Announcements

- **MP3** is due on Oct 22.

- **Exam 1** is coming soon: 10/21/2015 7-9 pm in SIEBL 1404

  Textbooks:

  Foundations of Sensation and Perception, by Mather

  Fundamentals of Computer Graphics, by Shirley

  New textbook:

  Virtual Reality by Steven LaValle: msl.cs.uiuc.edu/vr

  Review videos on human eye:

  https://www.youtube.com/watch?v=nbwPPcwknPU

  https://www.youtube.com/watch?v=yzyphSTkW2U

Announcements

Final project upcoming deadlines:

- **Oct 27**, submit two .jpg files as the answer to my piazza post:

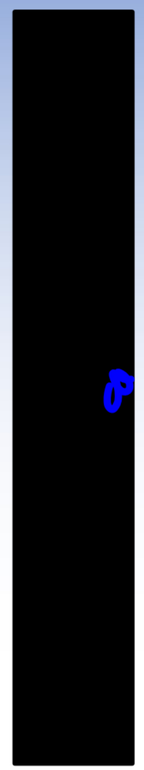
  1. Image for abstract/title. These will be posted on the class webpage: https://courses.engr.illinois.edu/cs498sl/gallery.php

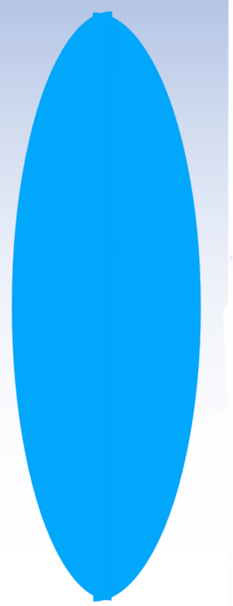
     You are showing the world what is possible!
     http://csctr.cs.umd.edu/
  2. Snapshot of your first scene for the final project in Unity

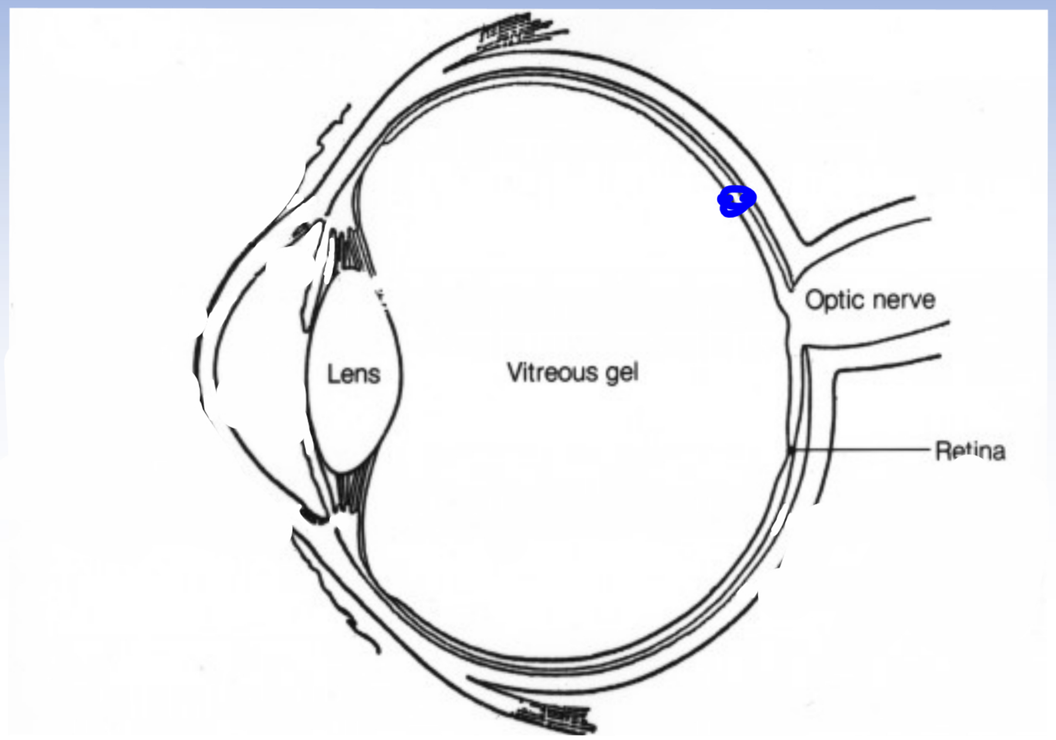
- **Nov 3**, a short video of your progress.

Unity Tutorials: Wed Oct 14 6pm , Th Oct 15 6pm

Eye Motion and VR: 3. Interaction with Photoreceptors







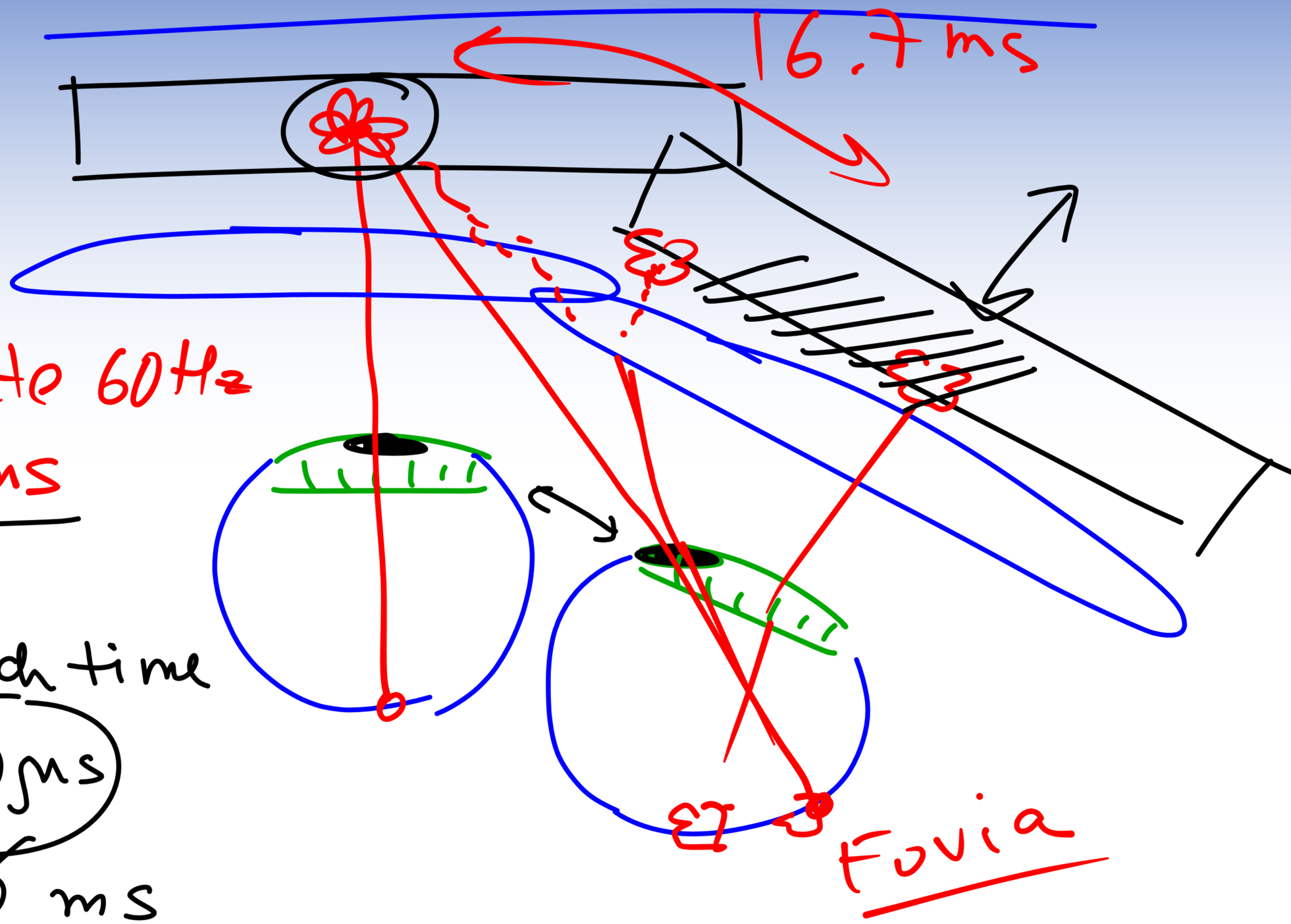
low-persistent display

1. Pixels on the display switch their color/intensity at some non-zero rate.
2. There is RGB sub pixel structure.
3. Frames might be off (black) at particular times.
4. Asynchronous (line-by-line) display scan out.
5. Photoreceptors are slow to respond. It takes them about 0.1-0.2 seconds to respond.
6. All of the eye movements shift the image on the retina.

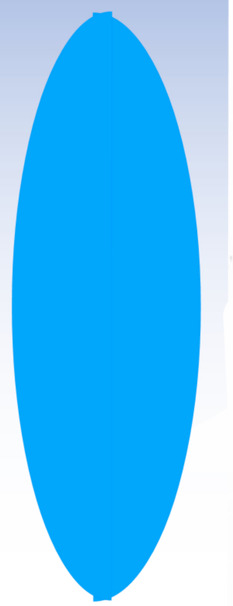
VOR and HMD

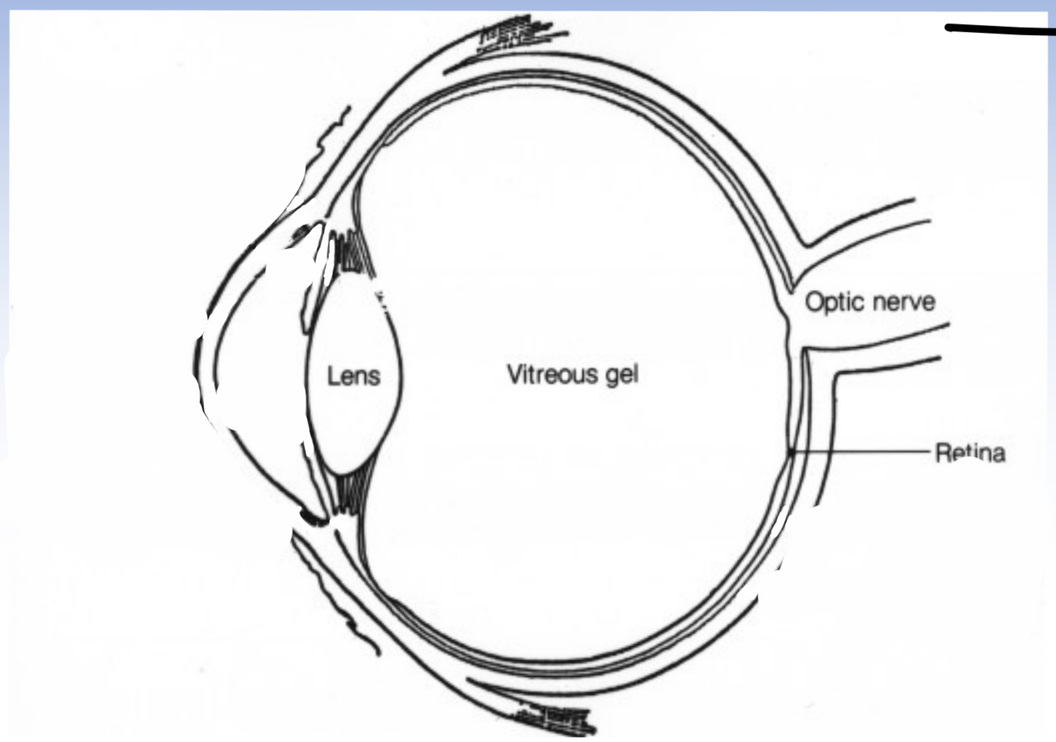
Frame Rate 60Hz
↝ 16,7 ms

judder
pixel switch time
oLED: ~~30~~ ms
LCD : ~~20~~ ms

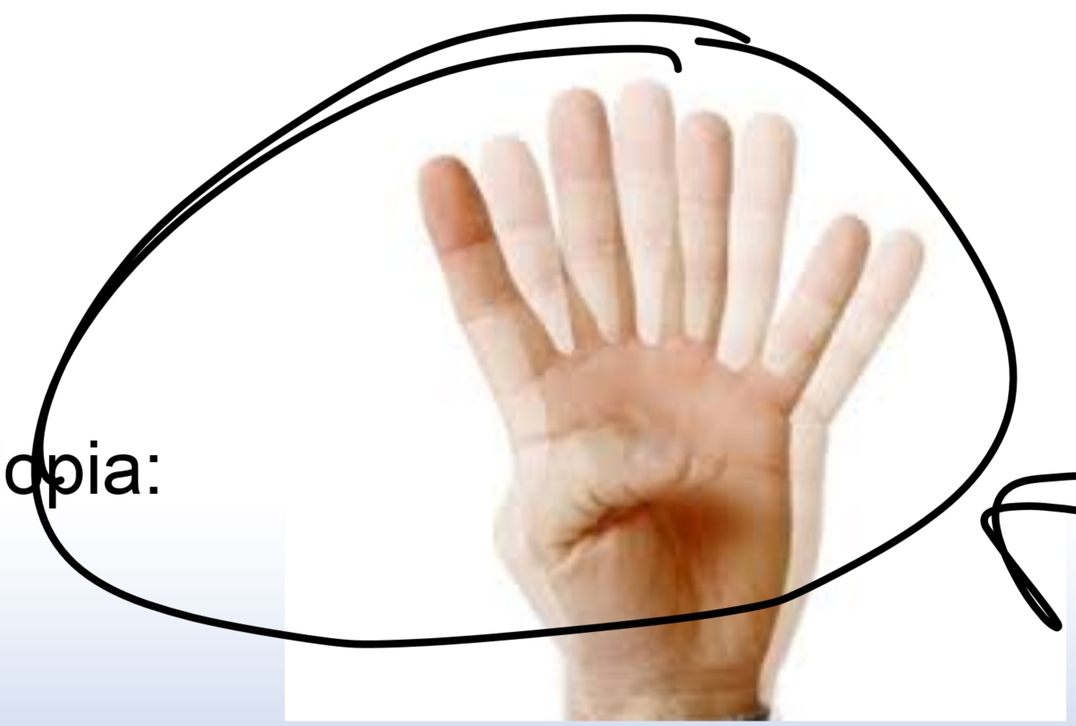


Eye Motion and VR: 4. Vergence : diverg. converg.



