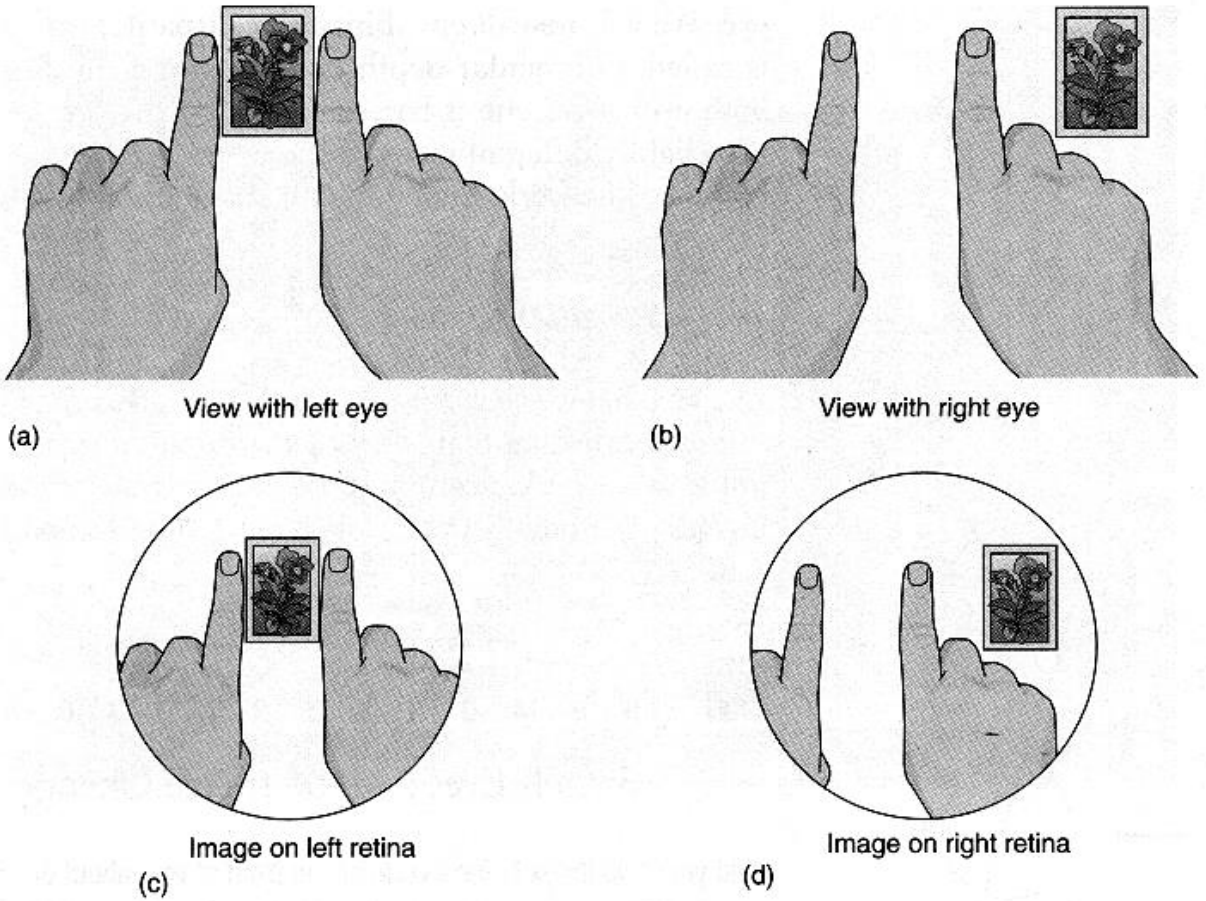
Perception of depth

- Depth cues
  - Binocular cues
    - Binocular disparity
    - Convergence

Monika Skolimowska/AP Images

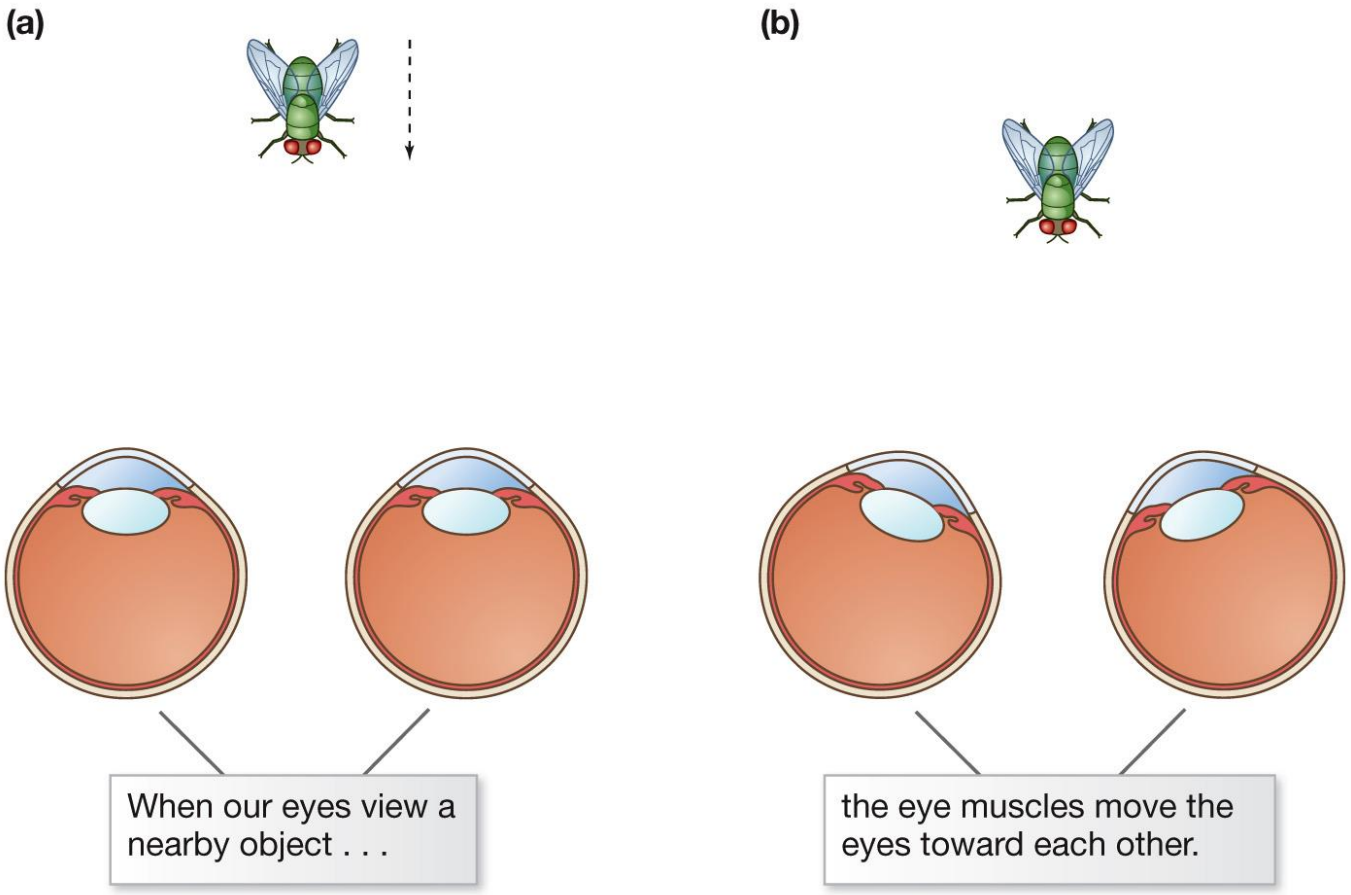
