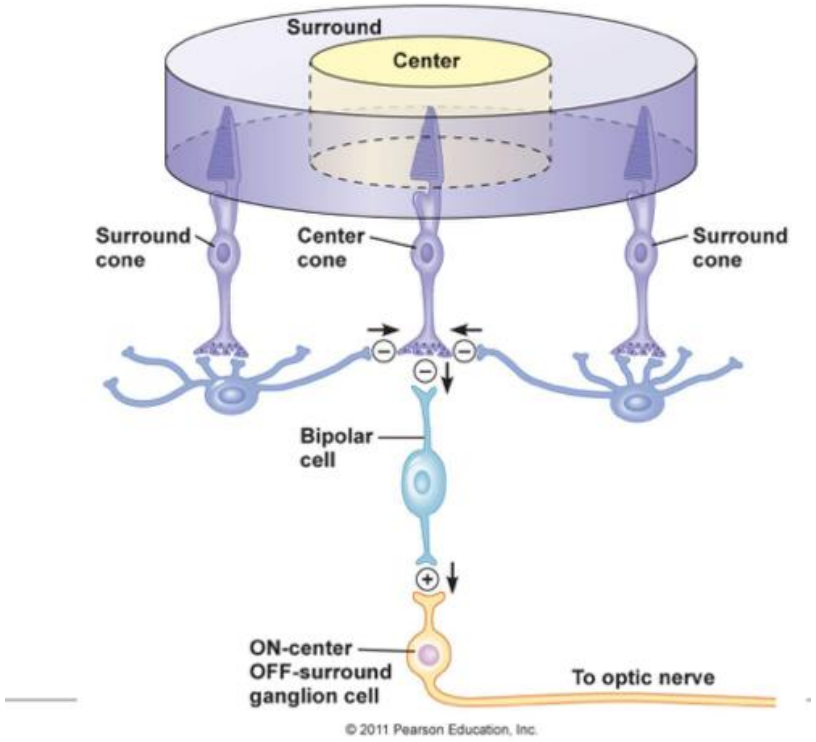
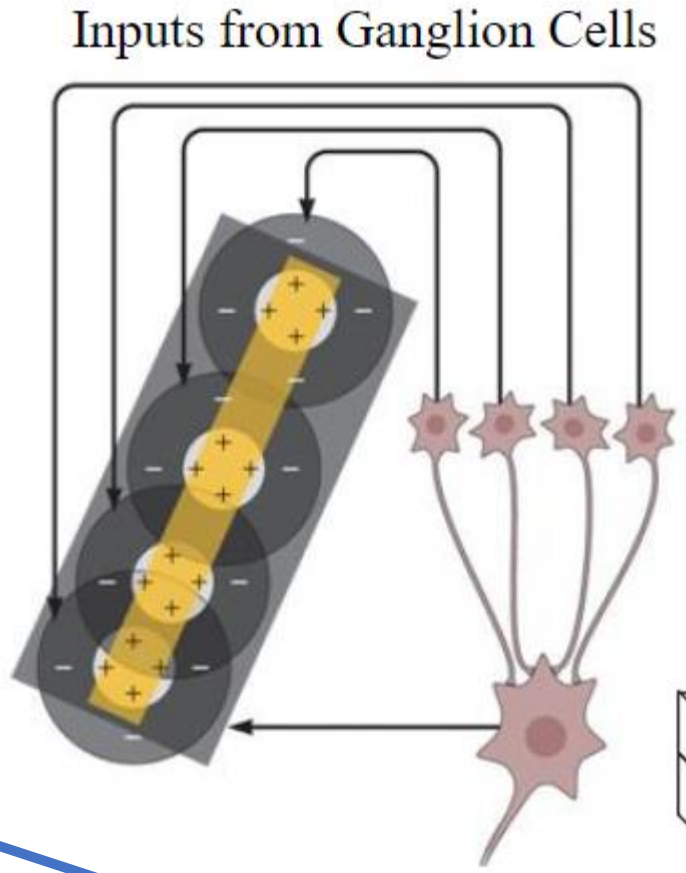
Round 4: Vision, Part 2

Form, Depth, Motion & Color Perception

12/11/2020

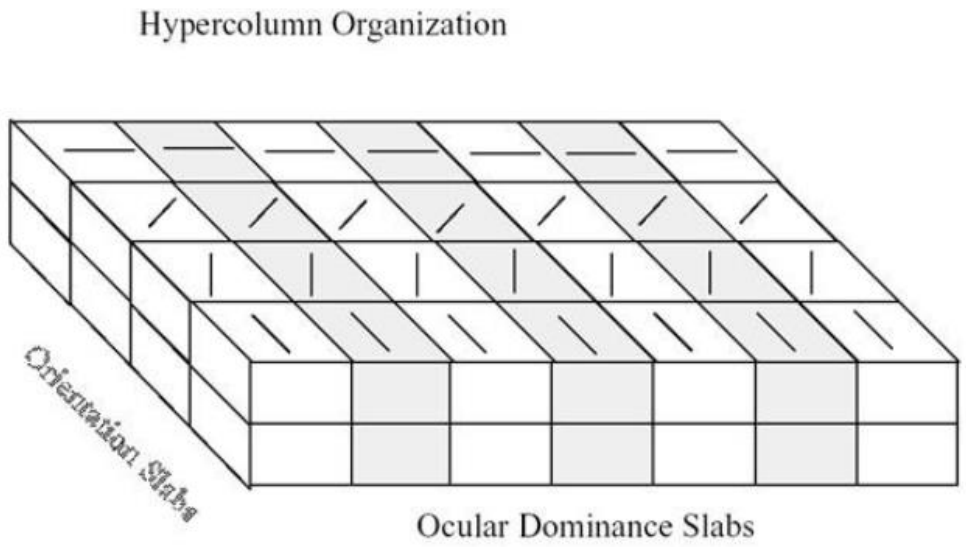
Kristy Snyder Colling, PhD

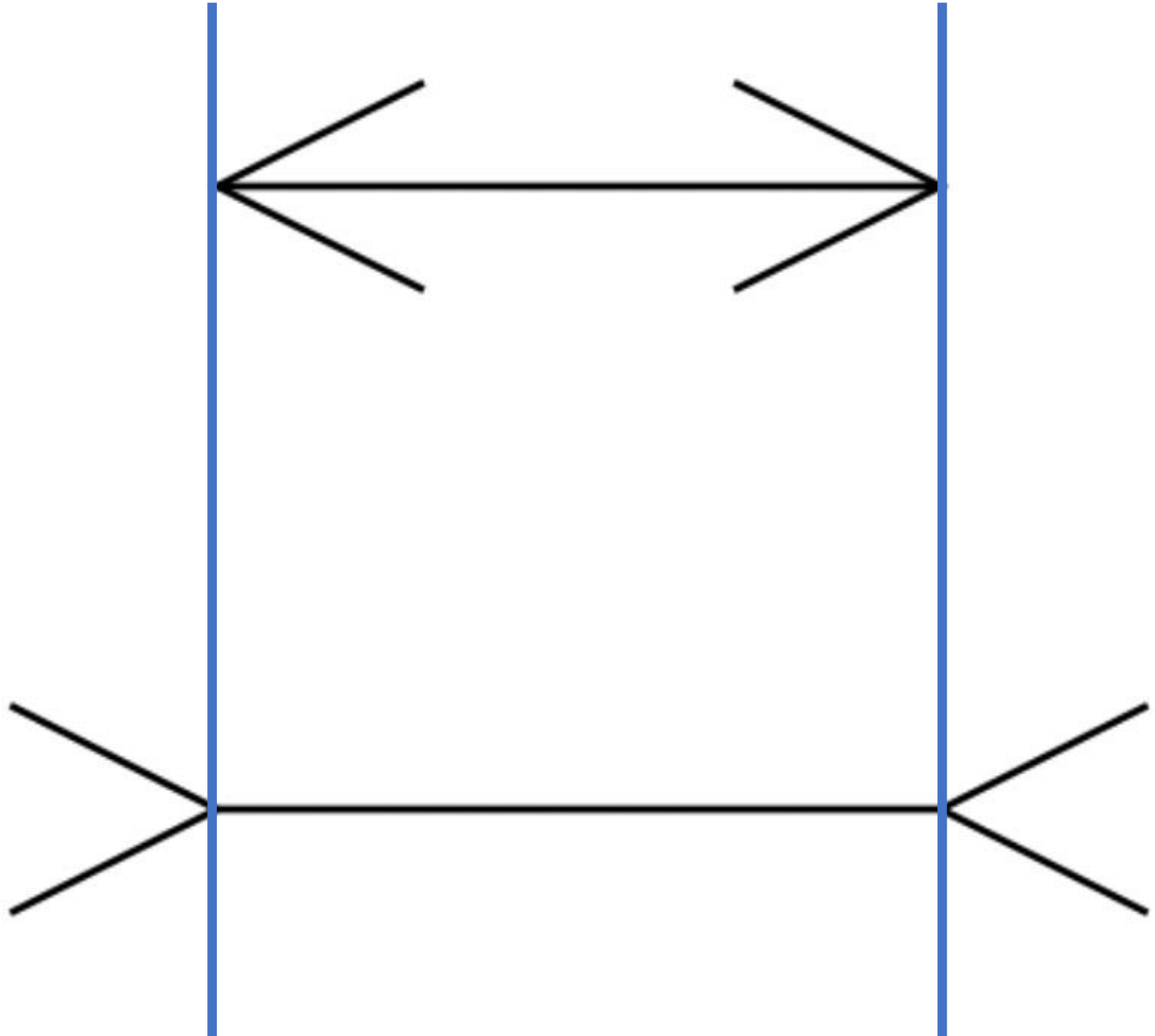

Surround
Center
Surround cone
Center cone
Surround cone
Bipolar cell
ON-center OFF-surround ganglion cell
To optic nerve
© 2011 Pearson Education, Inc.