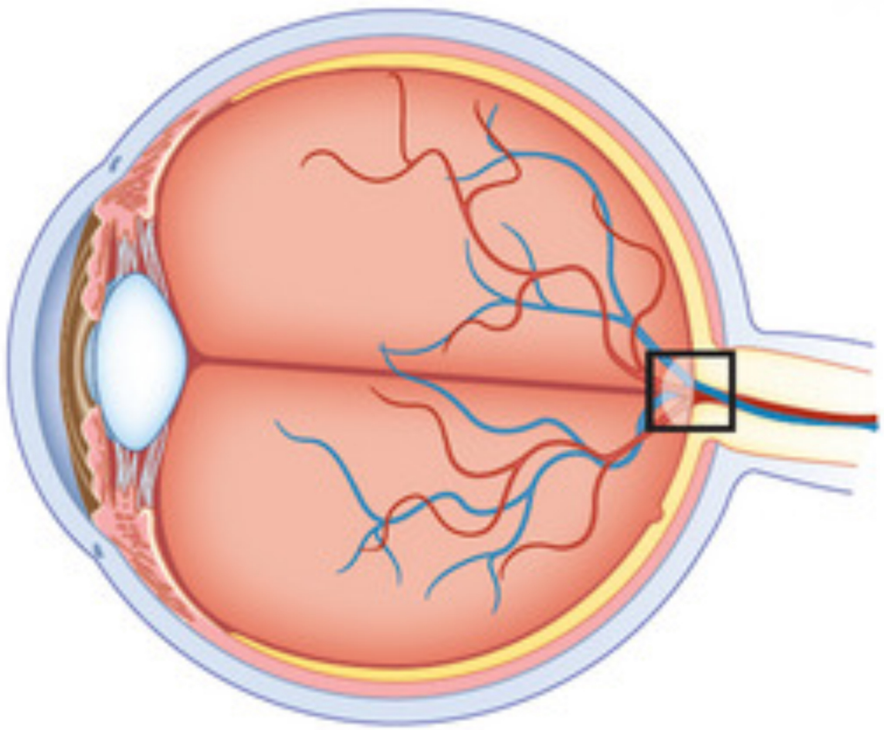


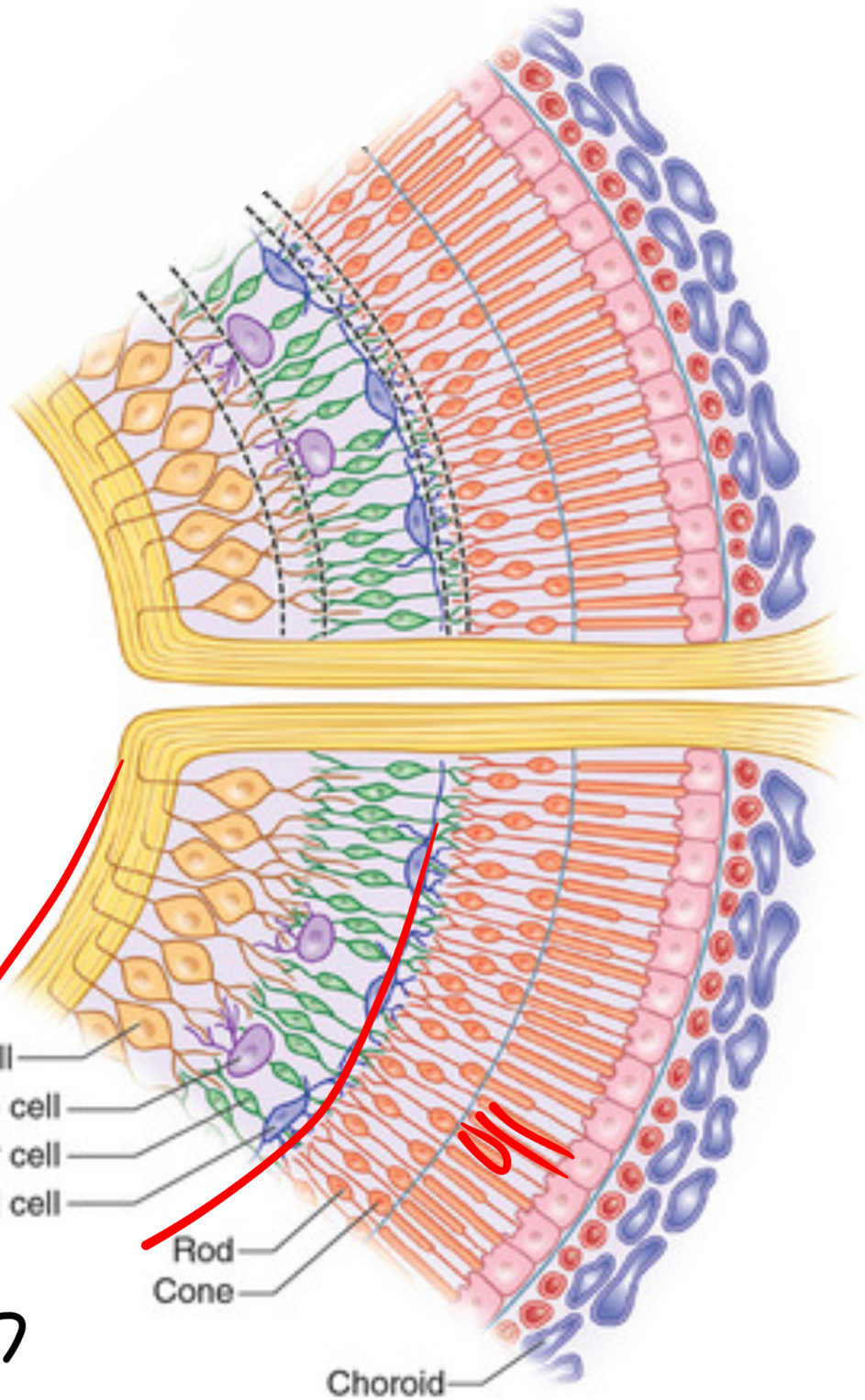
Diplopia:



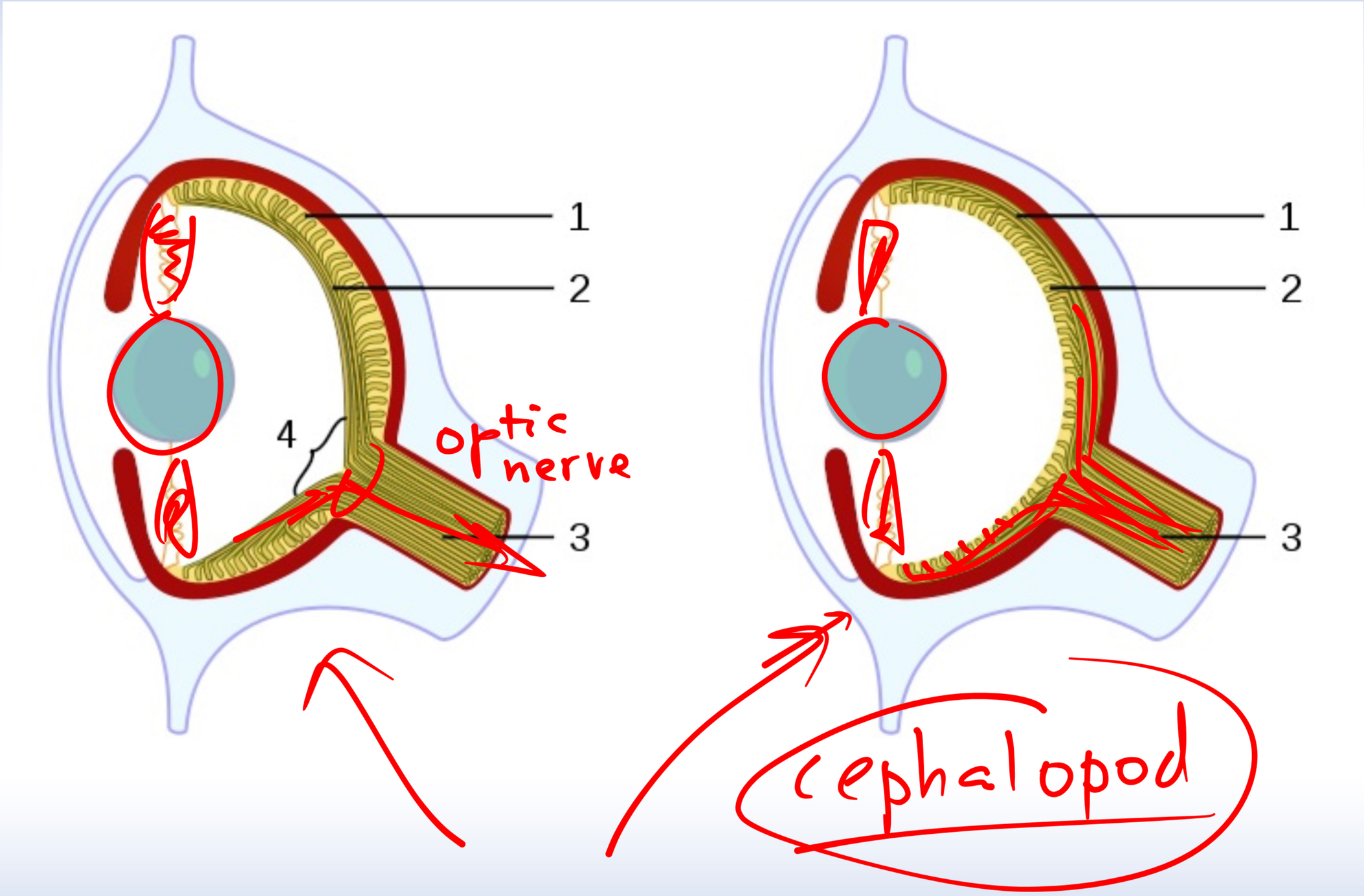
tightly coupled with ciliary muscles

Switching Gears: Human Perception

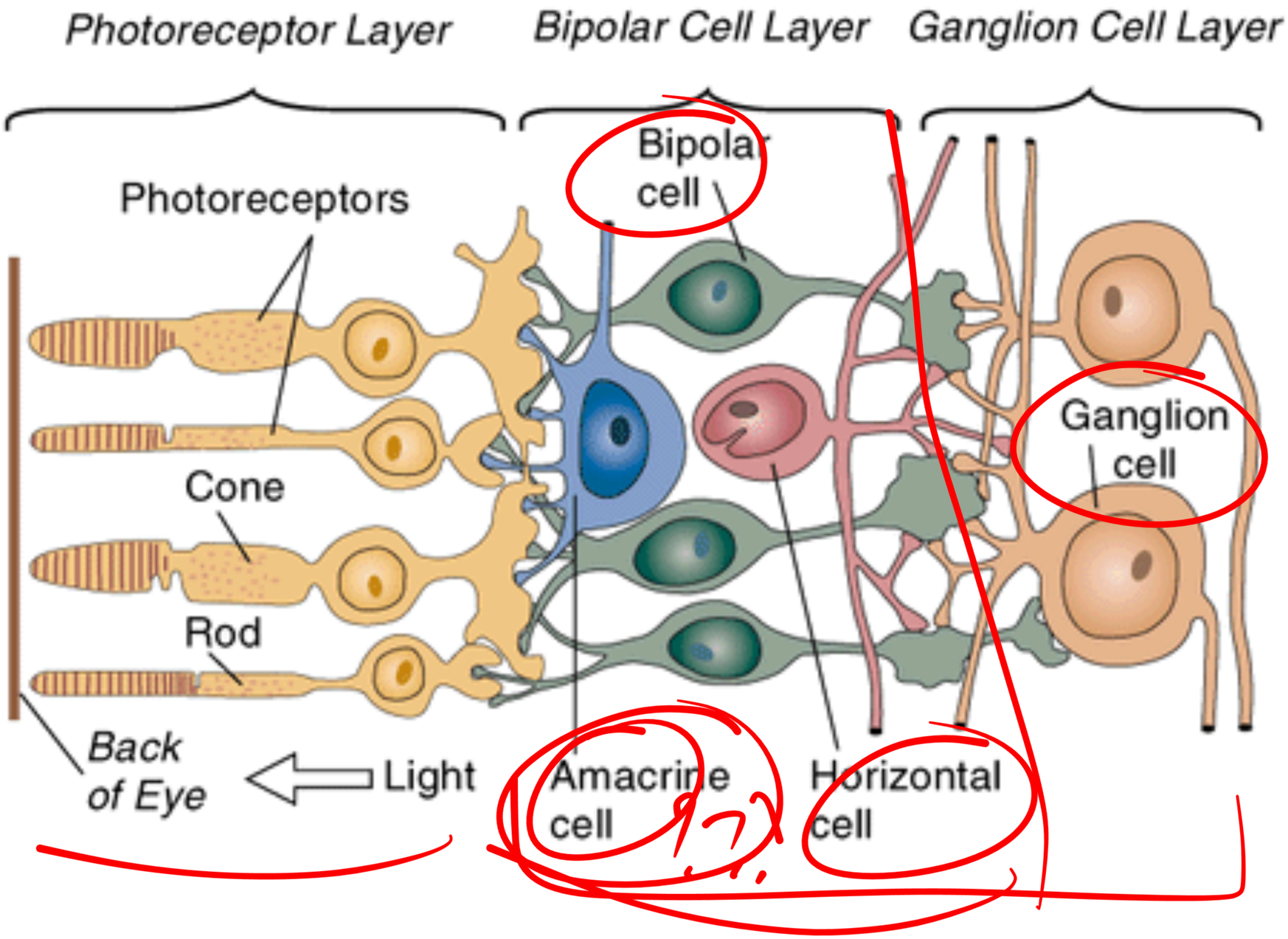




Evolution Choice for Humans

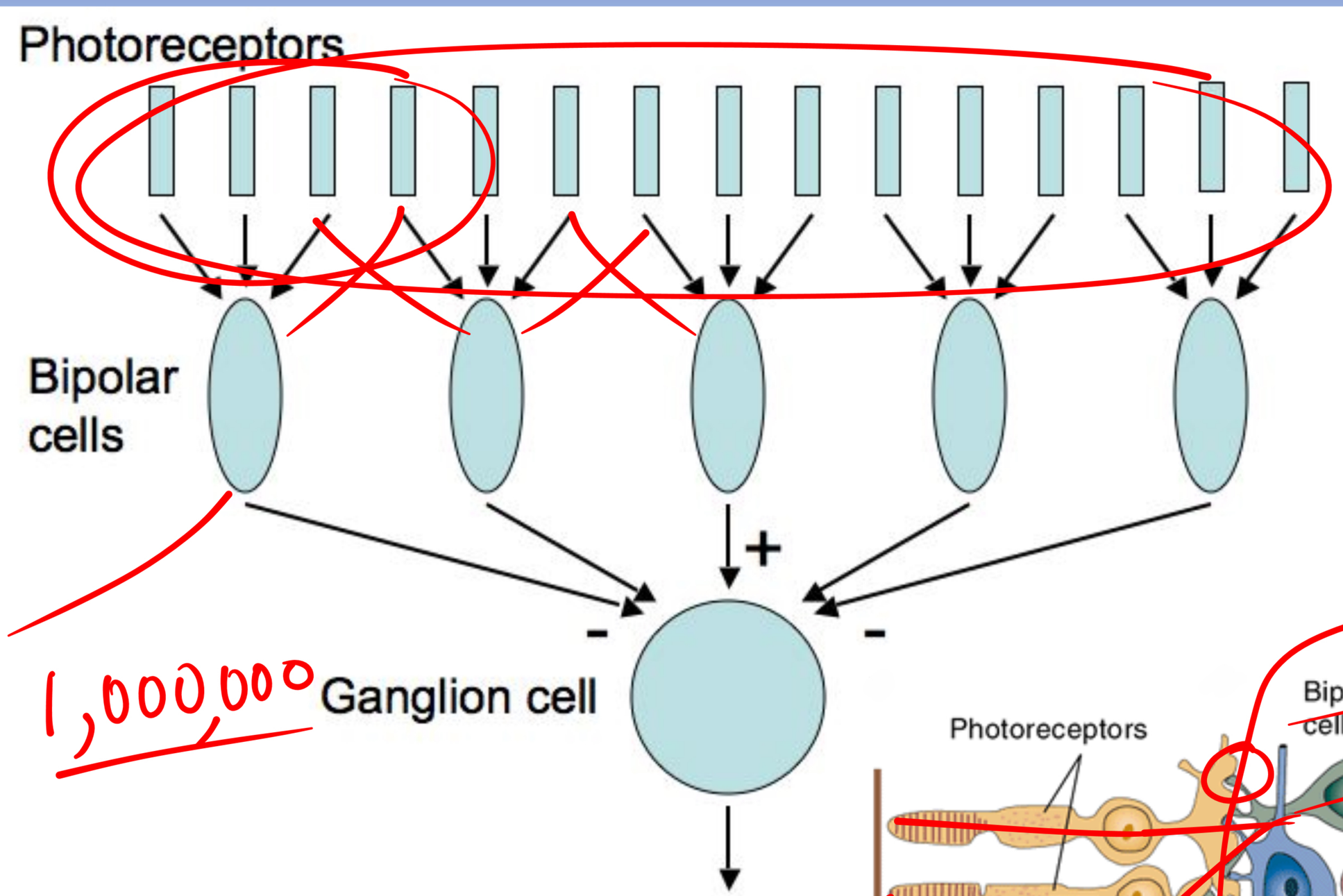


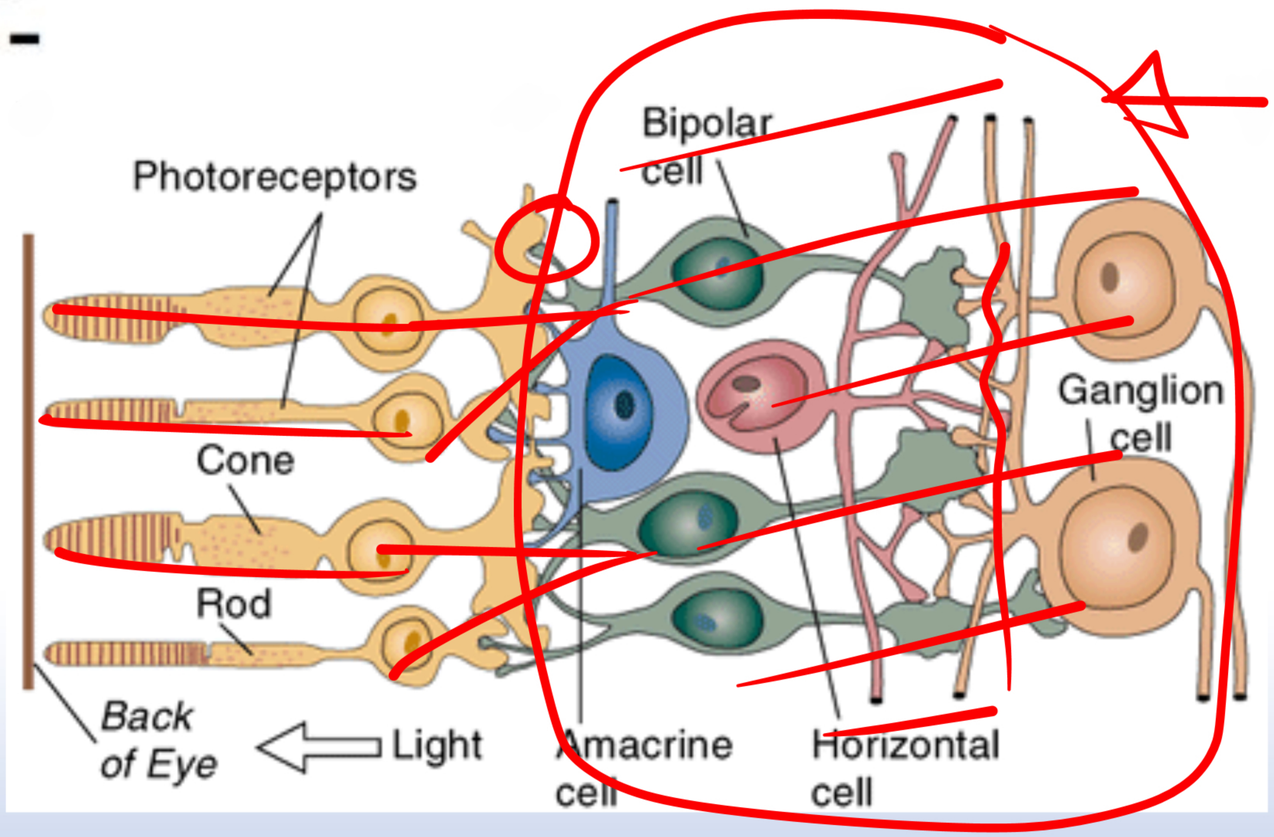
Retinal Circuitry



Source: Adapted from Dowling, J. E., and Boycott, B. B. *Proceedings of the Royal Society of London, B.*, 1966, *166*, 80–111