Perception of depth

- Binocular disparity



Perception of depth

- Convergence

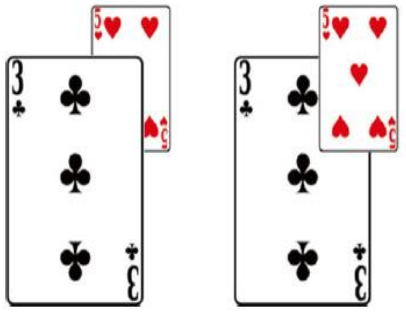


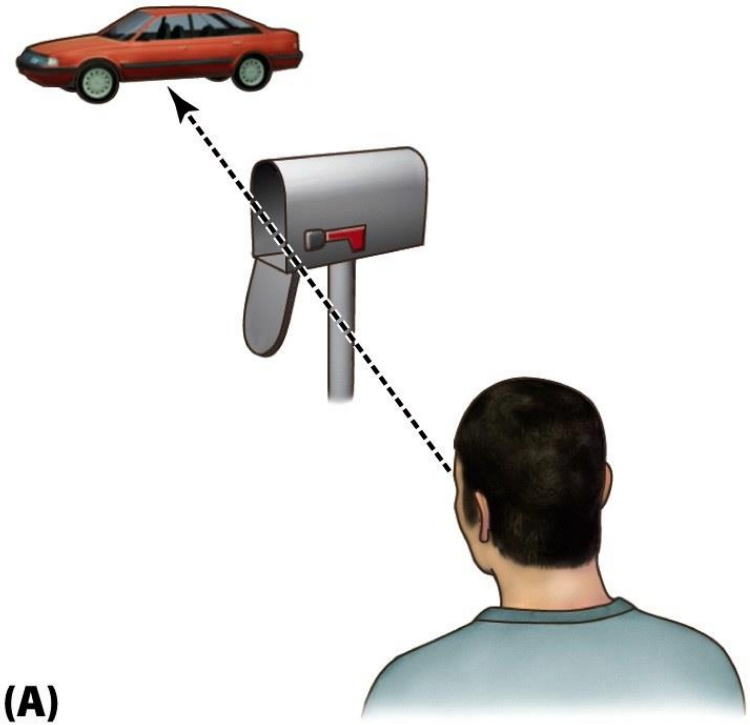
Perception of depth

- Depth cues
  - Binocular cues
    - Binocular disparity
    - Convergence
  - Monocular cues, e.g.,
    - Occlusion
    - Linear perspective
    - Texture gradients
    - Shadow
    - Motion parallax

Perception of depth

- Occlusion





(A)

(B)