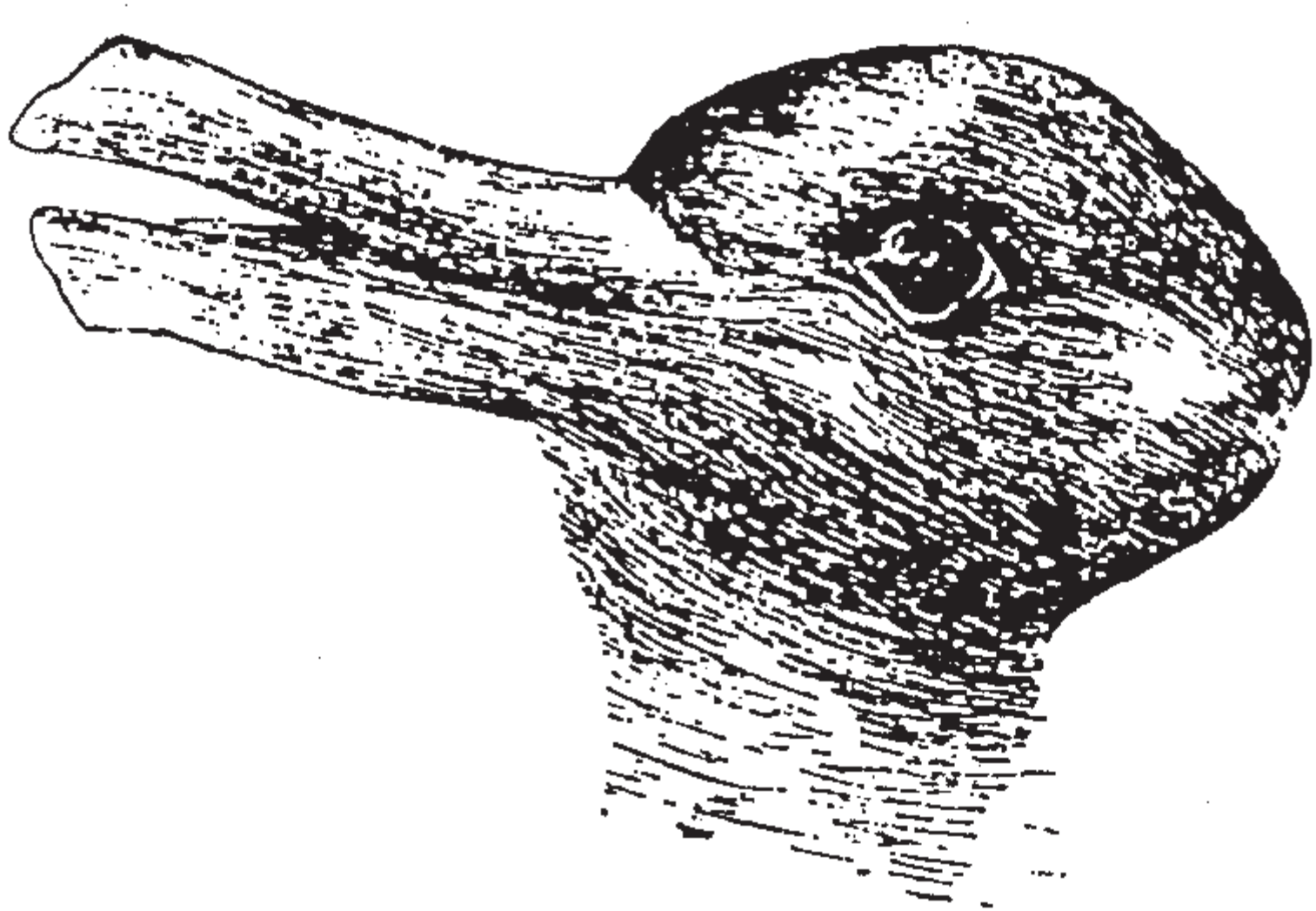

Inputs from Ganglion Cells

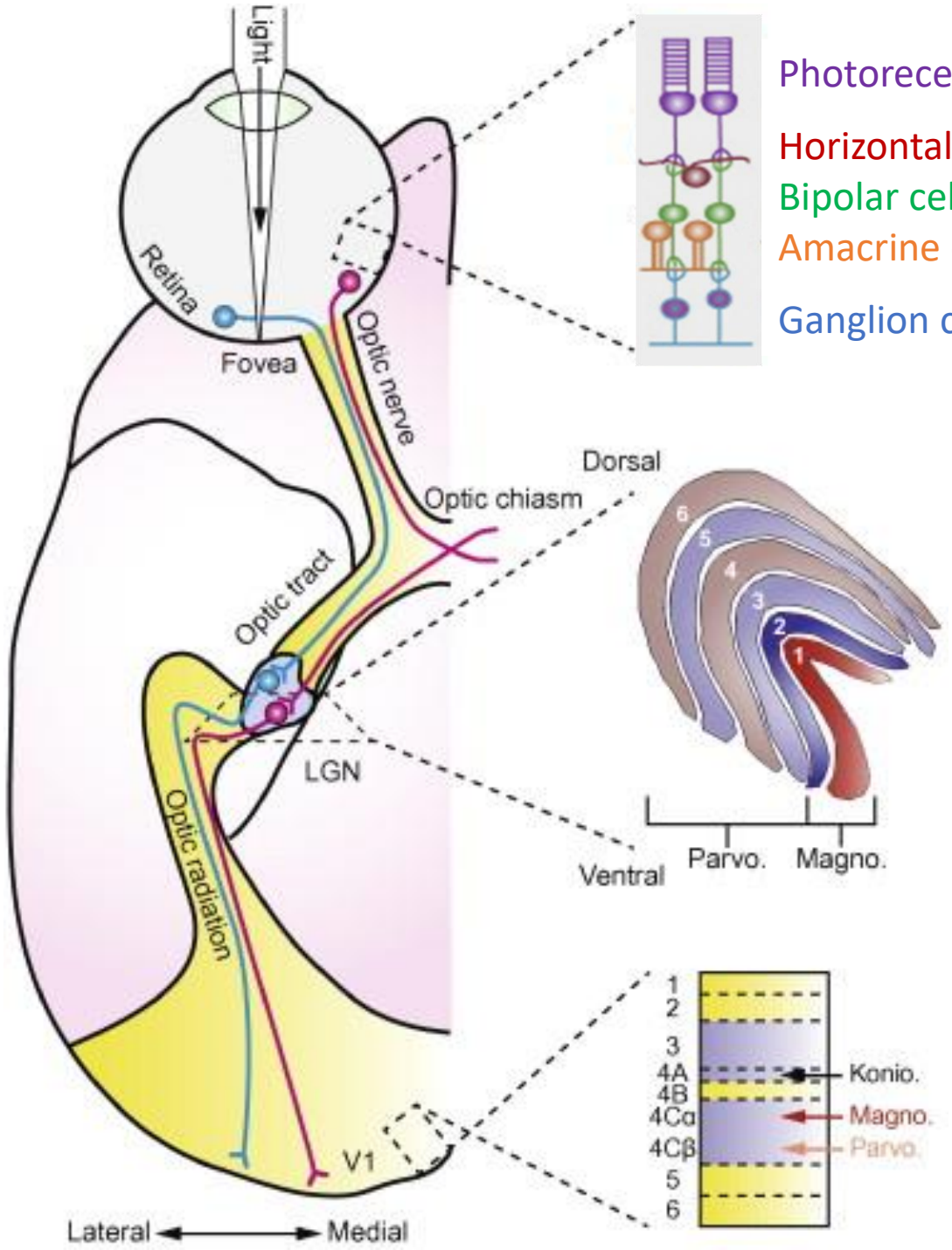
Eye

V1


Hypercolumn Organization
Orientation Slabs
Ocular Dominance Slabs







Photoreceptors

Horizontal cells

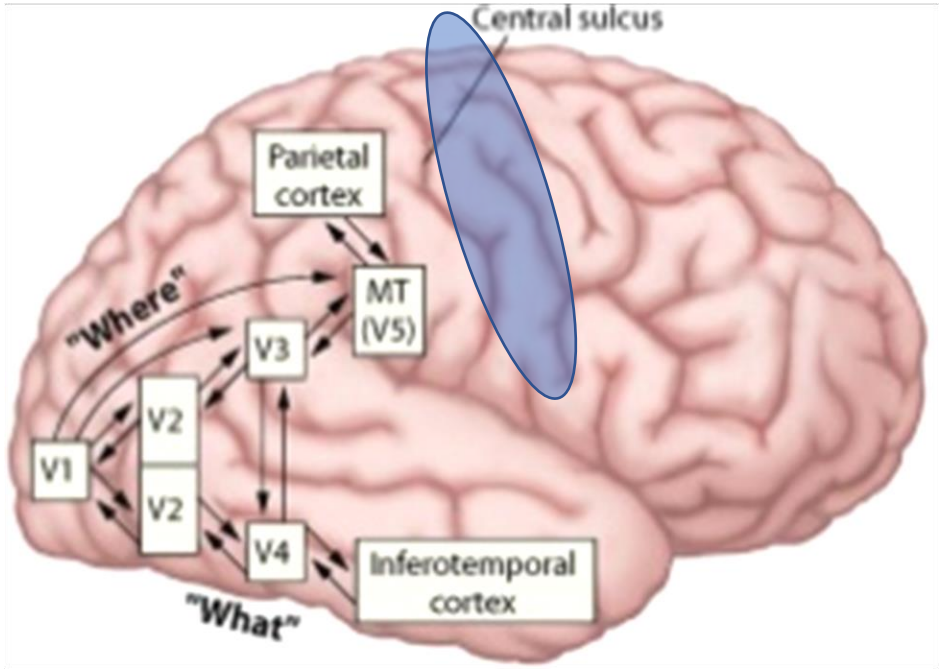
Bipolar cells

Amacrine cells

Ganglion cells

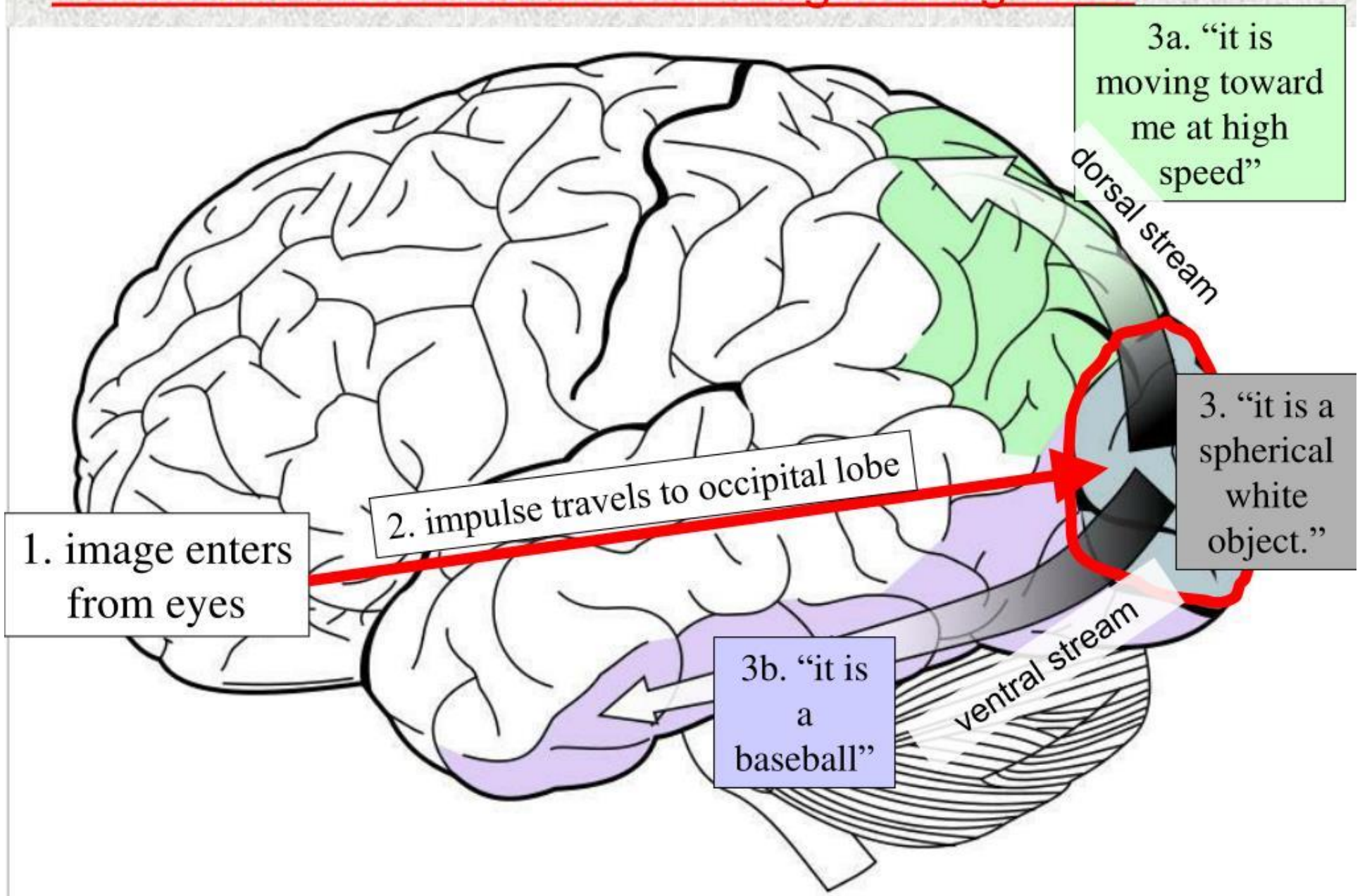
Functionally Distinct Ganglion cells begin <u>parallel processing</u> of visual information

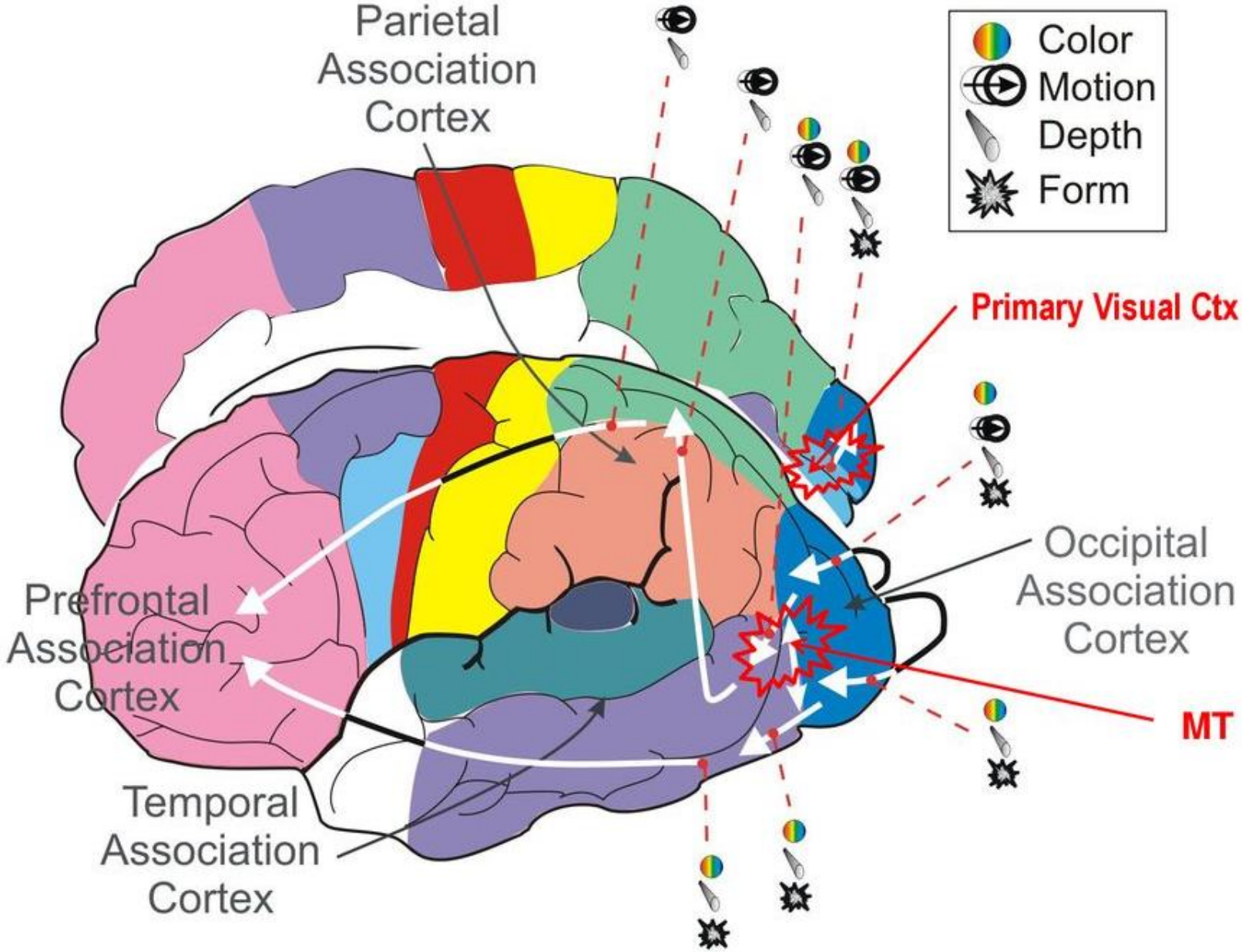
M	P
Large cell bodies Large dendritic fields Large receptive fields	Small cell bodies Small dendritic fields Small receptive fields
Large/Gross features Movement	Fine Details Color Vision
Projects to 2 ventral layers of LGN (Magnocellular layers)	Projects to 4 dorsal layers of LGN (Parvocellular layers)
Projects to layer 4 of BA 17 around the Calcarine Fissure	
Projects to 4Cα	Projects to 4Cβ