Hierarchical Processig: Receptive Field Model





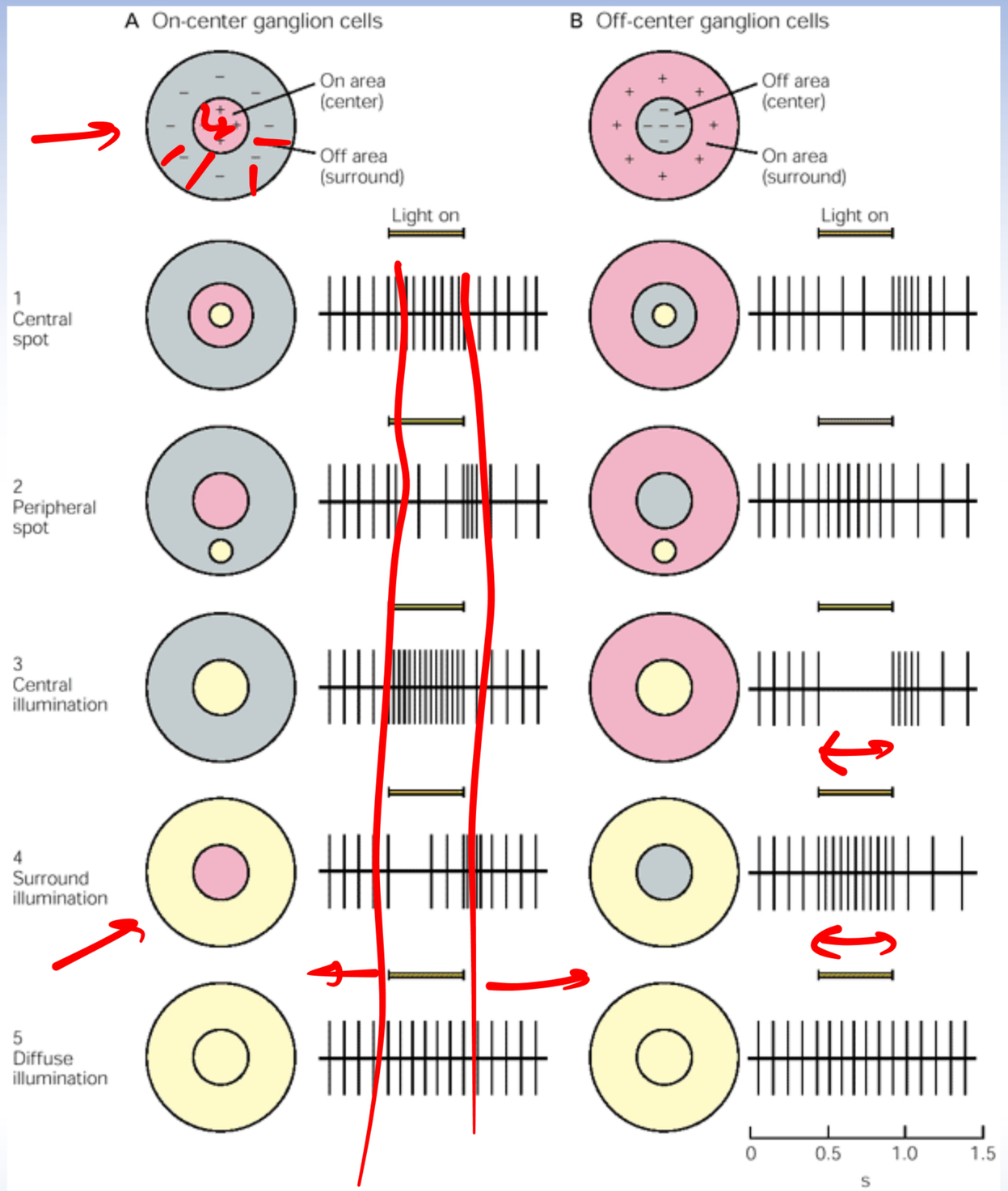
Ganglion Cells Response to Edges

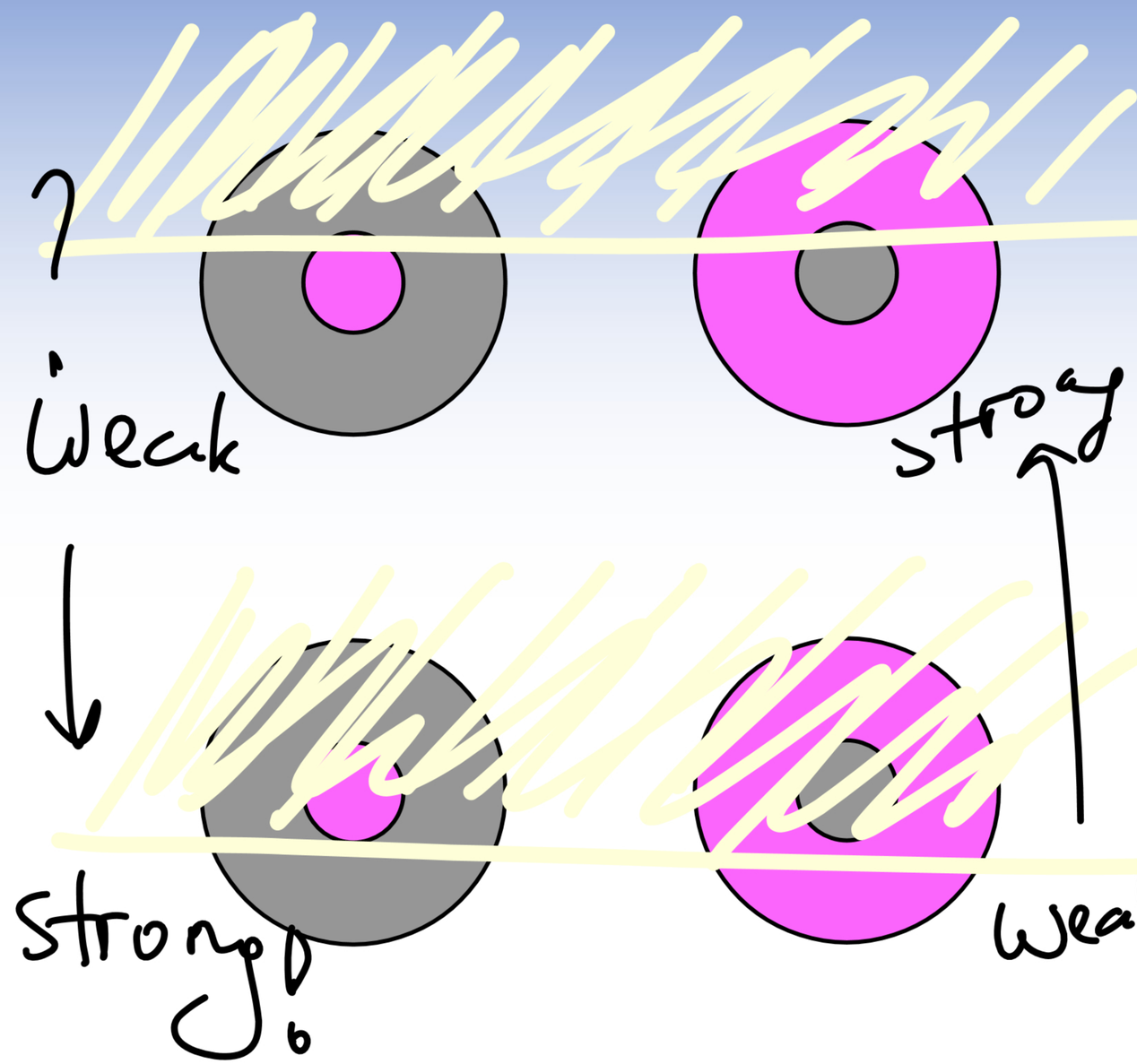
Input image
(cornea)

"Neural image"
(retinal ganglion cells)

Center-surround receptive fields: emphasize edges.

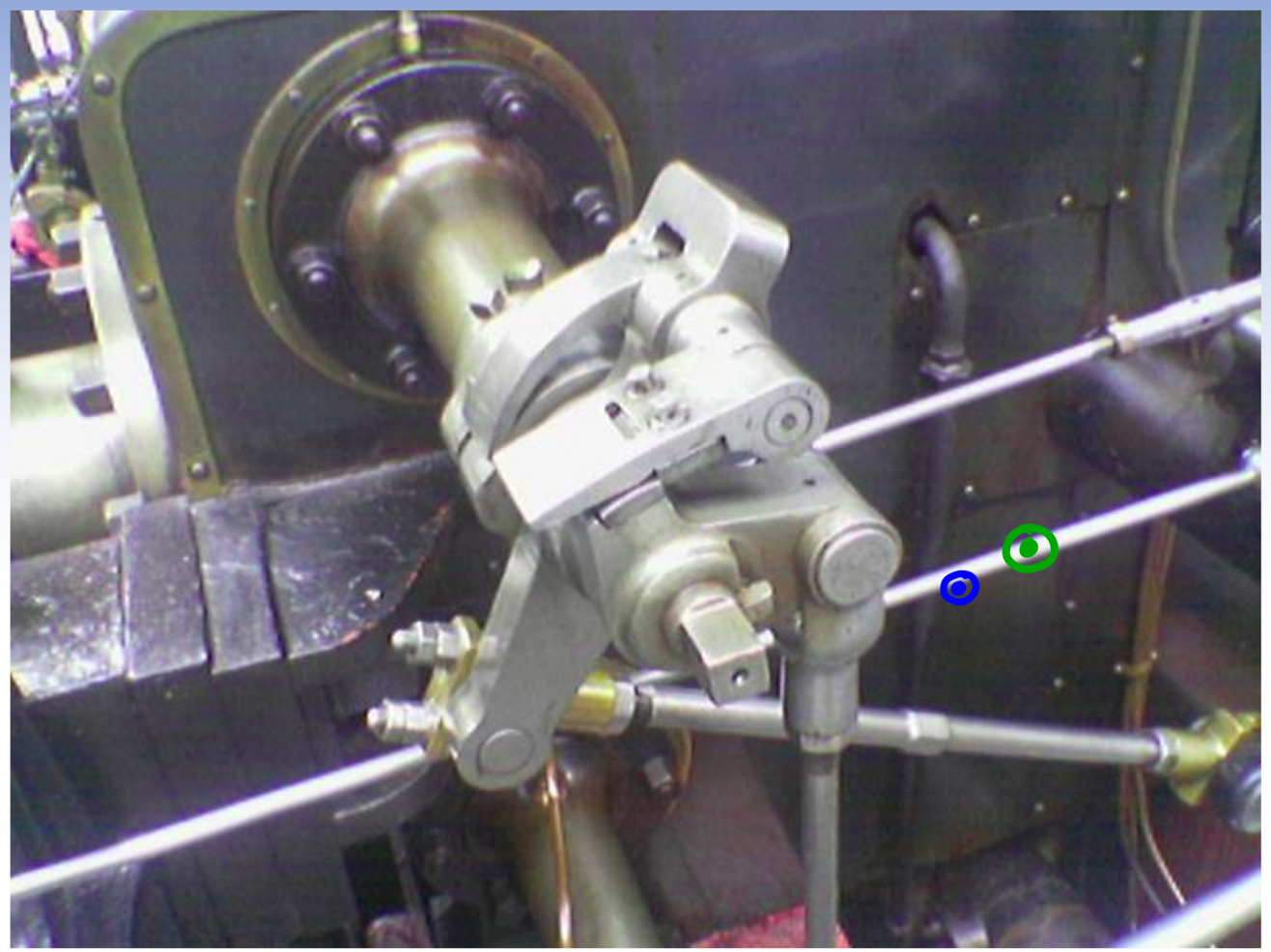
Receptive Fields of Ganglion Cells





https://www.youtube.com/watch?v=8nSLz4Kx7sg

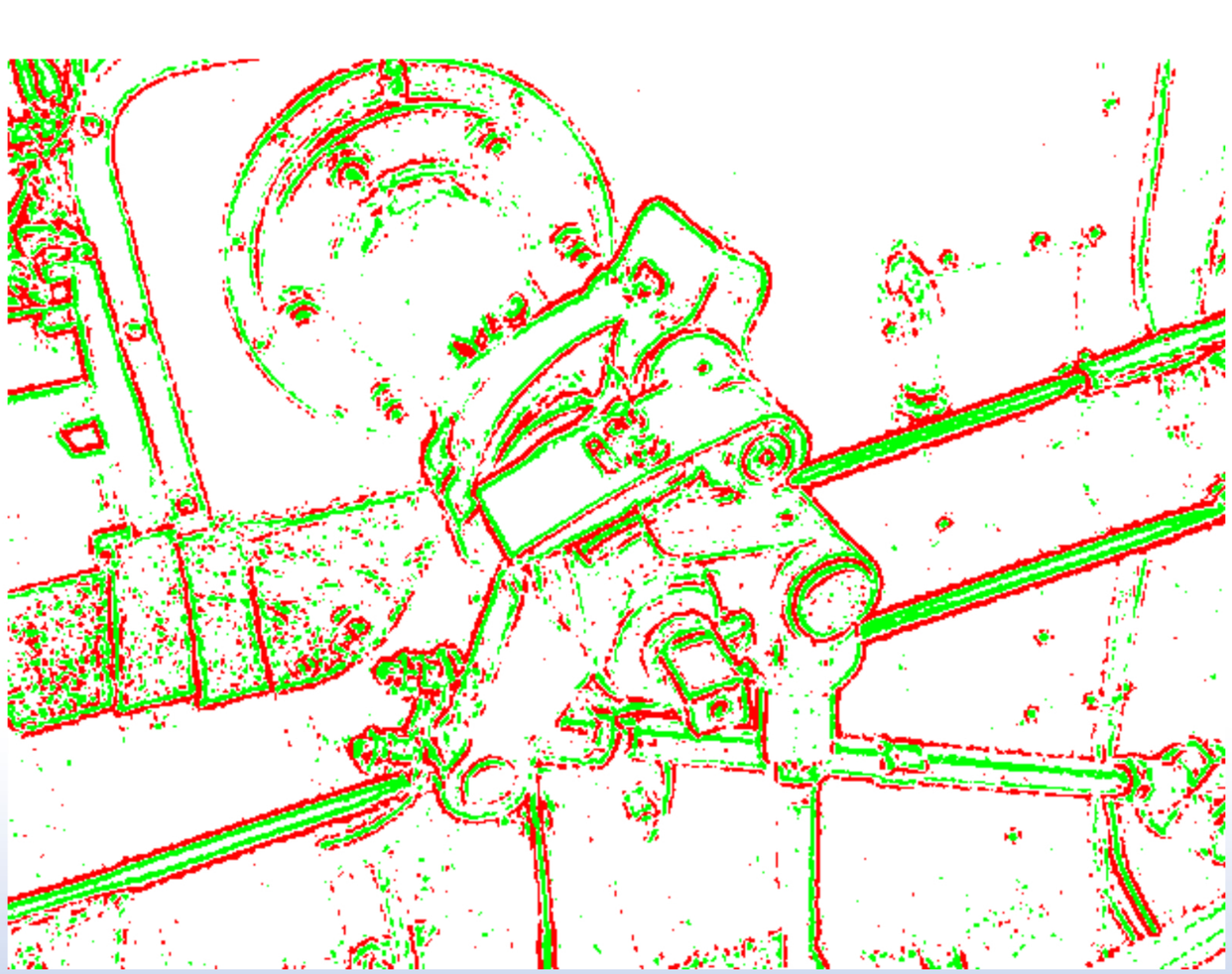
Ganglion Cells Preprocessing of an Image