Perception of depth

- Linear perspective

Perception of depth

- Texture gradients

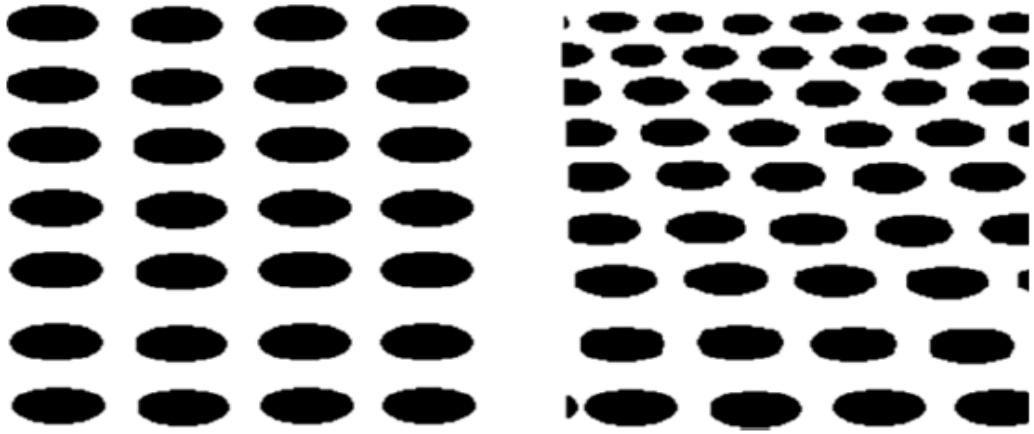
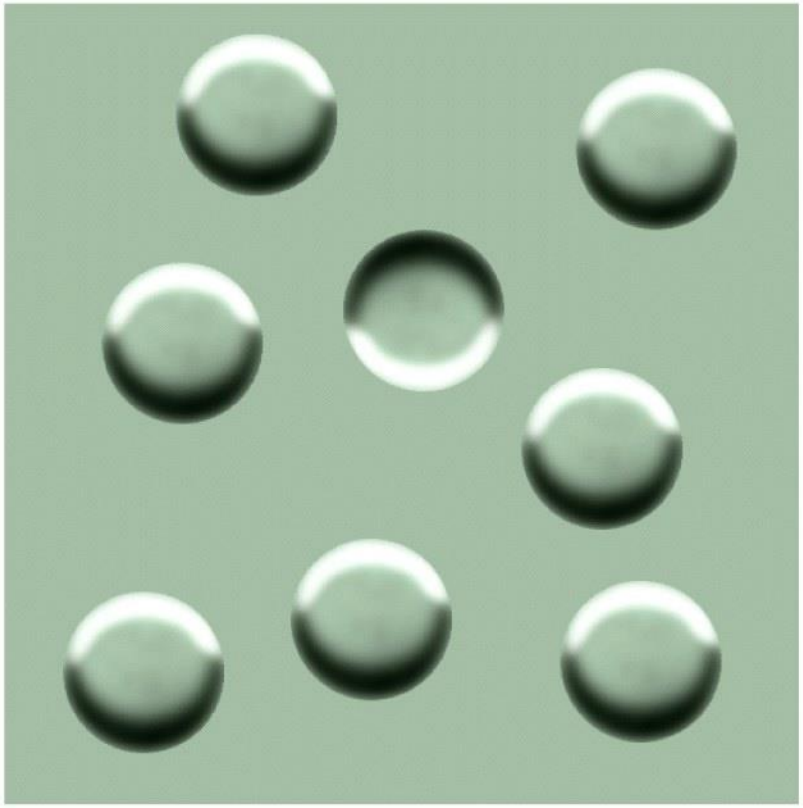


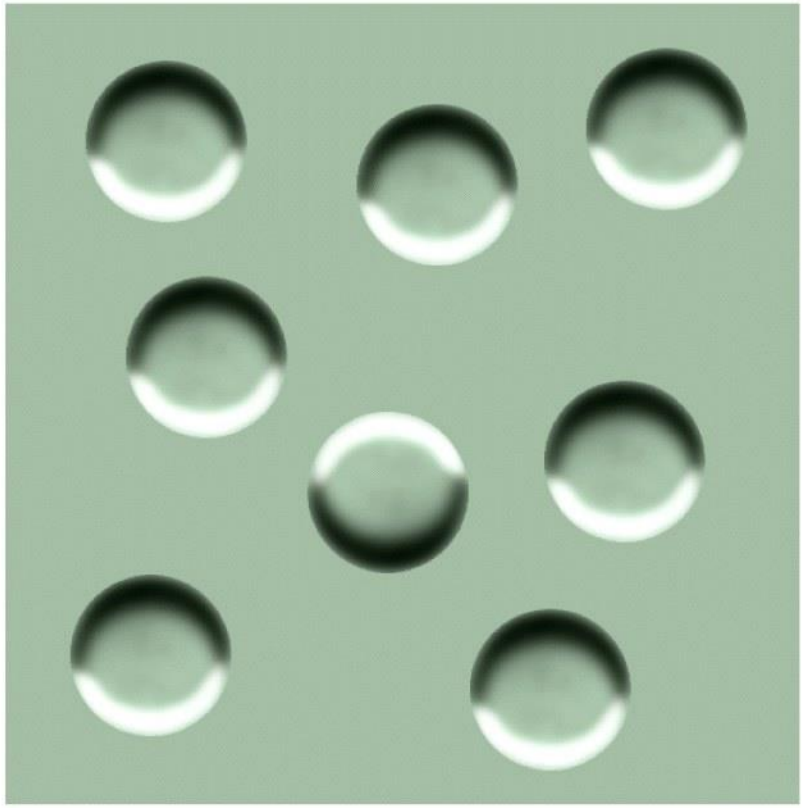
Fig. 7.2 When texture gradients are uniform, as on the *left*, no impression of depth is created; however, compressing points and using heterogeneous point size, on the *right*, give an impression of depth