- "What" Pathway – Object Processing
  - Color
  - Texture
  - Shape
  - Size
  - Details
- "Where" Pathway – Spatial Processing
  - Location
  - Movement
  - Spatial Relations and Transformation

dorsal and ventral stream of image recognition




Parietal
Association
Cortex
Color
Motion
Depth
Form
Primary Visual Ctx
Occipital
Association
Cortex
MT
Prefrontal
Association
Cortex
Temporal
Association
Cortex

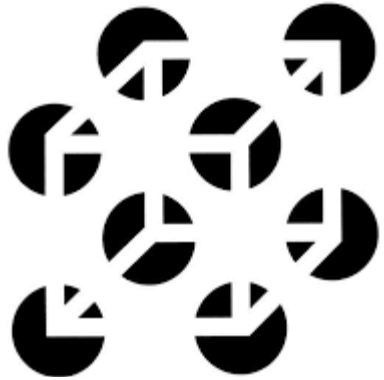
Form Perception

Gestalt – The whole is different from the sum of its parts

Form Perception

Gestalt – The whole is different from the sum of its parts

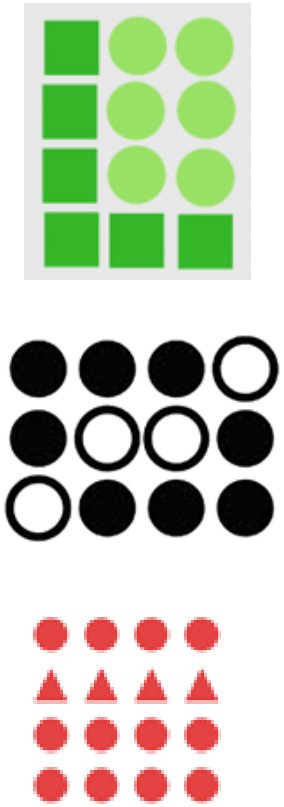
- Closure – Perceive that parts of the visual scene are connected, forming a coherent object even though there is no actual connection



Form Perception

Gestalt – The whole is different from the sum of its parts

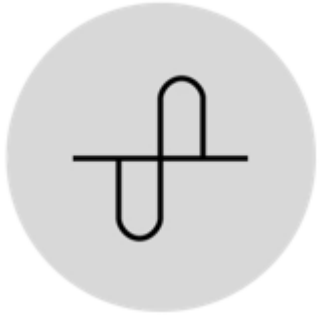
- Similarity – Objects tend to be grouped together if they are similar



Form Perception

Gestalt – The whole is different from the sum of its parts

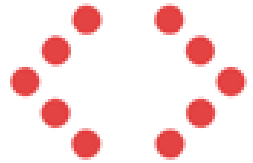
- Continuity – When there is an intersection between two or more objects people tend to perceive each object as a single uninterrupted object

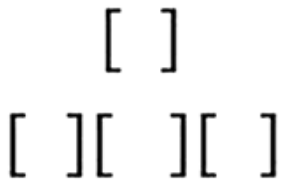


Form Perception

Gestalt – The whole is different from the sum of its parts

- Symmetry – Symmetrical shapes are grouped such that the perception is that of a single object

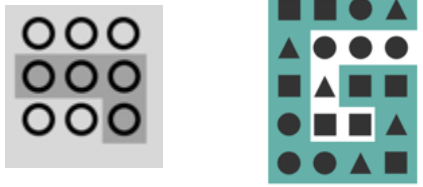




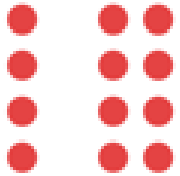
Form Perception

Gestalt – The whole is different from the sum of its parts

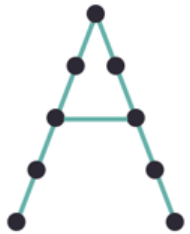
- Enclosure



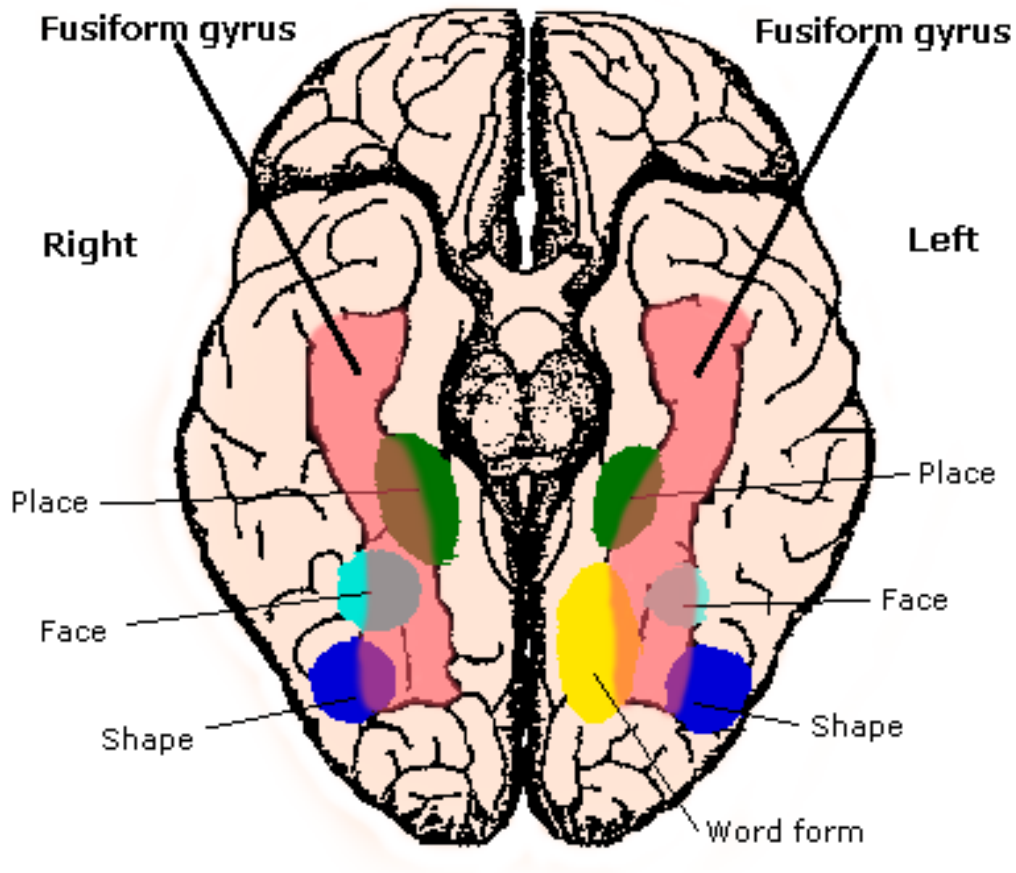
- Proximity



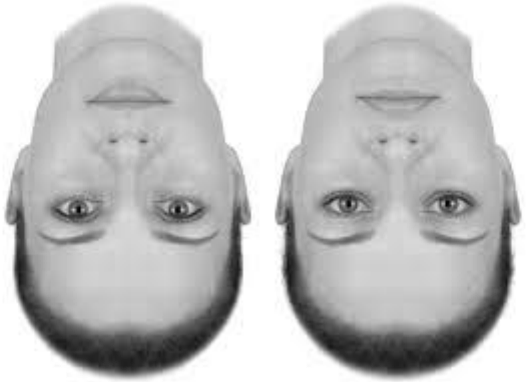
- Connection

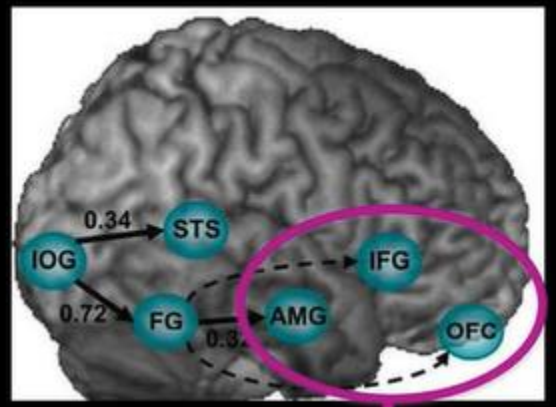


- Common Fate


Fusiform gyrus
Fusiform gyrus
Right
Left
Place
Place
Face
Face
Shape
Shape
Word form

Pareidolia - tendency to perceive faces in inanimate objects



-Interpret meaning from faces

Amygdala (limbic) and Prefrontal cortex
(Inferior Frontal Gyrus, Orbitofrontal Cortex)

PaulEkmanGroup

Depth Perception

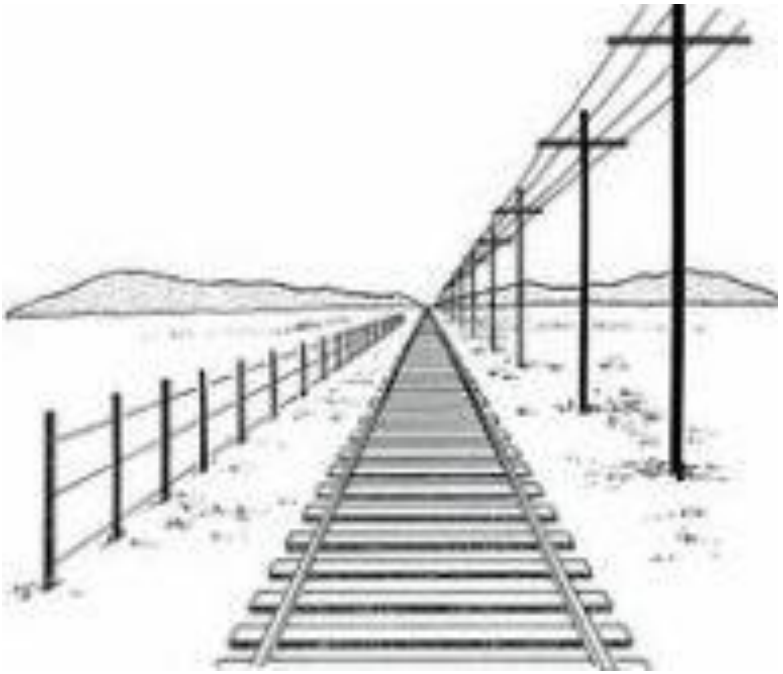
How to convert the 2-dimension retinal image to a 3-dimensional precept