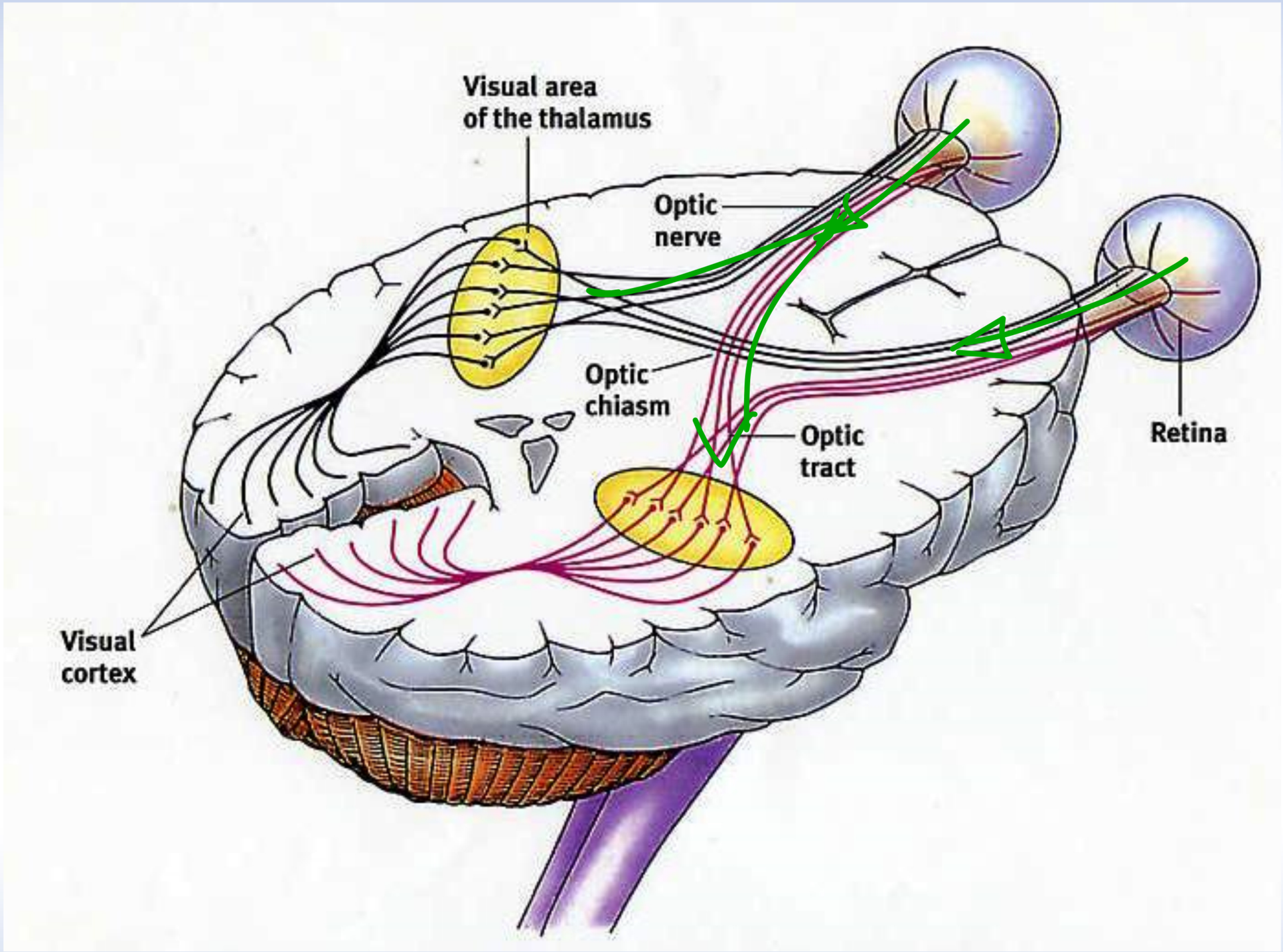
green — on center

red — off center

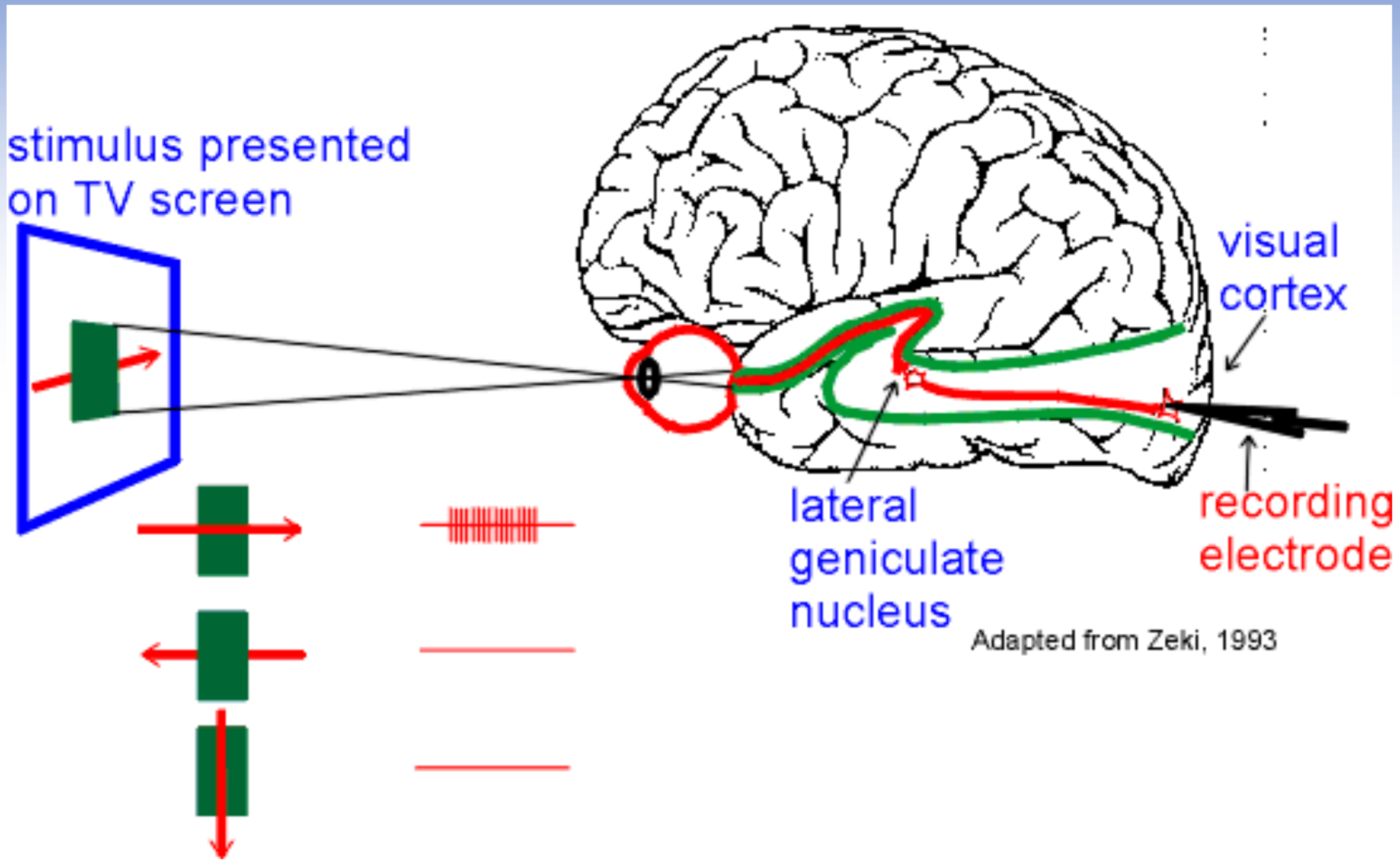
neural image →



Hierarchical Processing: Visual Pathways



Single Unit Recording



Adapted from Zeki, 1993

Single Unit Recording

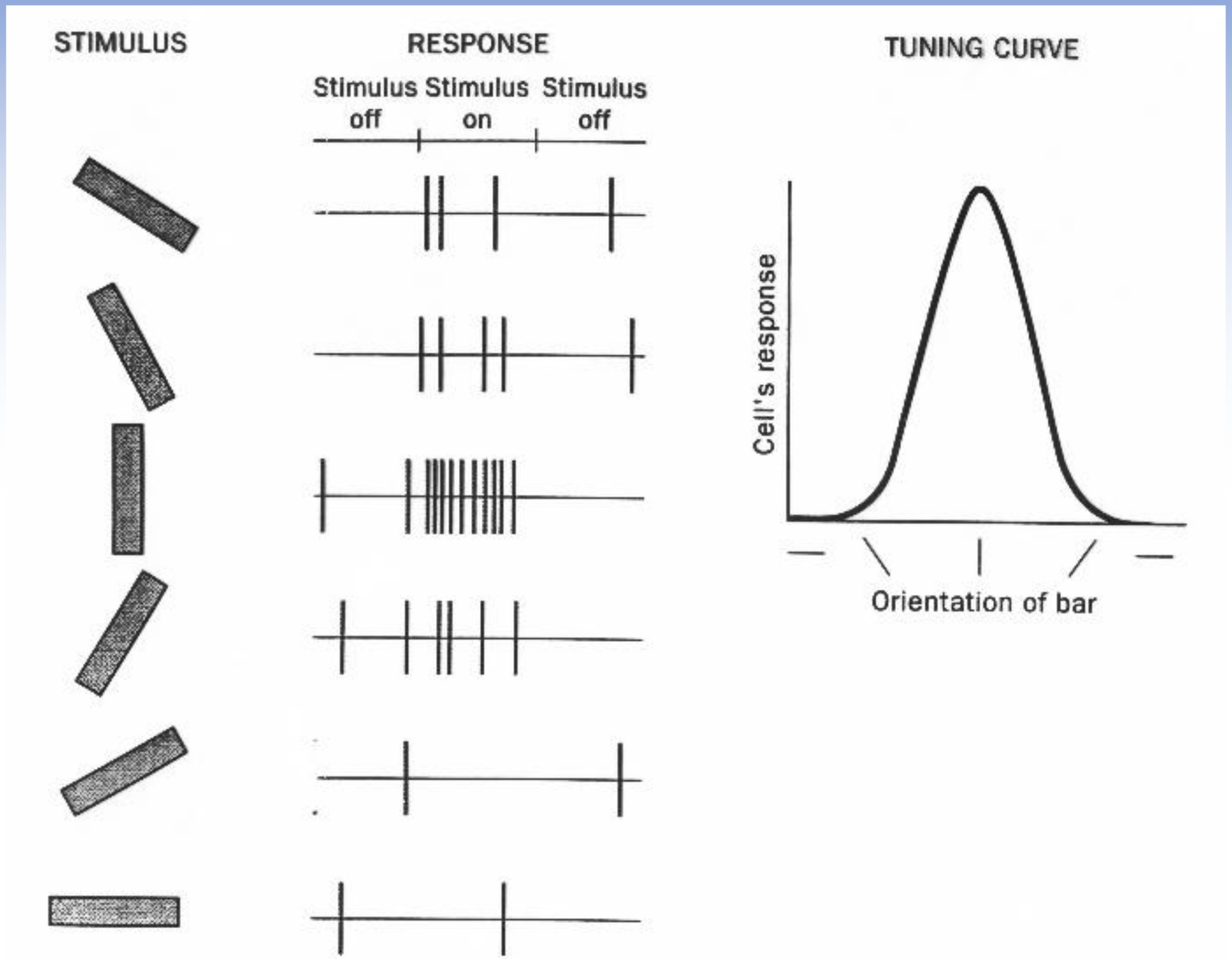


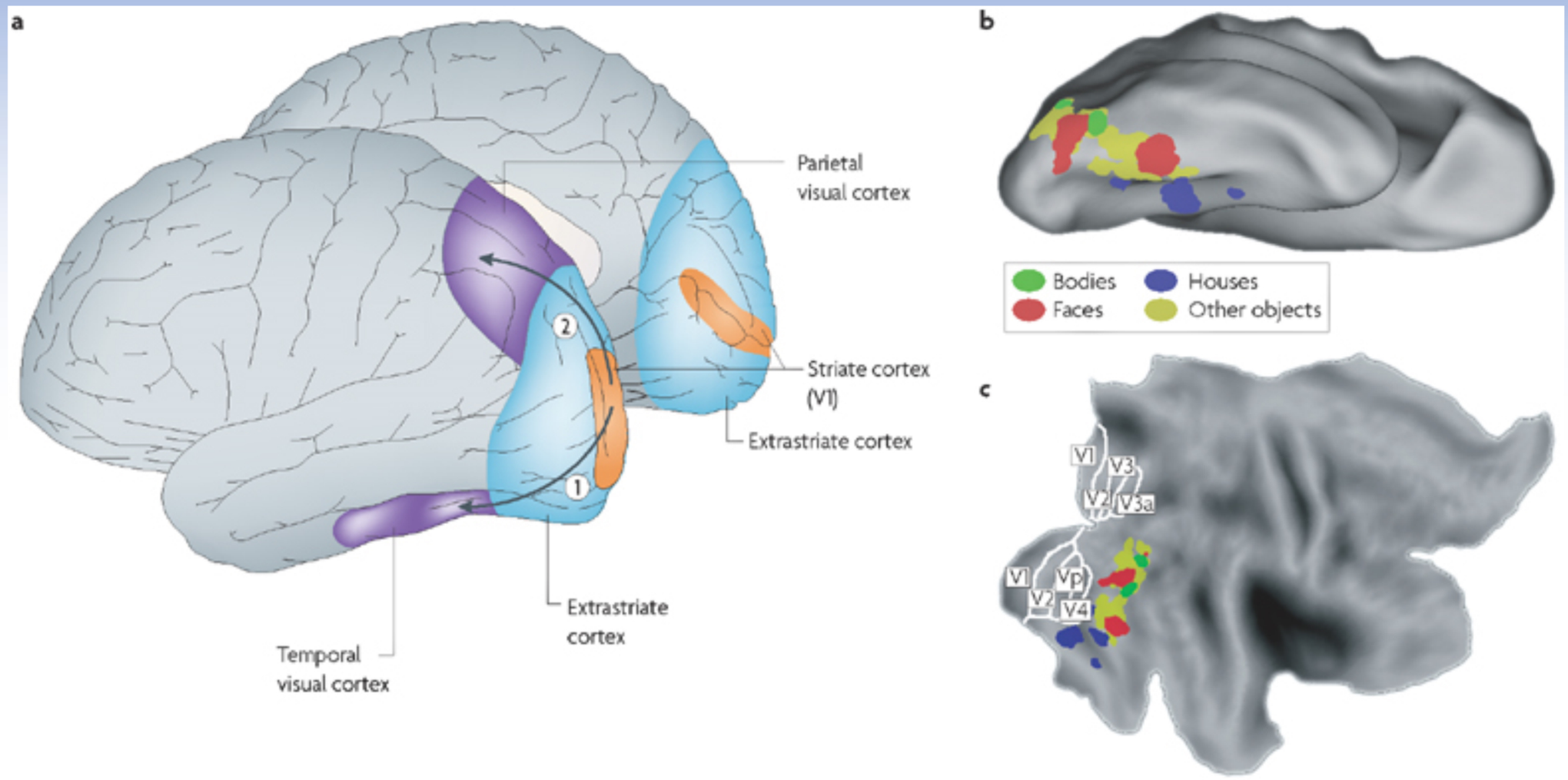
FIGURE 4.8 Response of a single cortical cell to bars presented at various orientations.

Hubel and Wiesel experiments

https://www.youtube.com/watch?v=KE952yueVLA