Perception of depth

- Shadow



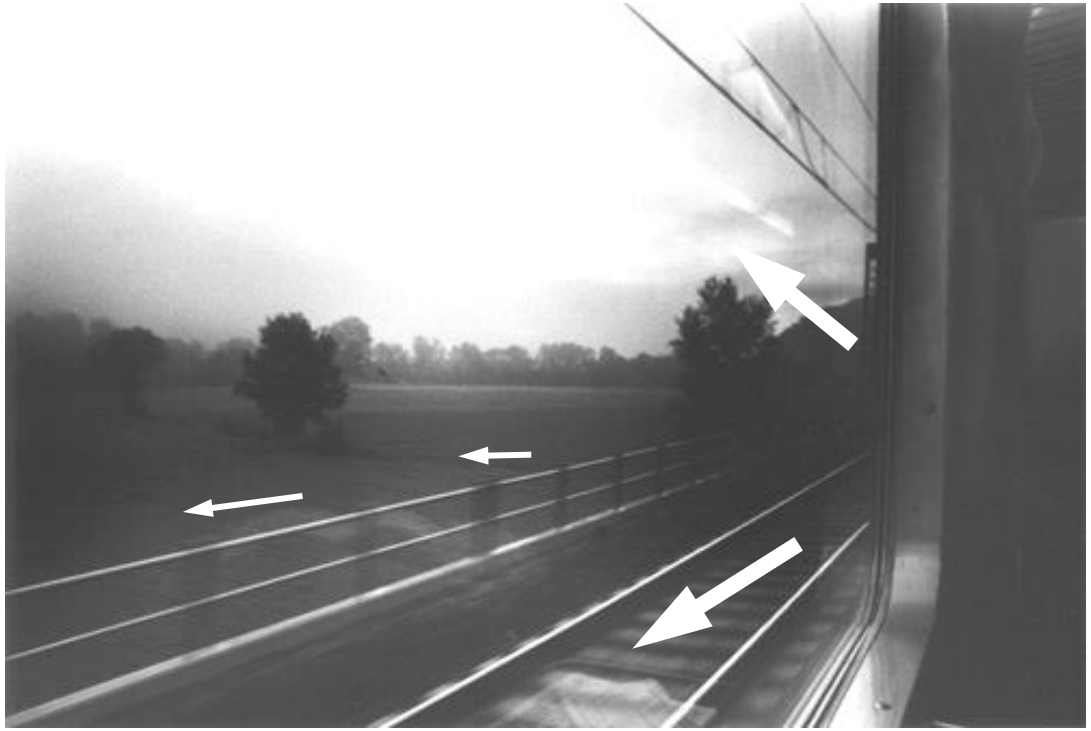
(A)



(B)