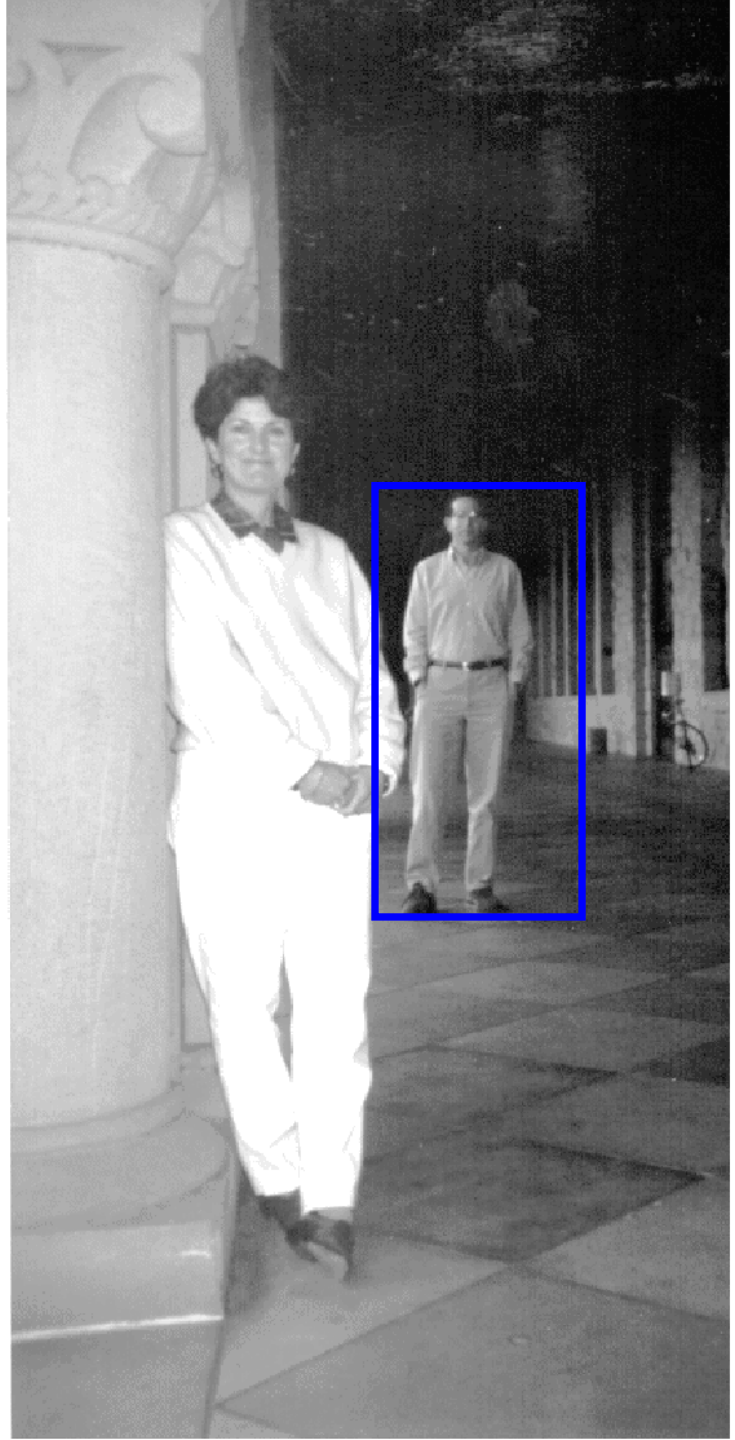
- Monocular cues
  - **Motion Parallax** – Differential motion
    - Images close to you move more than images that are far away.

Depth Perception

How to convert the 2-dimension retinal image to a 3-dimensional precept

- Monocular cues
  - **Linear & Size Perspectives**
    - Things that are further away are smaller on the retina so it is perceived as further away

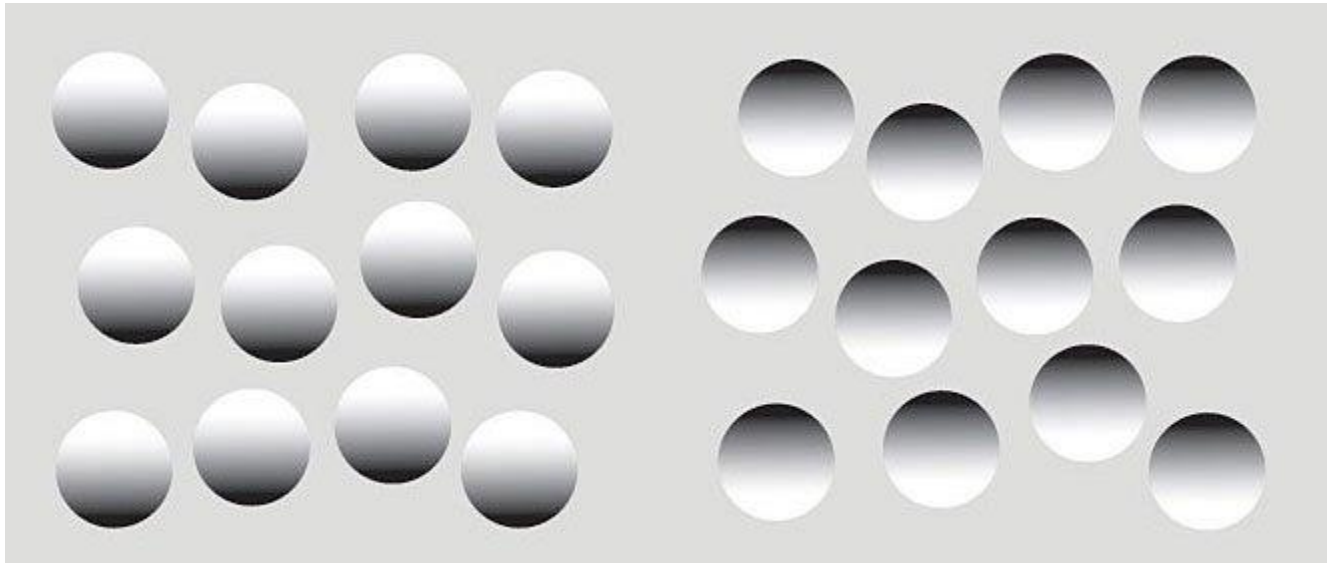




Depth Perception

How to convert the 2-dimension retinal image to a 3-dimensional precept

- Monocular cues
  - **Shading**
    - Brain assumes that objects are illuminated from above



Depth Perception

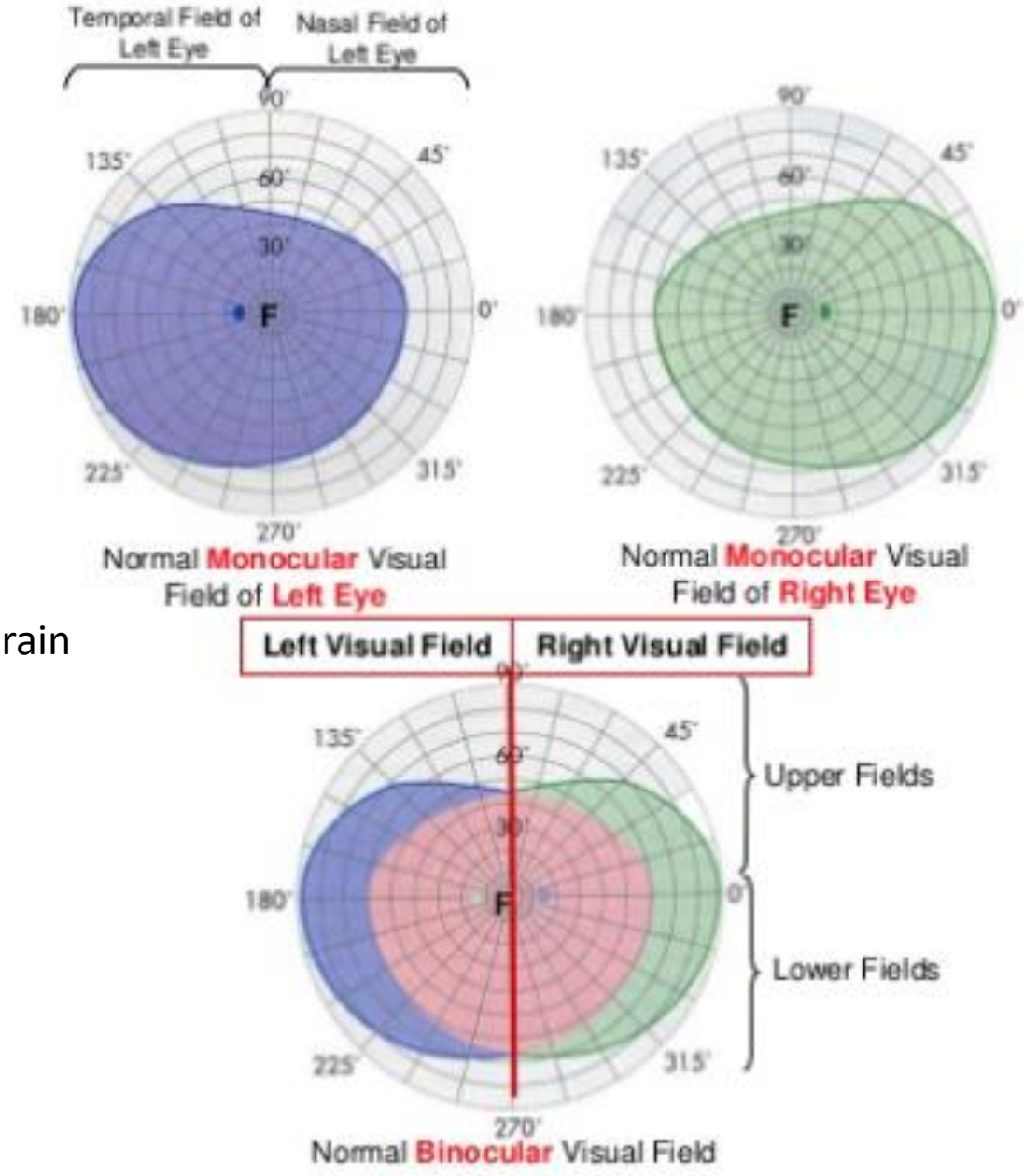
How to convert the 2-dimension retinal image to a 3-dimensional precept

- Monocular cues
  - **Interposition**
    - If an object blocks another the one blocking is assumed to be closer

Depth Perception

How to convert the 2-dimension retinal image to a 3-dimensional precept

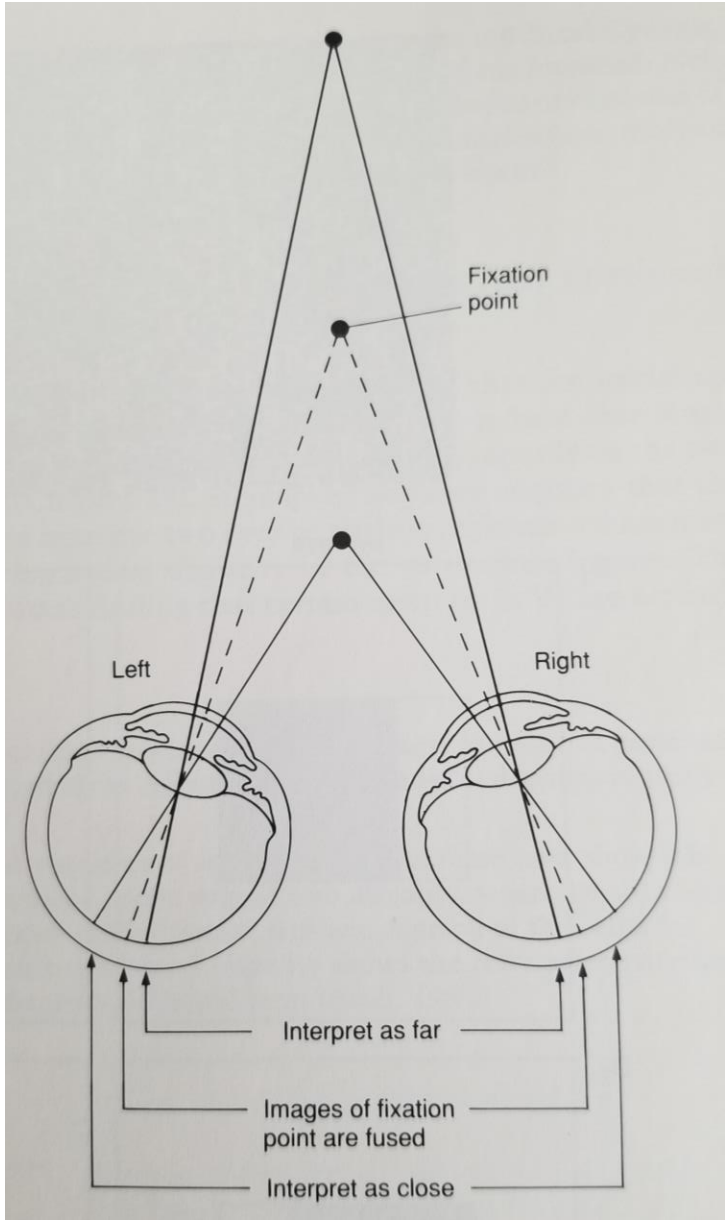
- Binocular cues
  - **Stereopsis**
    - Each eye gets a slightly different image and the brain compares the images to calculate distance



Depth Perception

How to convert the 2-dimension retinal image to a 3-dimensional precept

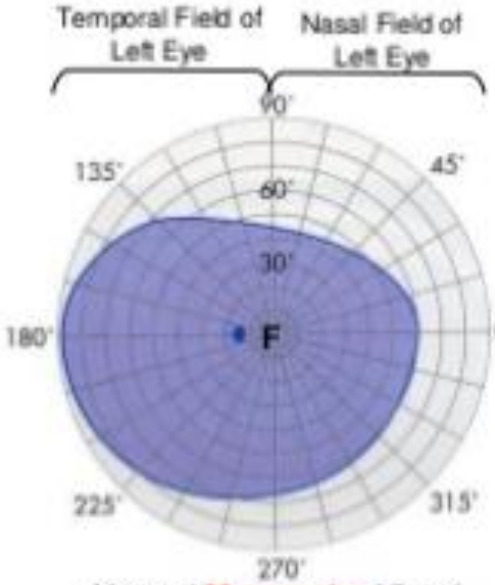
- Binocular cues
  - **Stereopsis**
    - Each eye gets a slightly different image and the brain compares the images to calculate distance
    - Works better closer up where there is more disparity