https://www.youtube.com/watch?v=Cw5PKV9Rj3o

Visual Cortex Hierarchy



Nature Reviews | Neuroscience

Depth Perception: Depth Cues

Importance to VR: If we present enough depth cues to the brain, the brain can be tricked into doing the computations instead of GPUs and CPUs!!!

Depth Perception:

***SENSATION & PERCEPTION 3e,* Figure 6.12**

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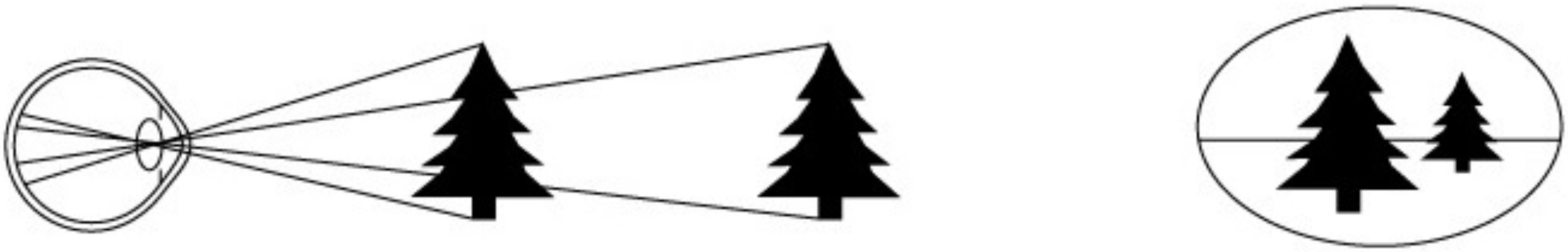
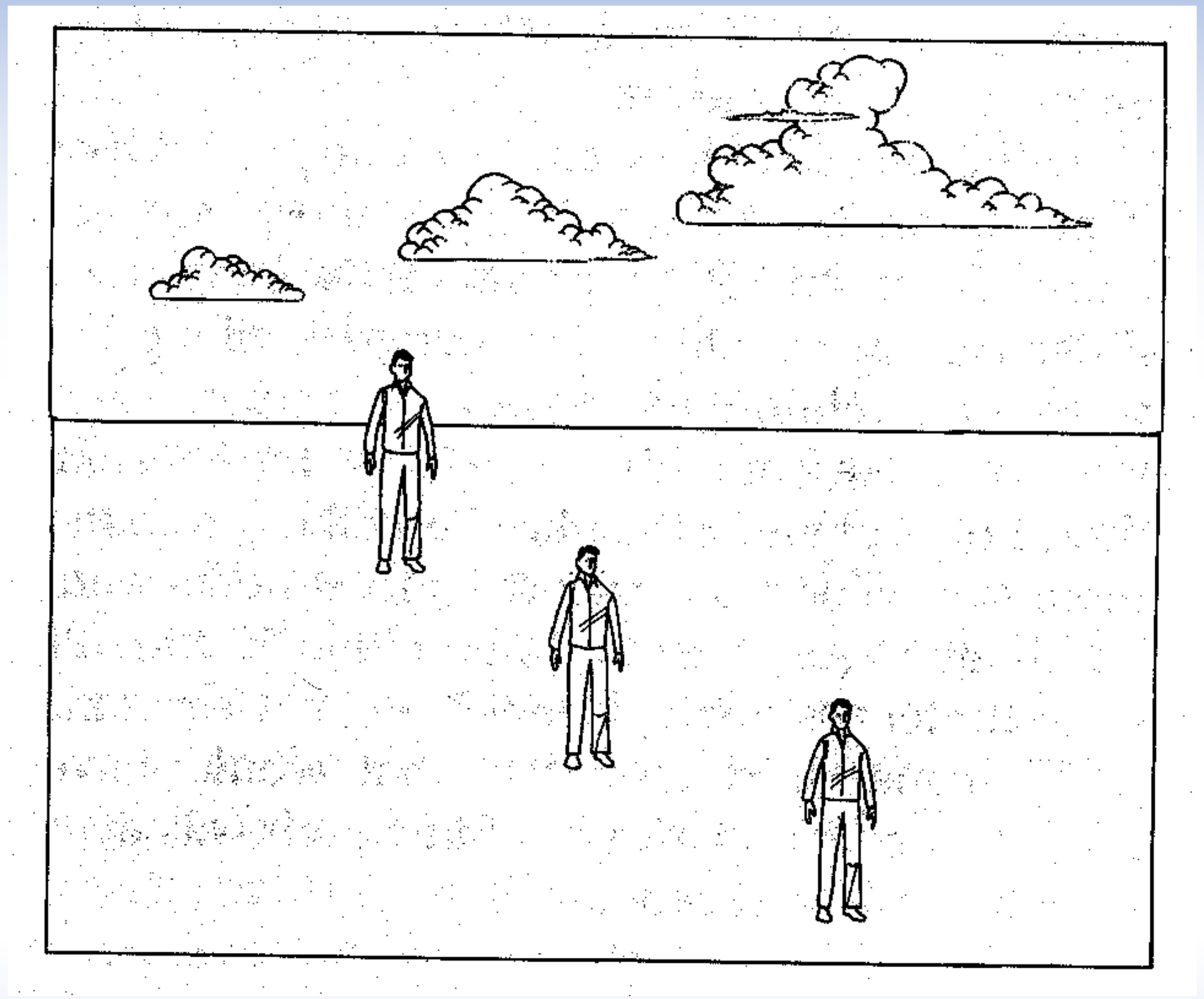
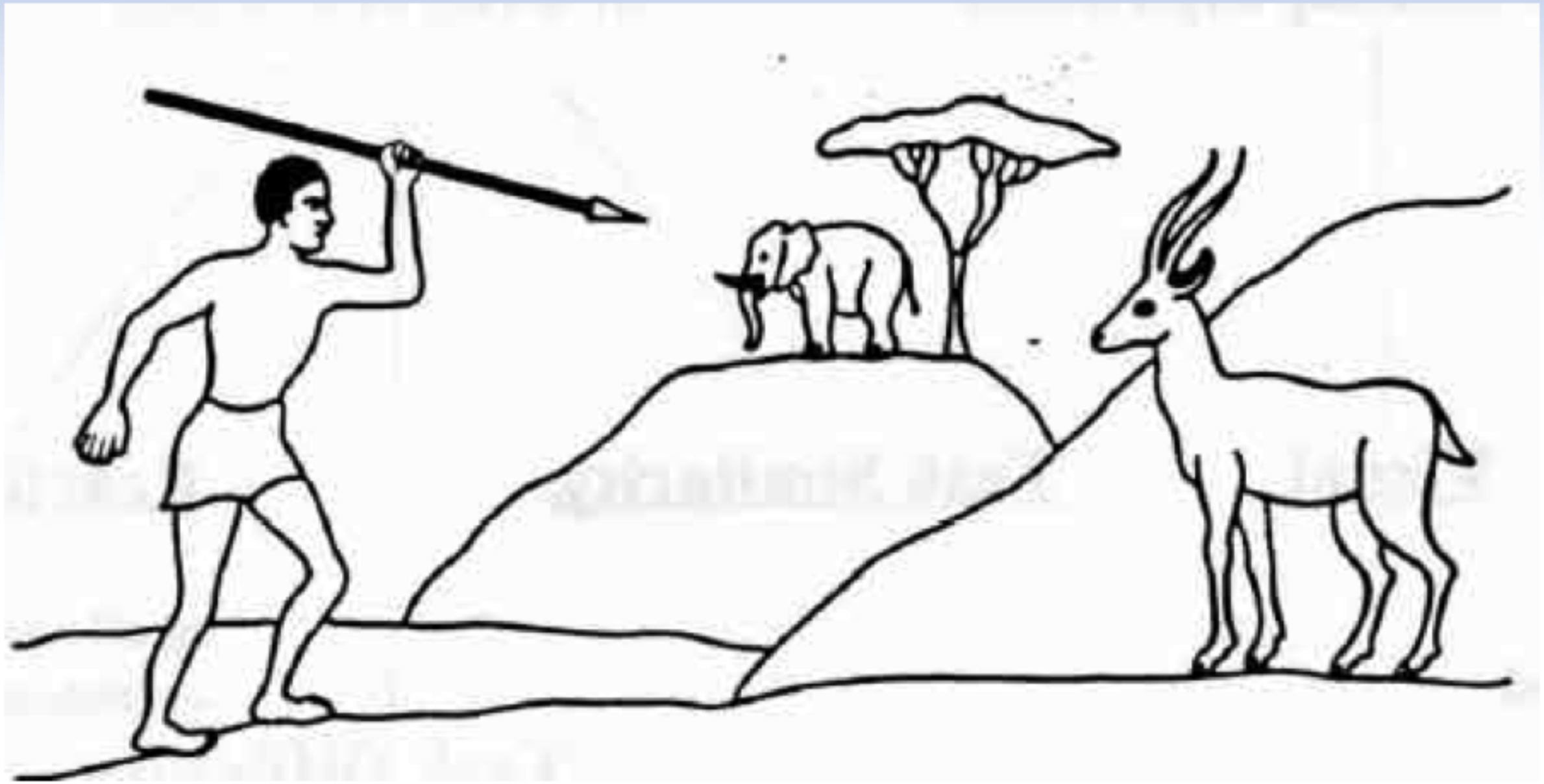