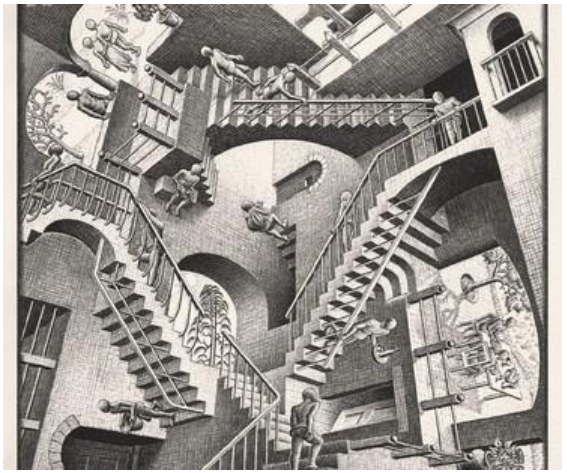
Perception of depth

- Motion parallax



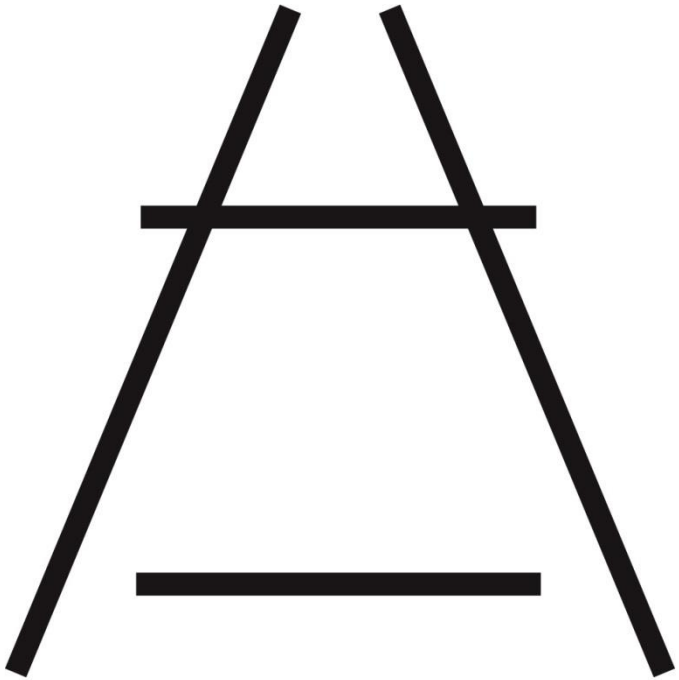
- The Dutch artist Maurits Cornelis Escher has mastered the development of scenes involving this kind of deception

- Or “trompe-l’oeil” illustrations allowing to see how fine use of depth cues by painters can create powerful impressions, sometimes dizzying, of a third dimension.



Perception of size

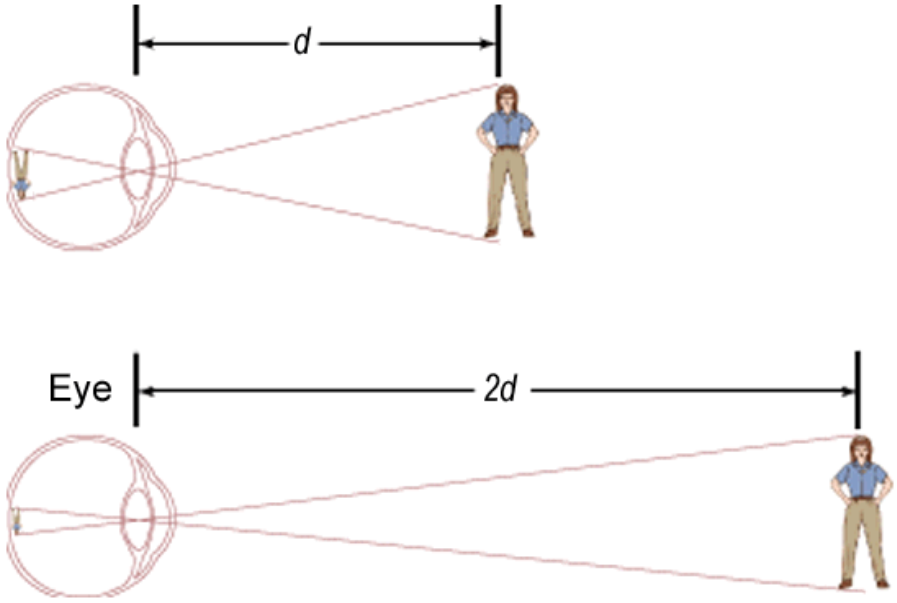
- Size perception depends on perceived distance

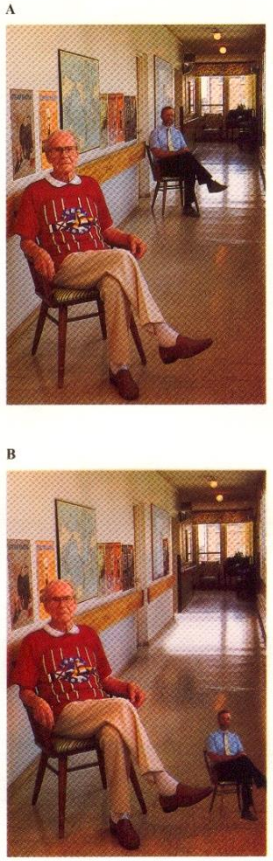


"seeing is not just a simple stimulation of retinal cells"