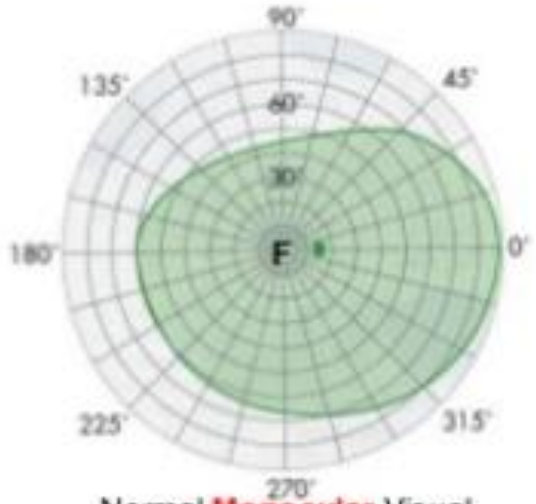
Depth Perception

How to convert the 2-dimension retinal image to a 3-dimensional precept

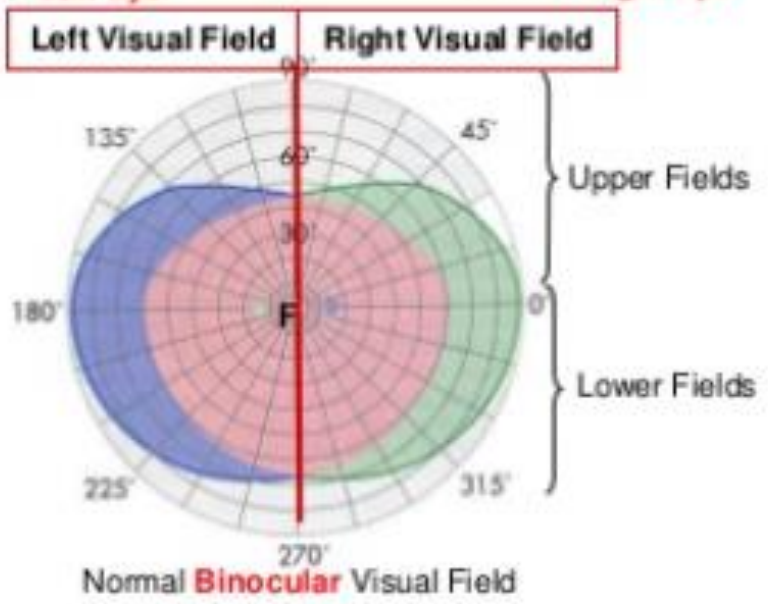
- Binocular cues
  - **Stereopsis**
    - Each eye gets a slightly different image and the brain compares
    - Works better closer up where there is more disparity
    - Further apart - more disparity - better depth perception (e.g., hammerhead shark)



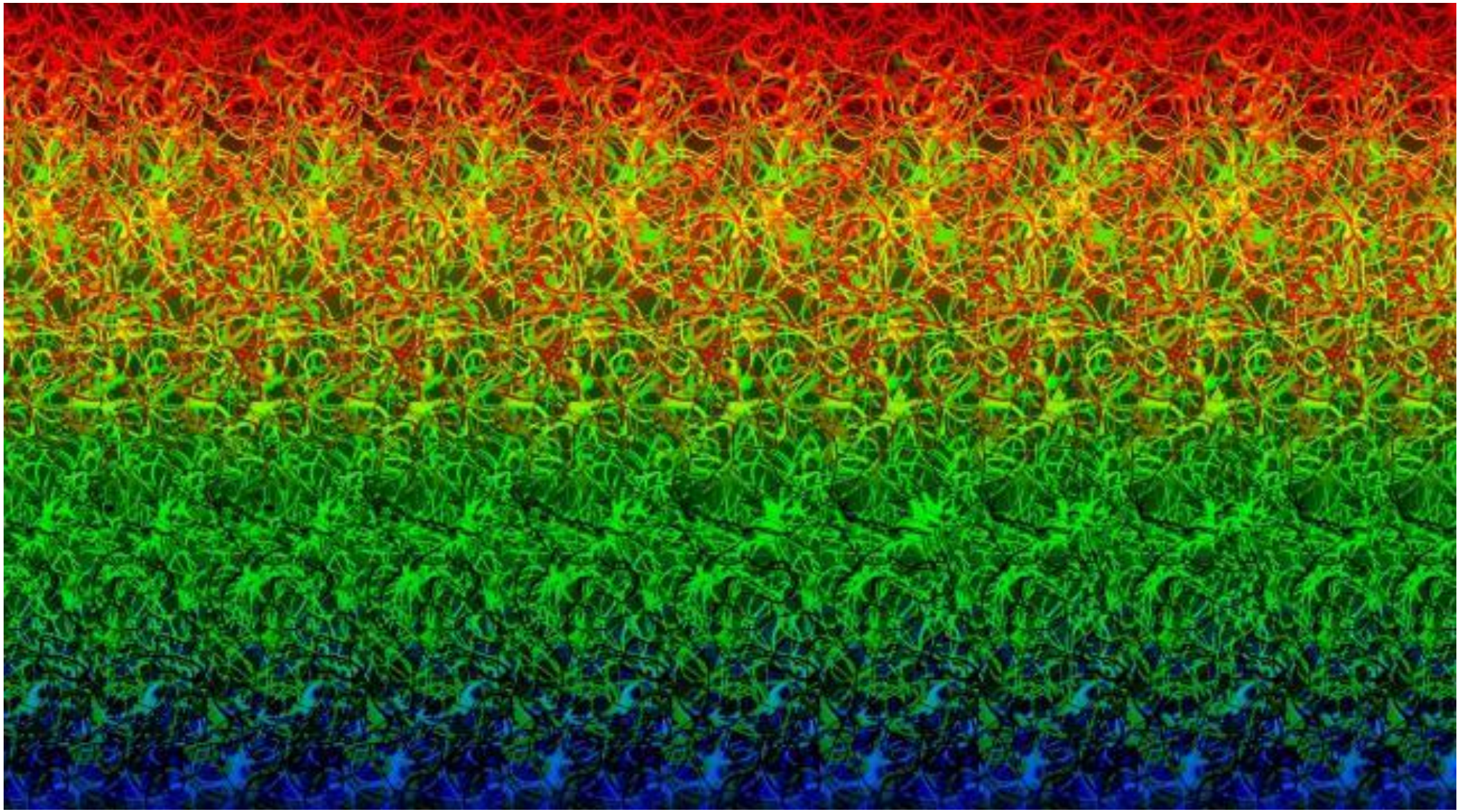
Normal **Monocular** Visual Field of **Left Eye**