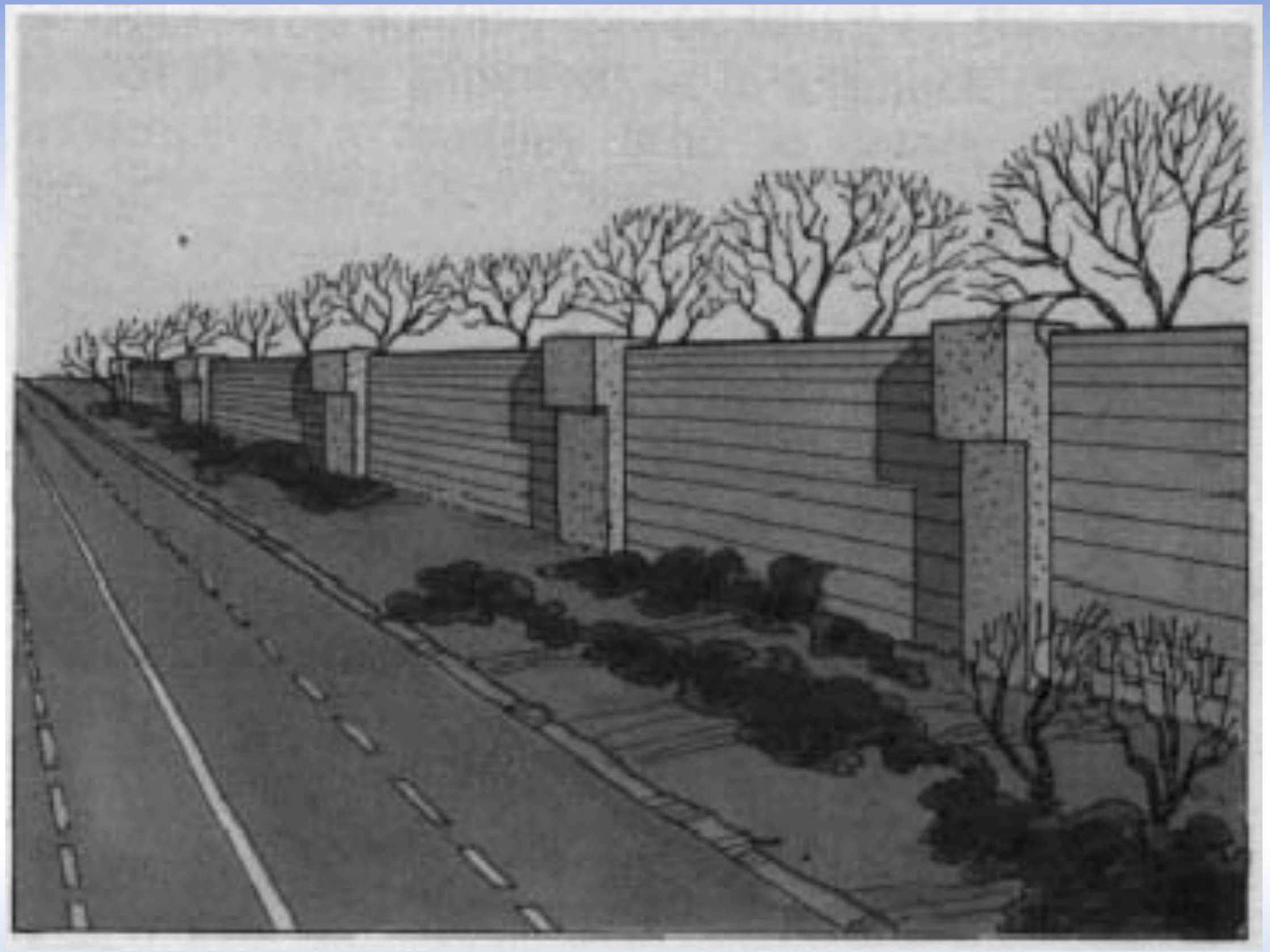
Depth Perception:



Depth Perception:

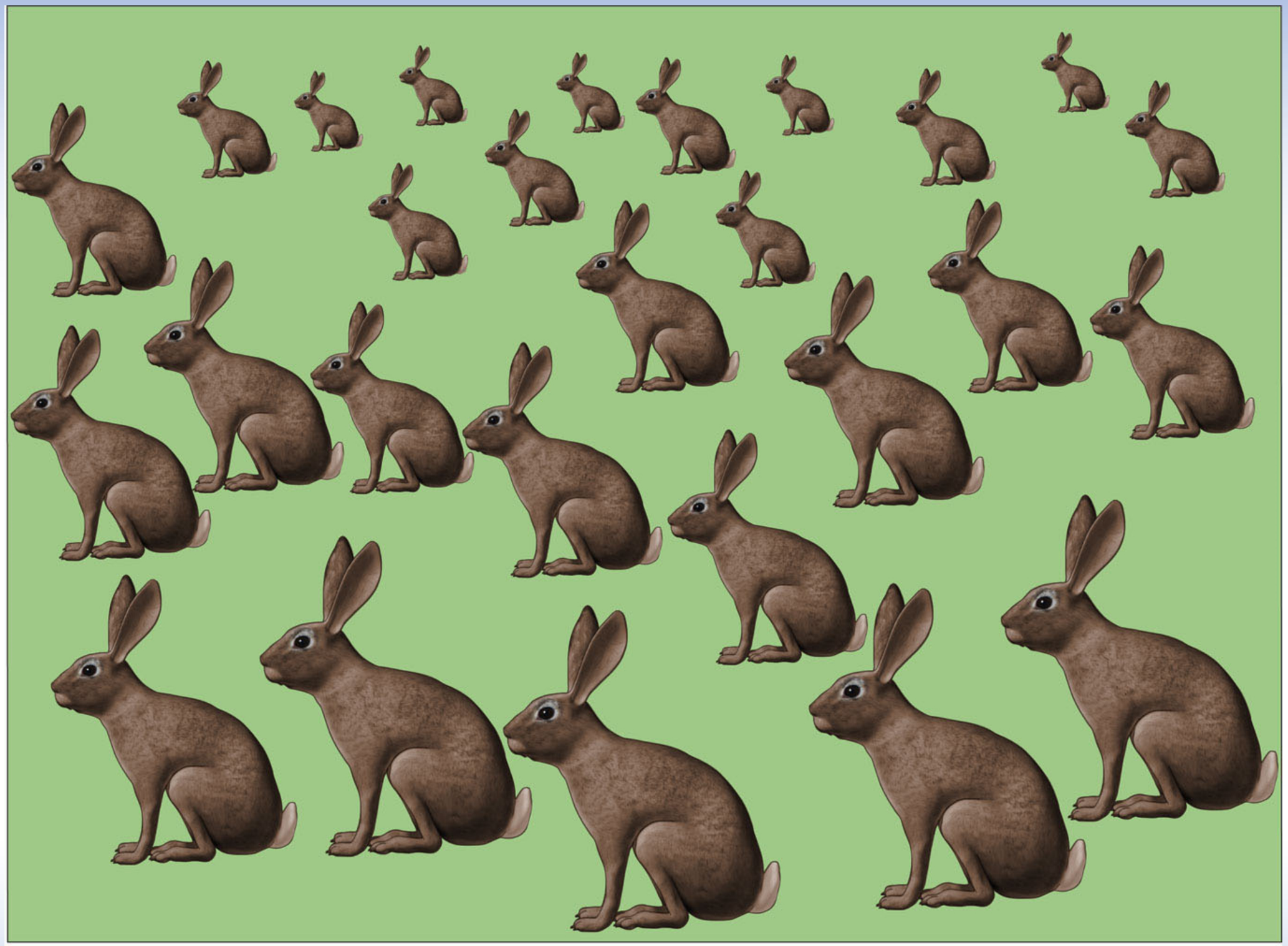


Depth Perception:



Depth Perception:

Depth Perception:



***SENSATION & PERCEPTION 3e*, Figure 6.8**

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Depth Perception:

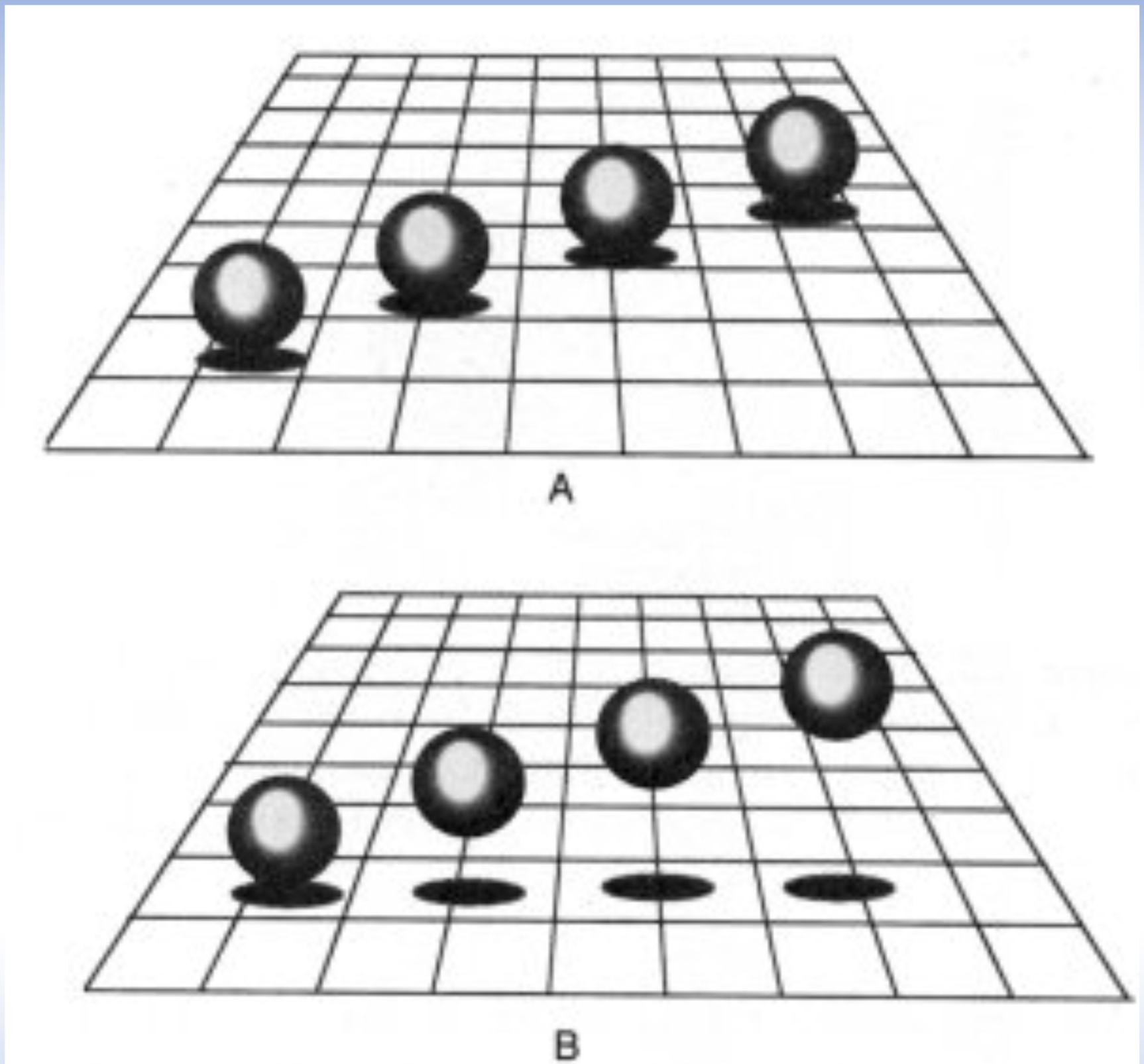
Have you seen VR experiences taking advantage of this? Be the fist one!

Depth Perception:

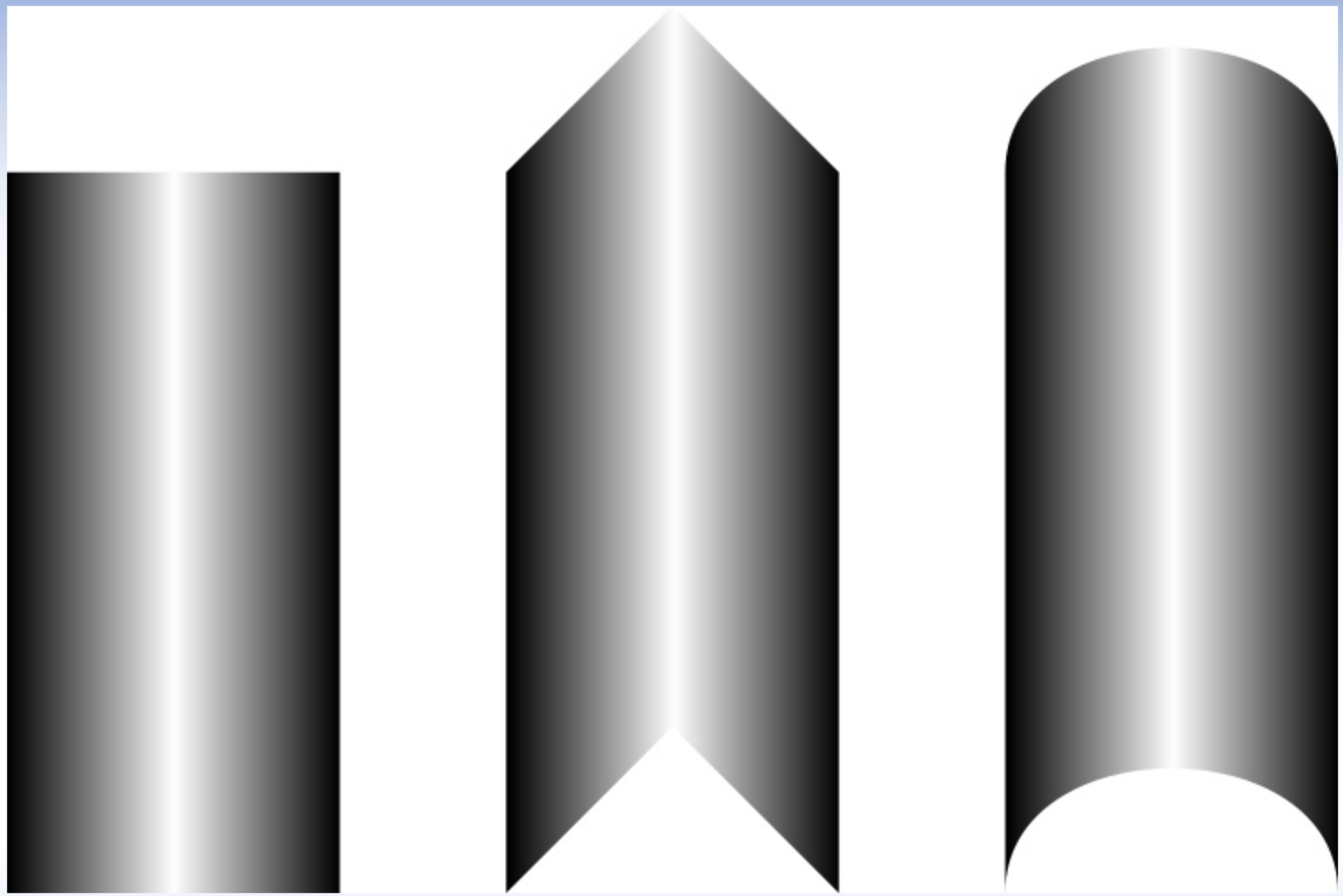
Have you seen VR experiences taking advantage of this? Be the fist one!