Perceptual constancies

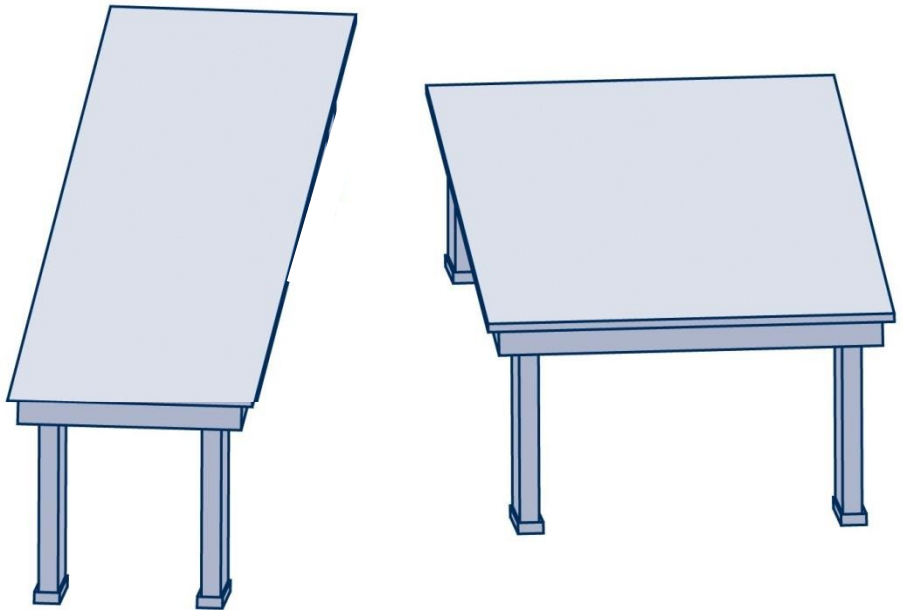
- We correctly perceive different properties of distal stimuli despite continuously changing proximal stimuli.
  - Size constancy





Perceptual constancies

- We correctly perceive different properties of distal stimuli despite continuously changing proximal stimuli.
  - Size constancy
  - Shape constancy