Normal **Monocular** Visual Field of **Right Eye**

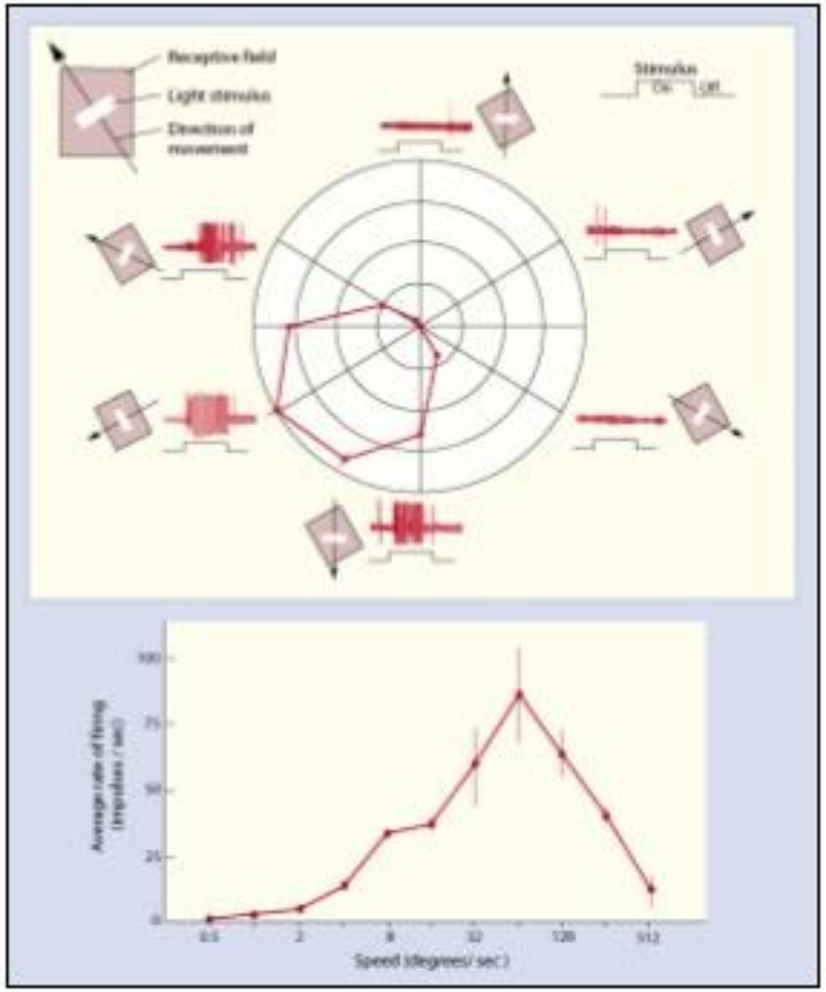


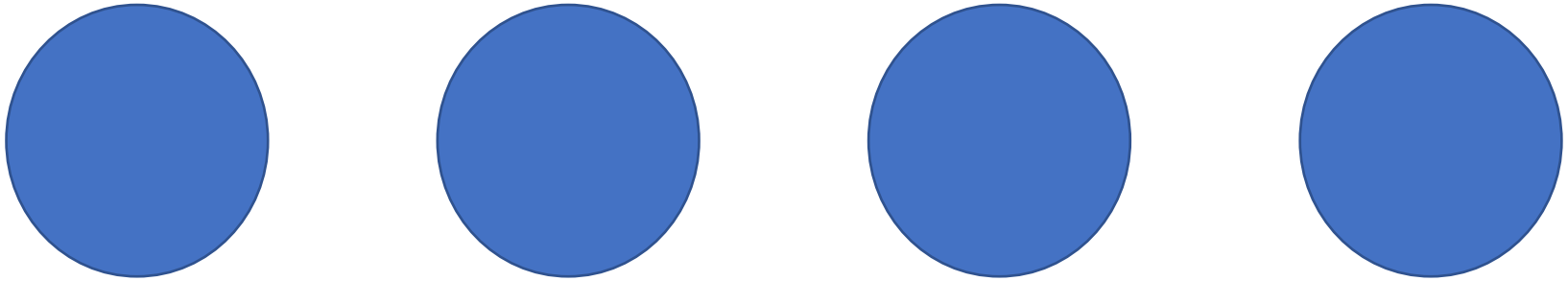
Normal **Binocular** Visual Field

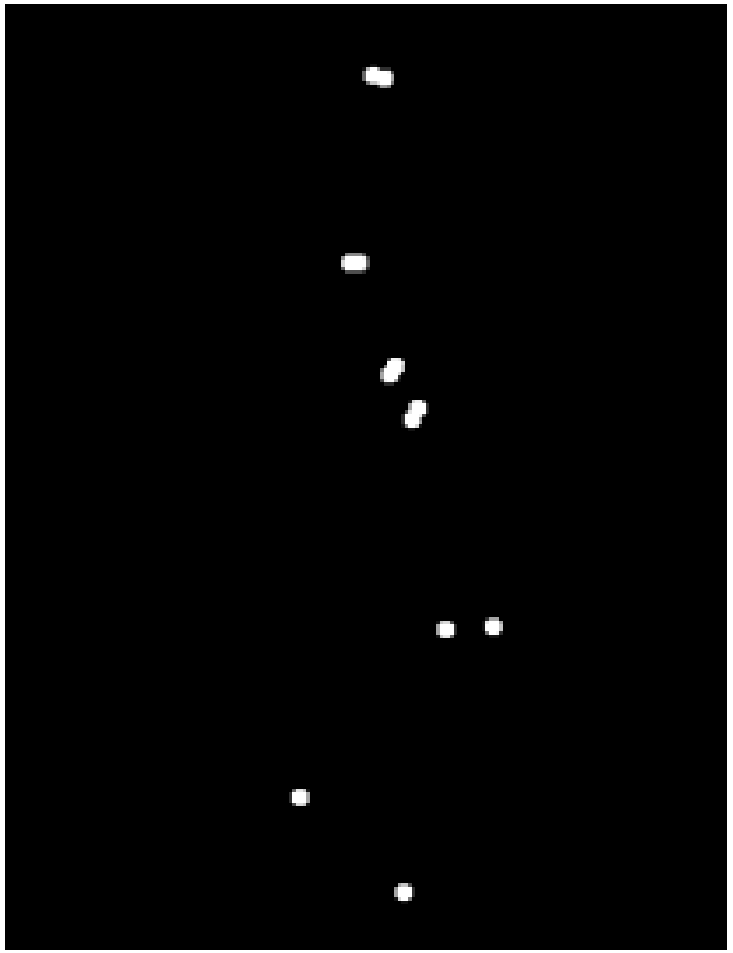


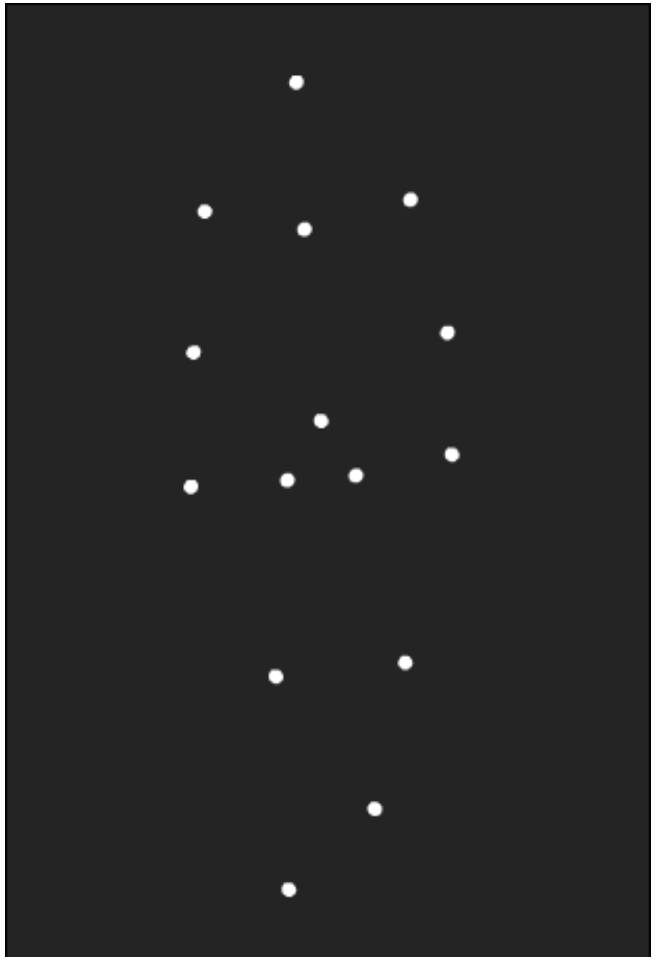
Motion Perception

- Motion is temporal. Its perception depends on the successive activation of cells
- When eyes are still, image of moving object moves across the retina. Information about movement is relayed to the brain through sequential firing of receptors across the retina.
- When the eye follows an object, the image stays in one place in the retina and the information is conveyed to the brain by movement of the eyes or head.
- MT has retinotopic map that conveys information about the speed and direction of motion.
- Direction sensitive cells in MT – organized in columns - like V1 organized with direction sensitive cells
- By stimulating certain cells movement direction can be directly affected







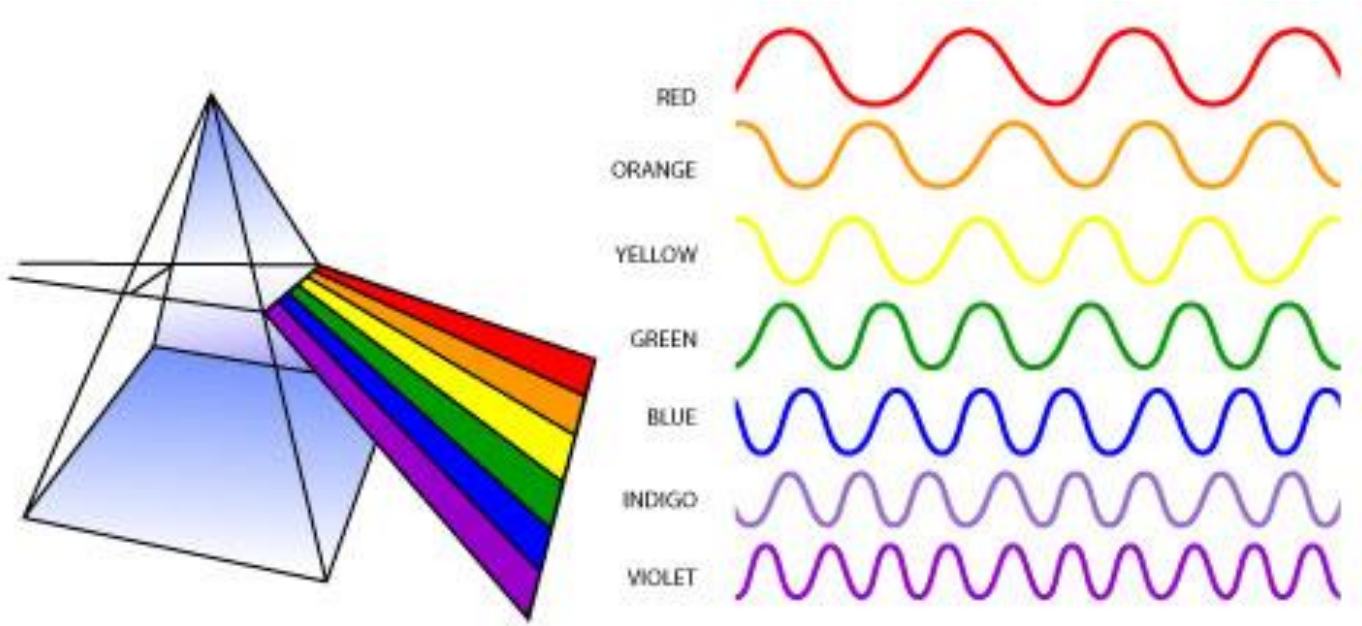


Color

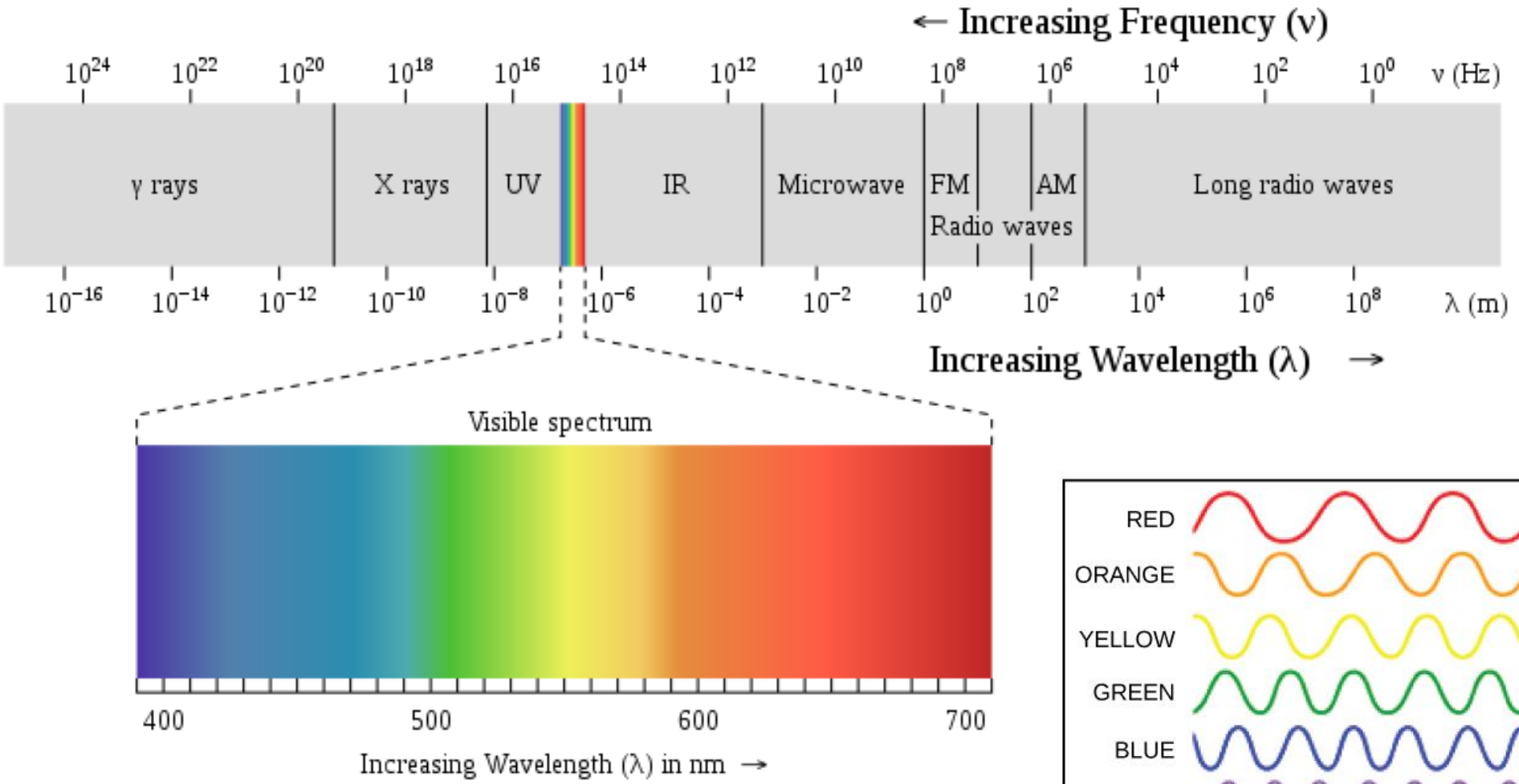
Color

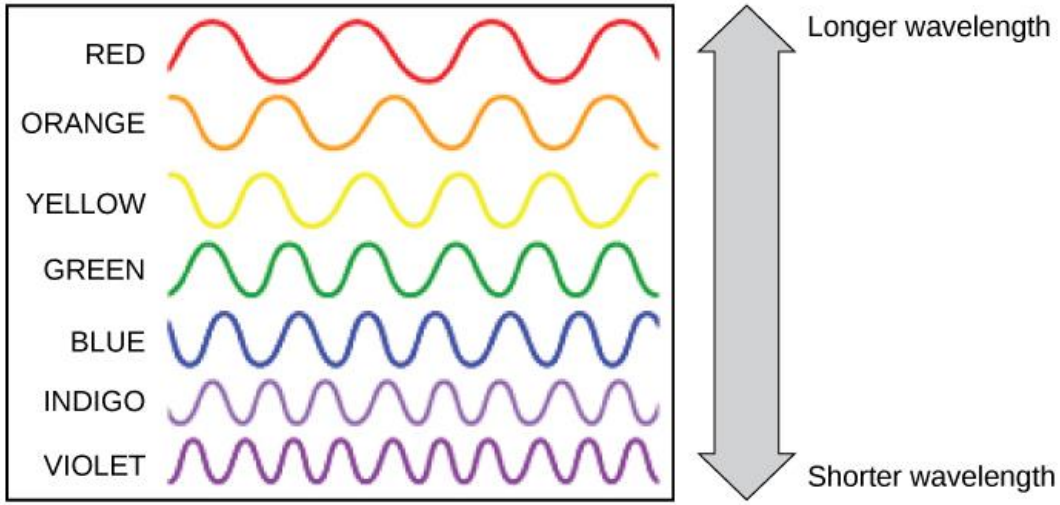
Color

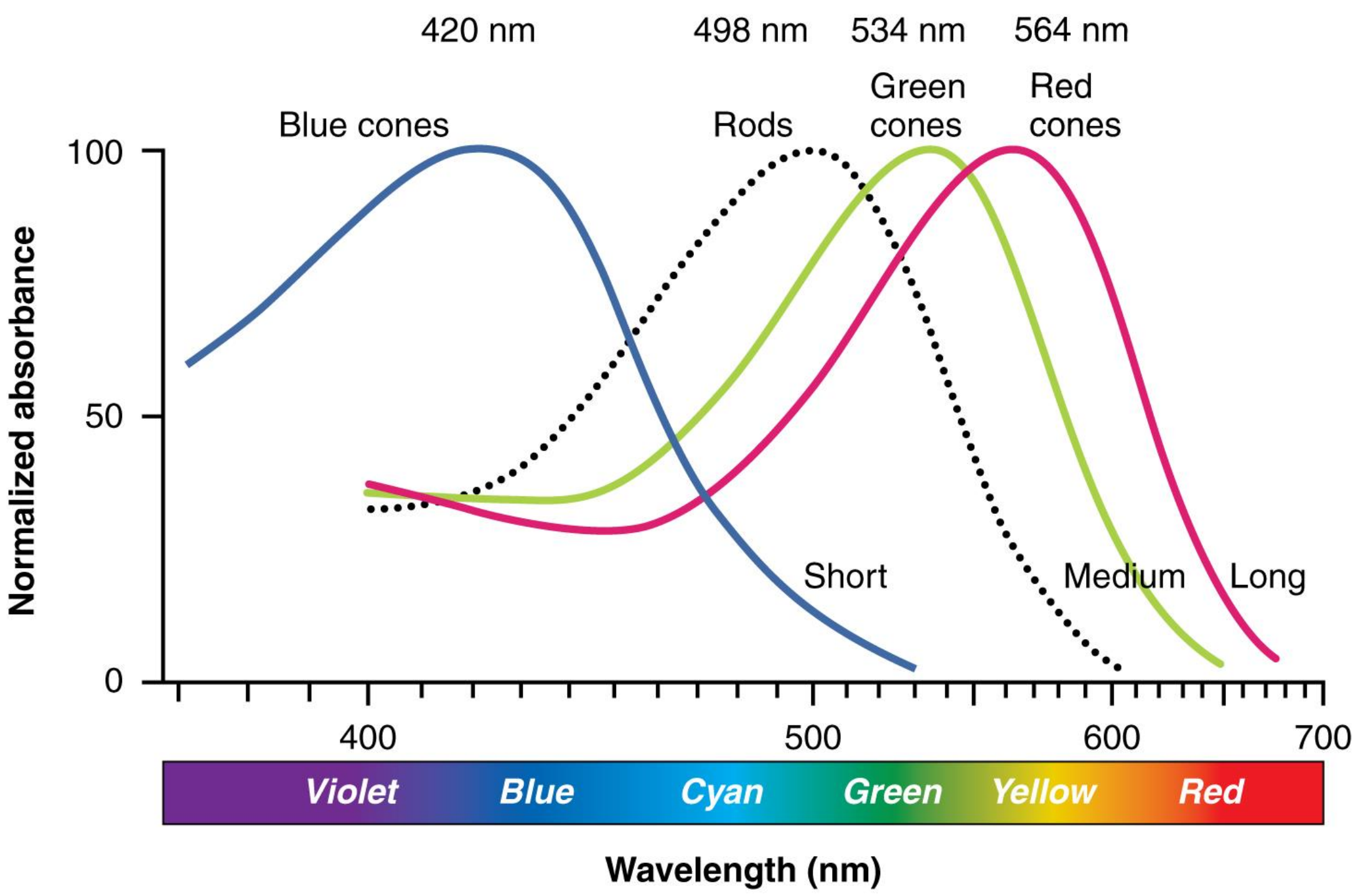
- White is not the absence of color, It is the combination of all colors
- Newton (1672 – age 29) prism experiment found the rainbow color spectrum