Depth Perception:

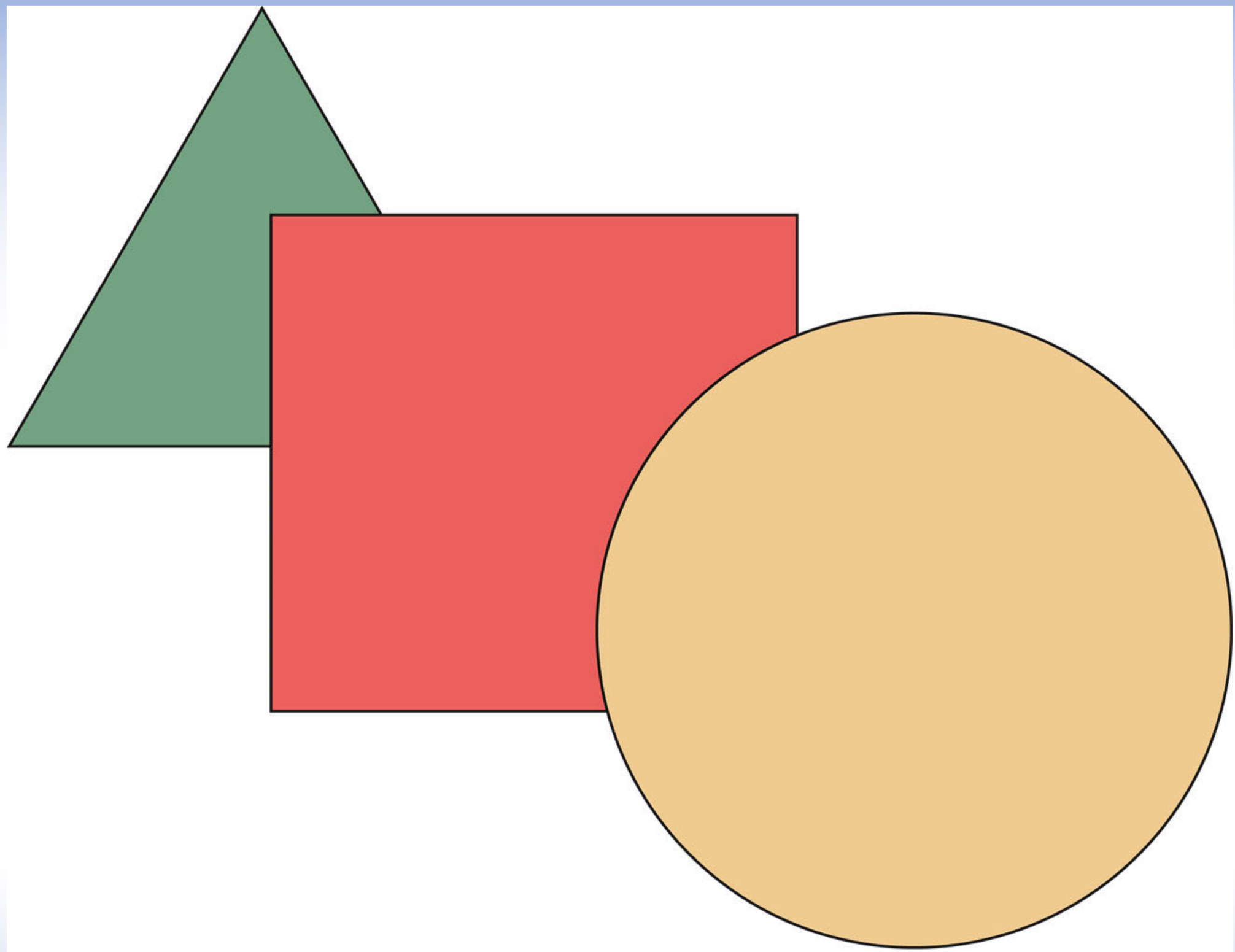
Depth Perception:



Depth Perception:



Depth Perception:



***SENSATION & PERCEPTION 3e,* Figure 6.5**

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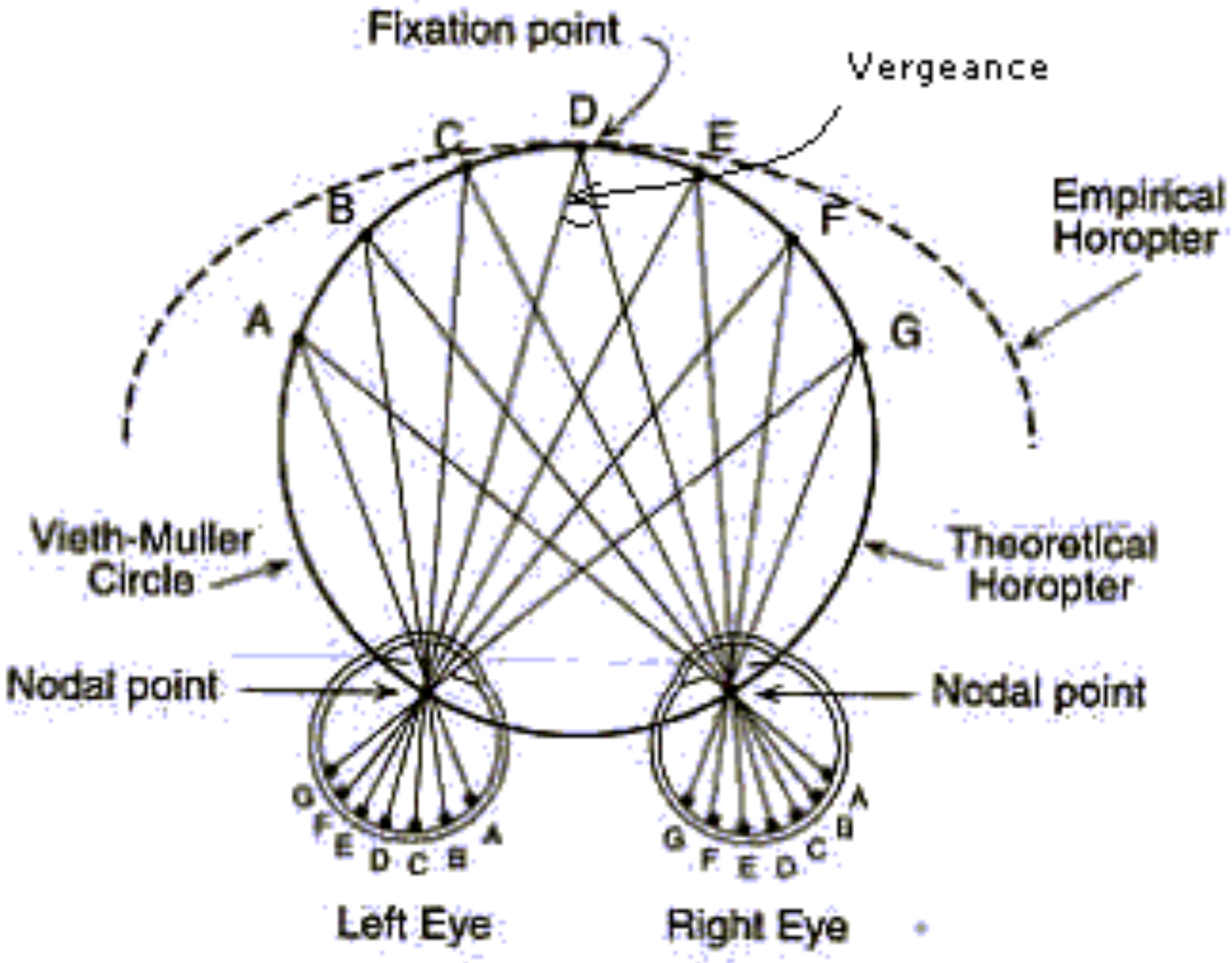
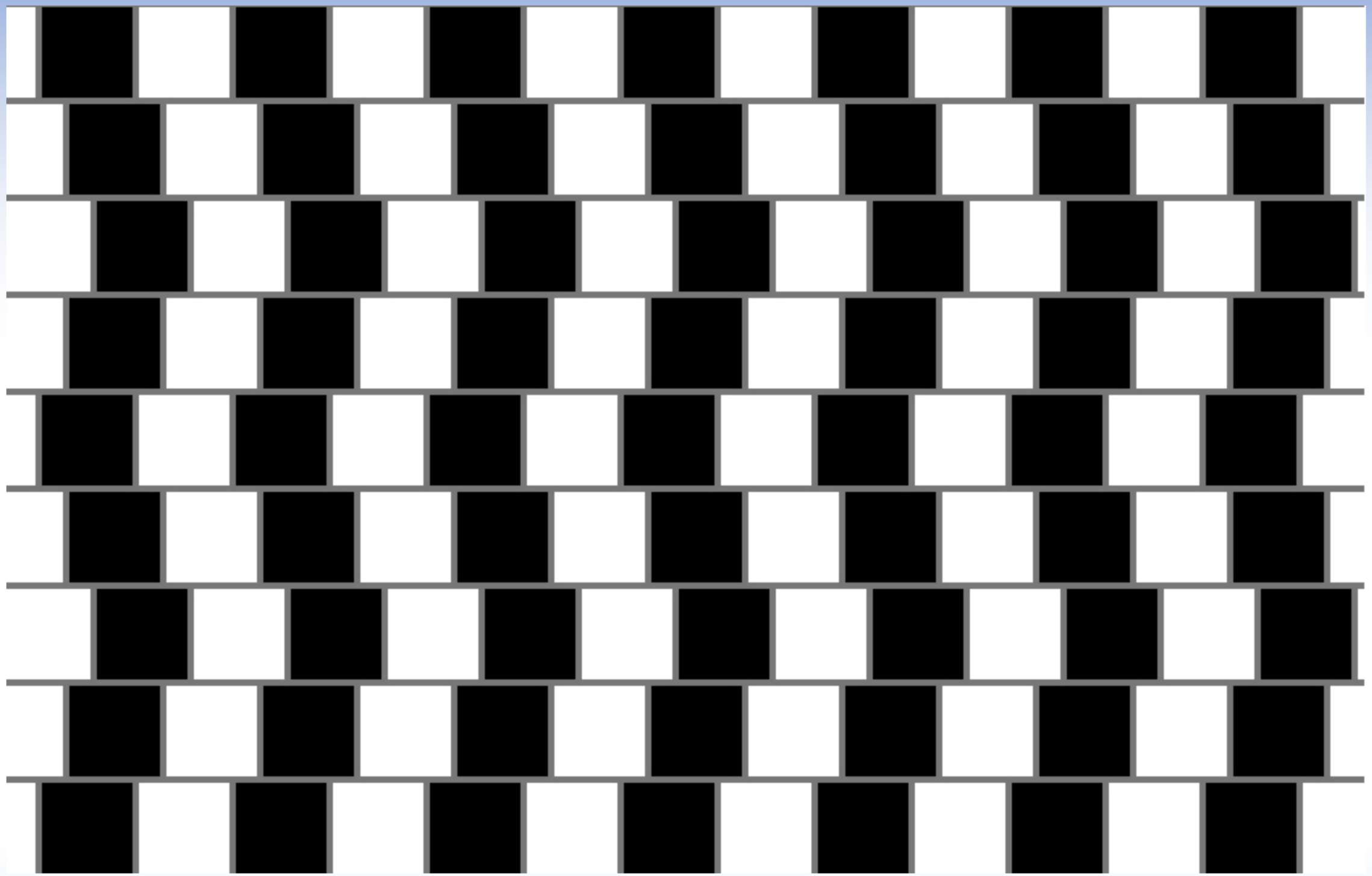
Depth Perception:

Depth Perception: Stereo

Depth Perception: Accomodation



Depth Perception: Café Tile Illusion