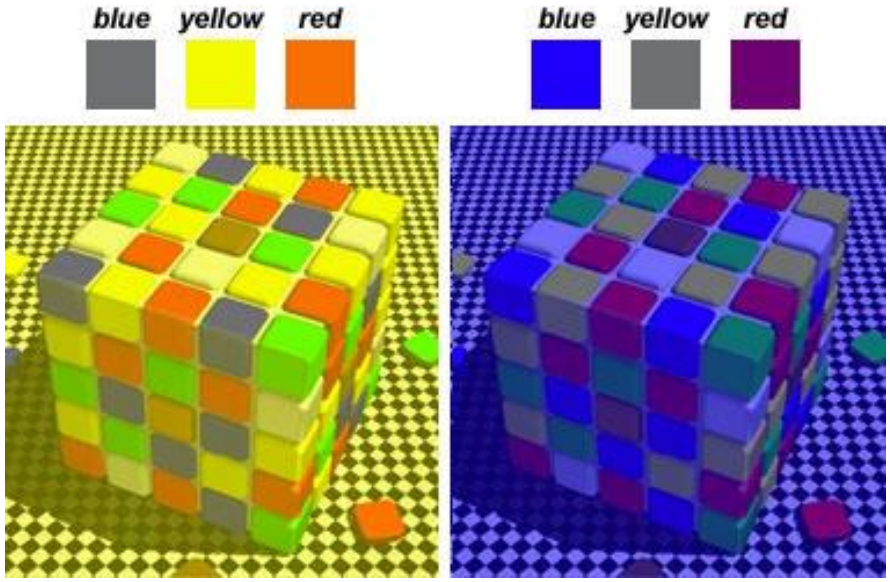


Perceptual constancies

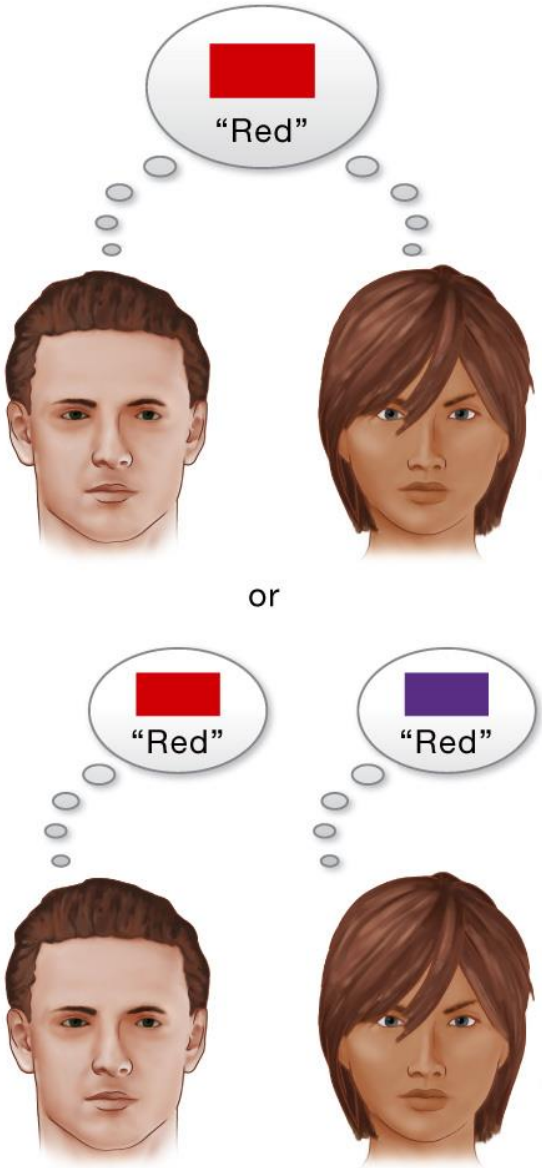
- We correctly perceive different properties of distal stimuli despite continuously changing proximal stimuli.
  - Size constancy
  - Shape constancy
  - Lightness constancy

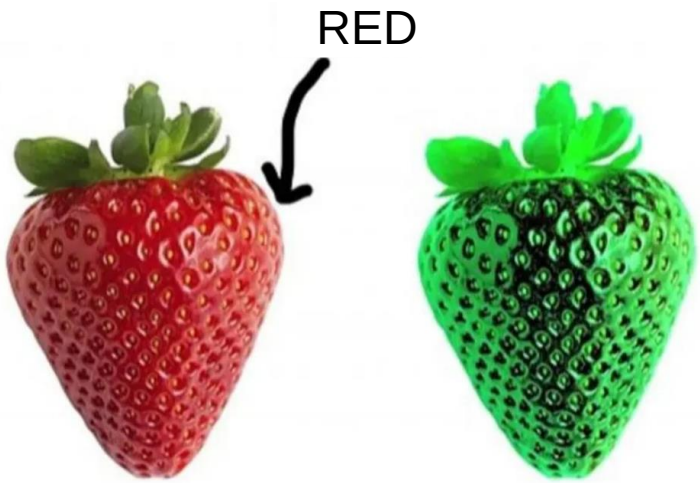
Perceptual constancies

- We correctly perceive different properties of distal stimuli despite continuously changing proximal stimuli.
  - Size constancy
  - Shape constancy
  - Lightness constancy
  - Color constancy



Qualia





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Predictions (bonus content)

https://www.cnet.com/science/biology/features/1-puzzling-reason-ai-may-never-compete-with-human-consciousness/

https://slate.com/technology/2017/04/heres-why-people-saw-the-dress-differently.html