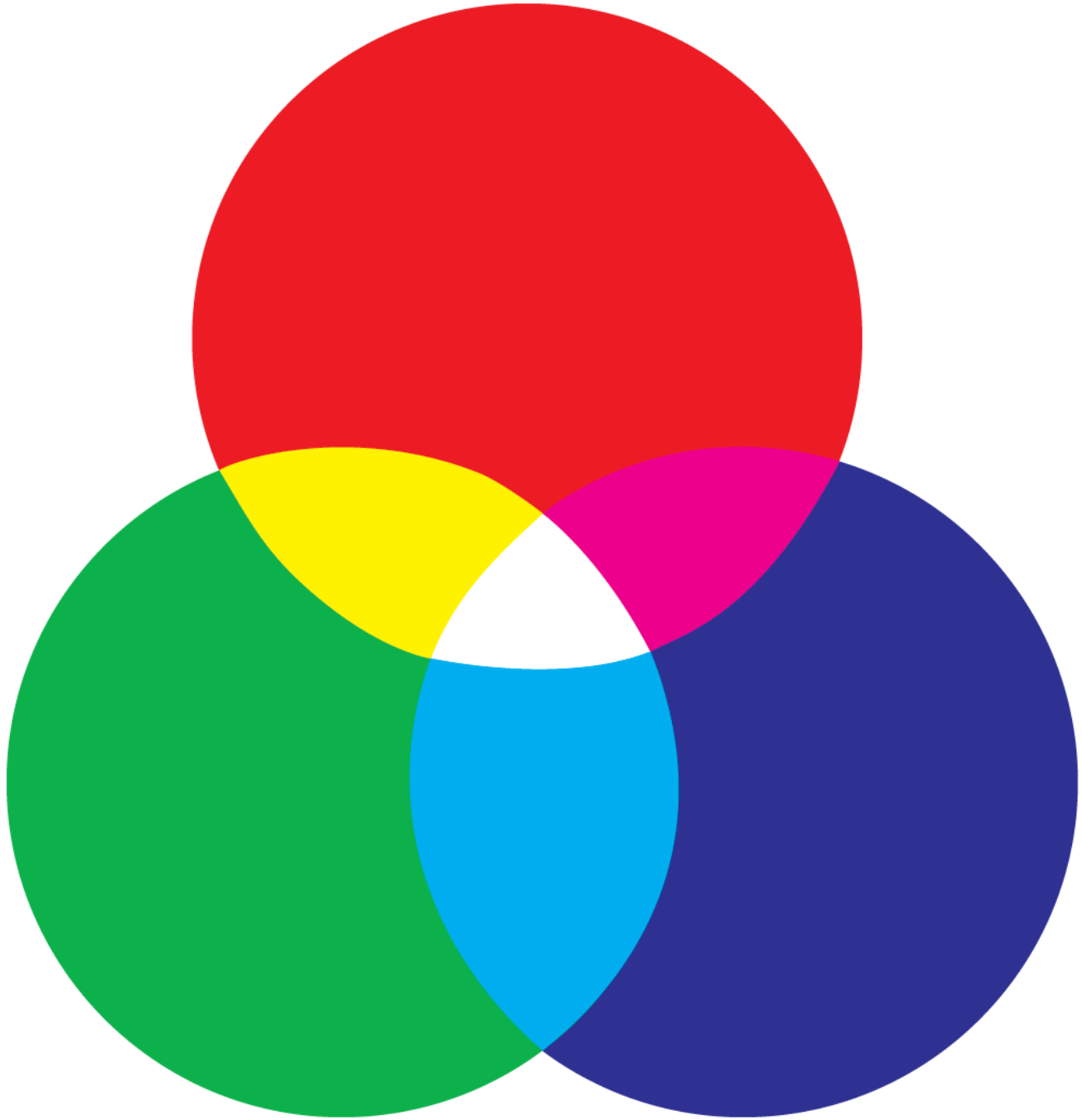


Electromagnetic Spectrum






420 nm
498 nm
534 nm
564 nm
Blue cones
Rods
Green cones
Red cones
100
50
0
Normalized absorbance
Short
Medium
Long
400
500
600
700
Violet
Blue
Cyan
Green
Yellow
Red
Wavelength (nm)



Colors:

Color model: RGB

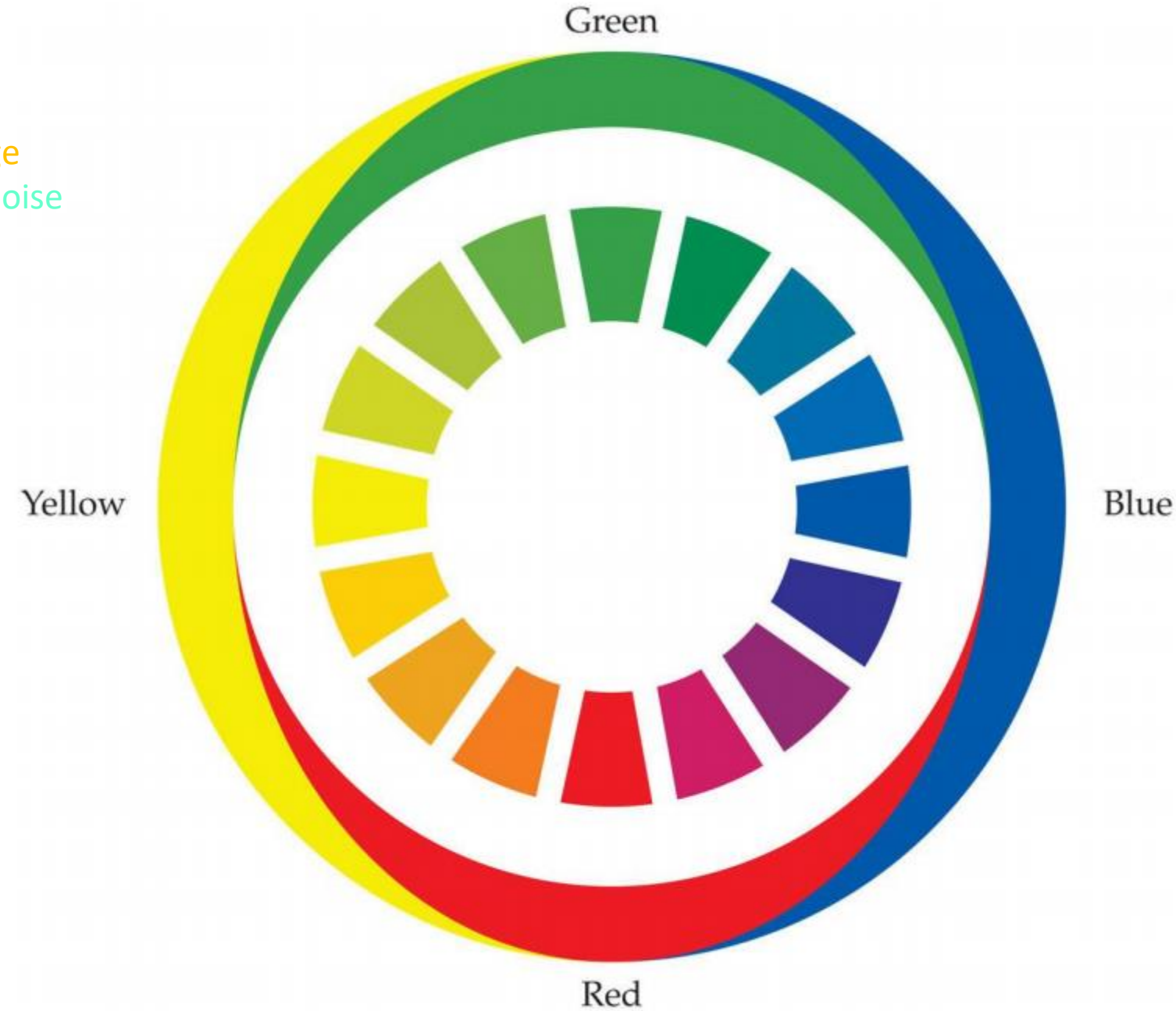
Red: 170

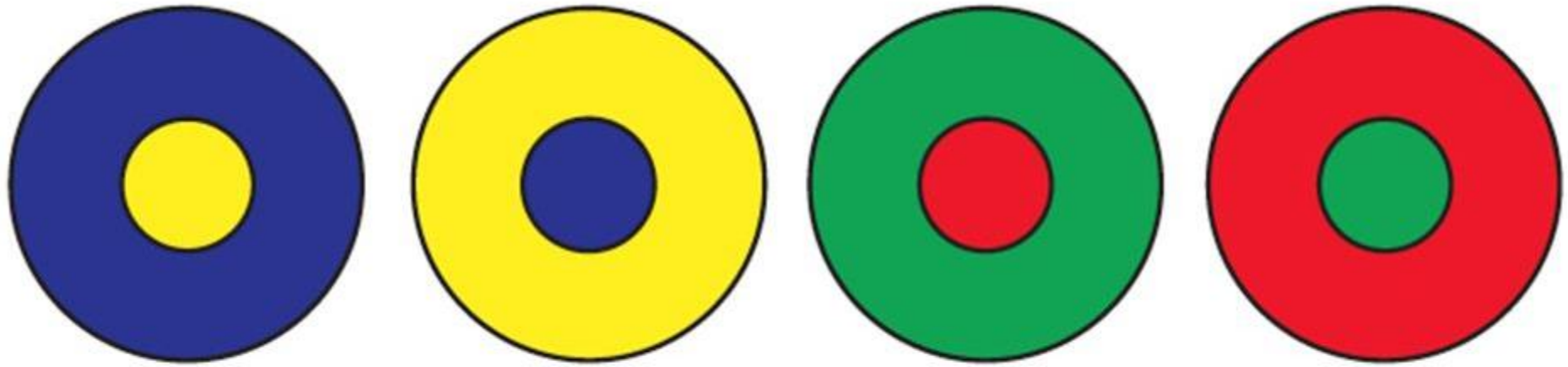
Green: 65

Blue: 199

Red + Blue = Purple
Red + Yellow = Orange
Green + Blue = Turquoise

Red + Green = ?
Blue + Yellow = ?



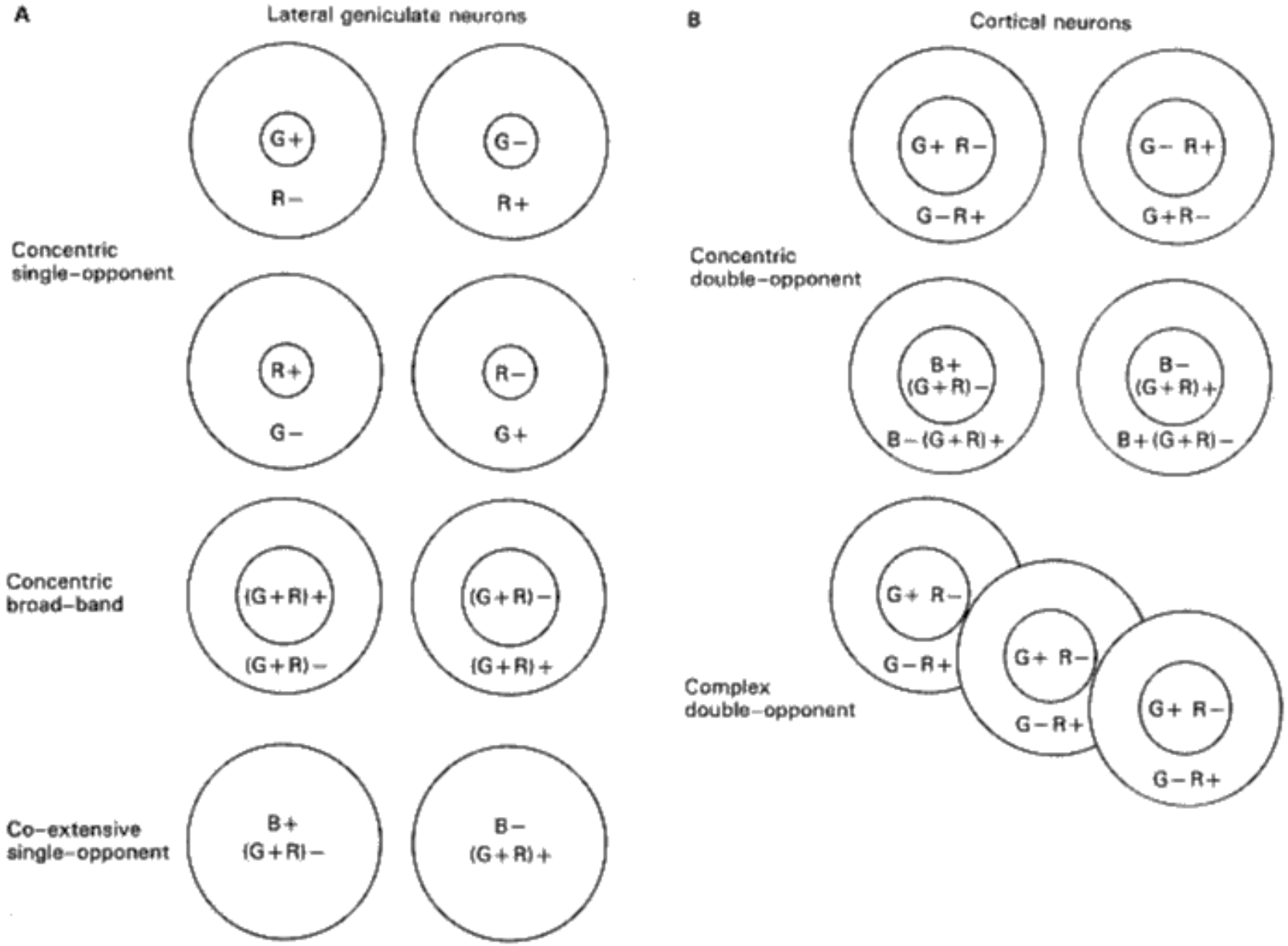


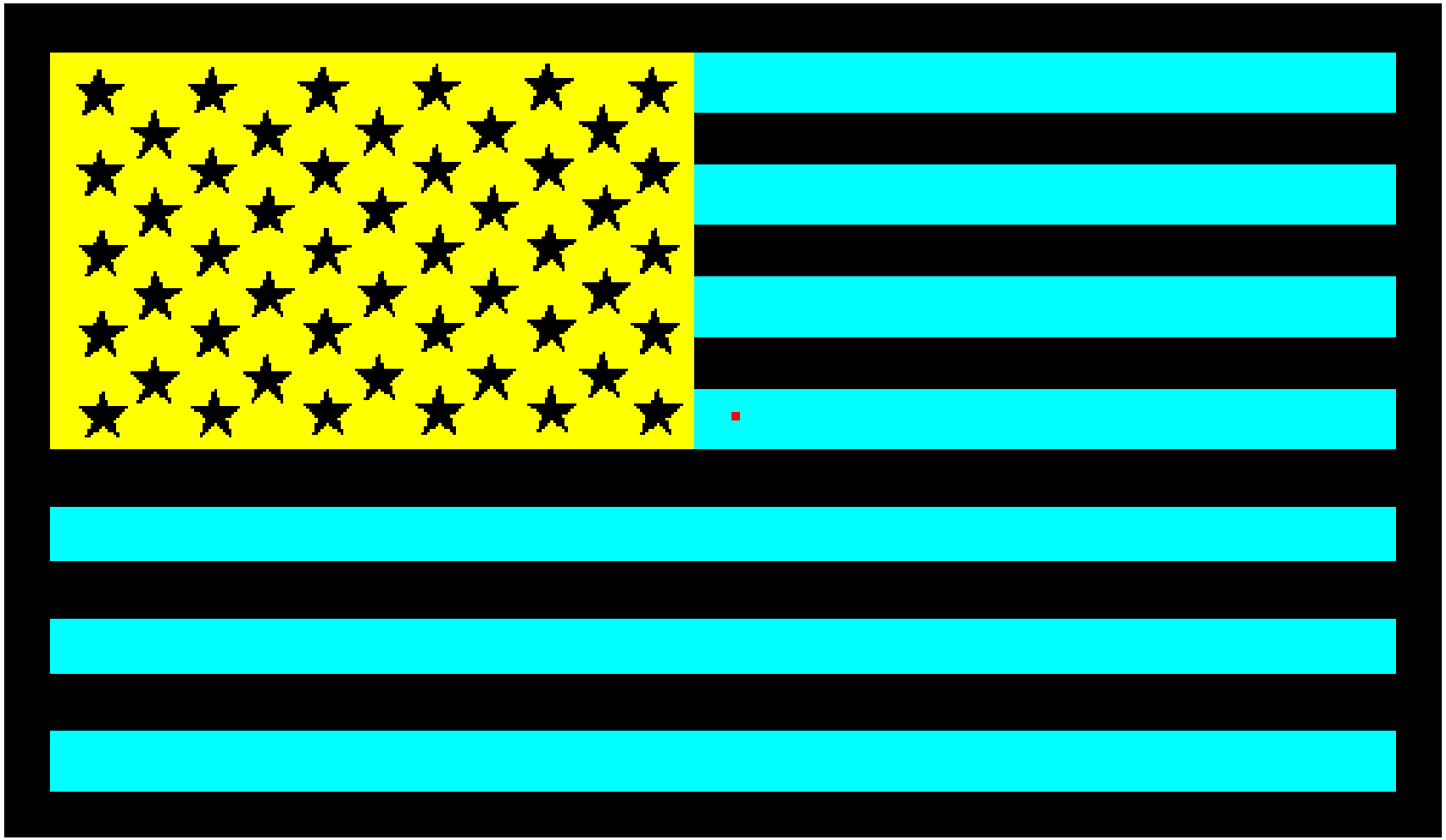
Yellow on, blue off

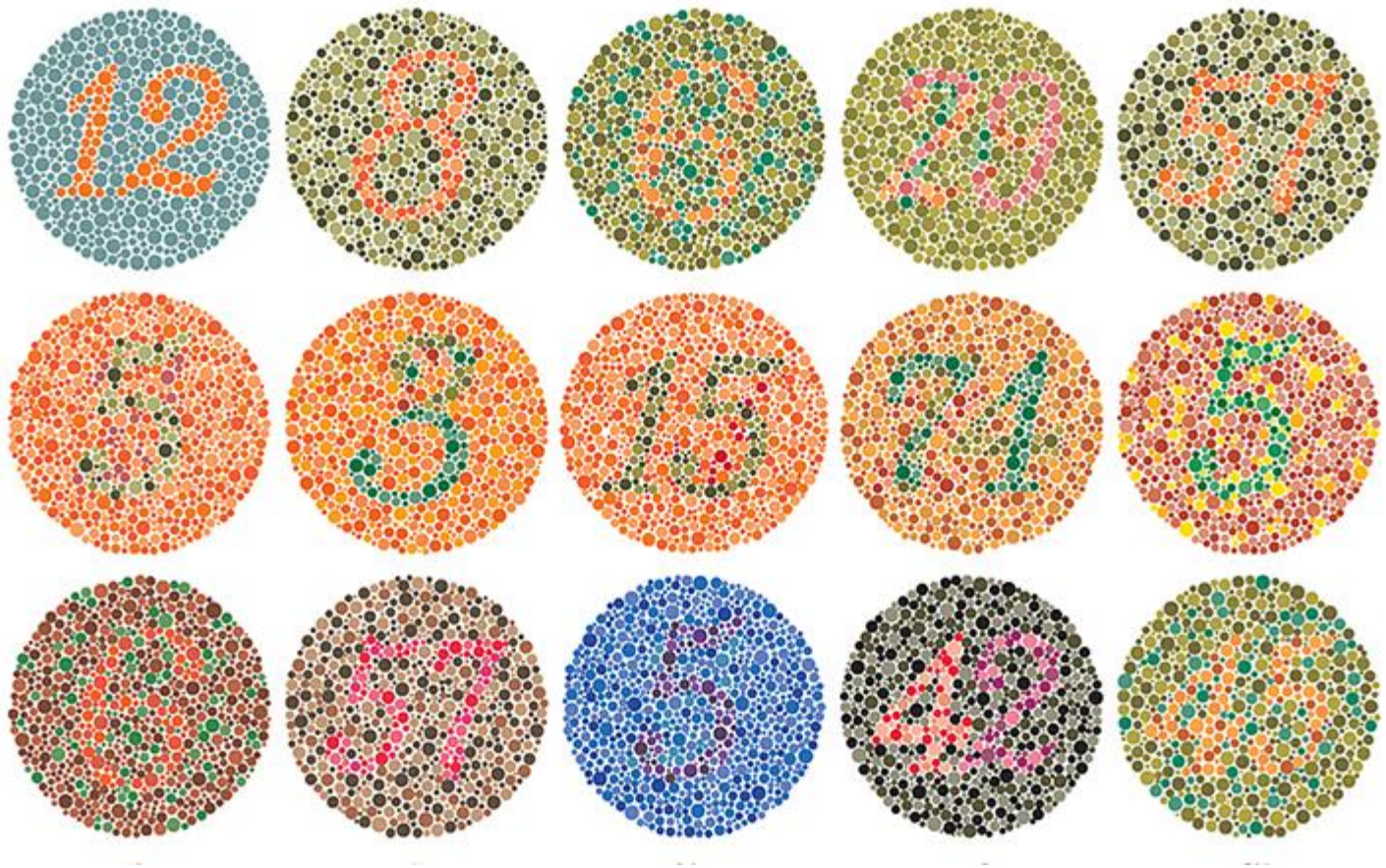
Blue on, yellow off

Red on, green off

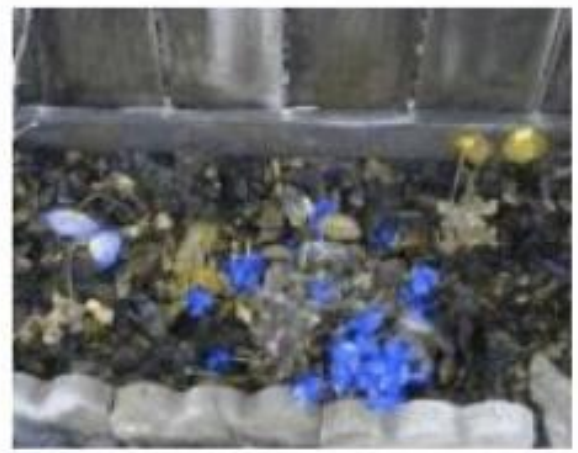
Green on red off


A
Lateral geniculate neurons
G+
R−
G−
R+
Concentric
single-opponent
R+
G−
R−
G+
Concentric
broad-band
(G+R)+
(G+R)−
(G+R)−
(G+R)+
Co-extensive
single-opponent
B+
(G+R)−
B−
(G+R)+
B
Cortical neurons
G+ R−
G−R+
G− R+
G+R−
Concentric
double-opponent
B+
(G+R)−
B−(G+R)+
B−
(G+R)+
B+(G+R)−
Complex
double-opponent
G+ R−
G−R+
G+ R−
G−R+
G+ R−
G−R+

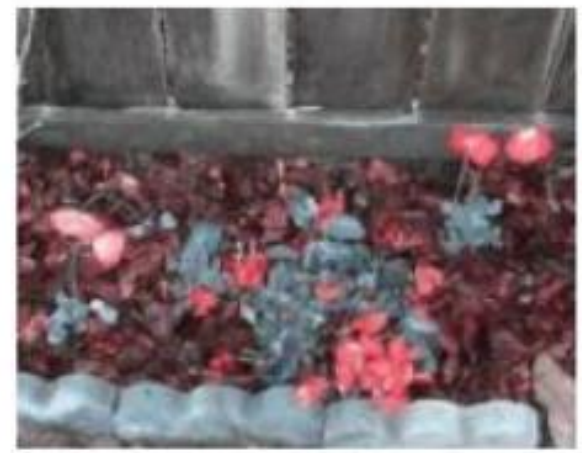



12
8
29
70
35
5
3
16
74
6
45
2
97

normal



red/green color blind



blue/yellow color blind

Color Vision in other Animals

- Dogs have 2 cones (blue & green). They can distinguish red from blue but not red and green.
- Owls have 5xs more rod density than we do.
- Bees and butterflies have 4 cones can see ultraviolet light – flowers have ultraviolet patterns
- Mantis shrimp has 16 kinds of cones can see ultraviolet, infrared, and even polarized light