CS 498 VR

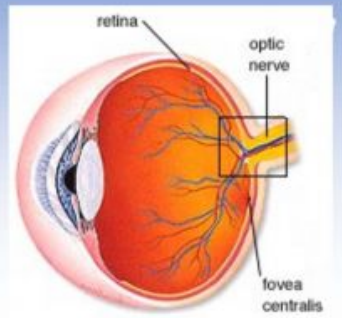
Lecture 14 - 3/14/2018

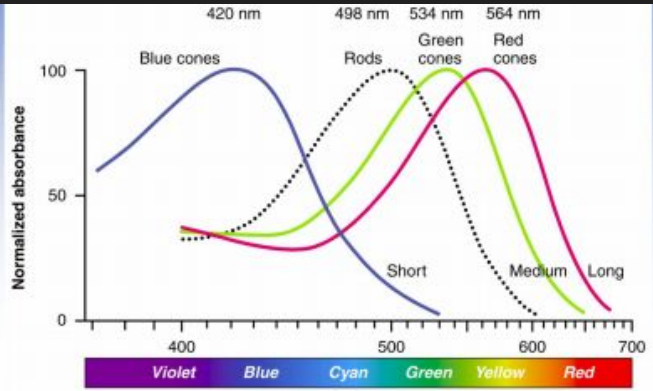
go.illinois.edu/VRlect14

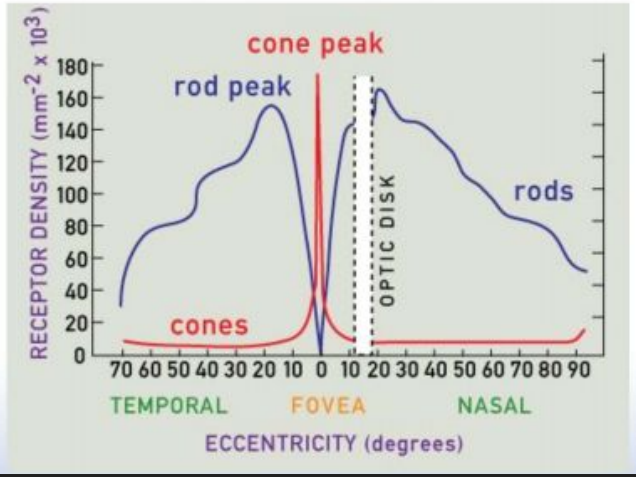
Review Questions

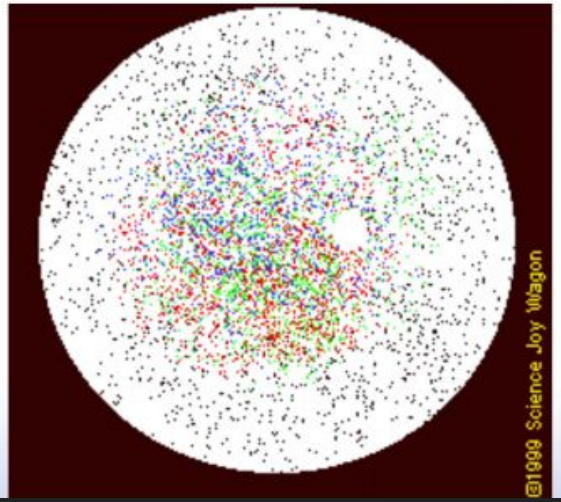
1. What are the two types of photoreceptors?
2. How much display resolution is enough in VR?
3. Which area has cone peak?

Rods and Cones Placement

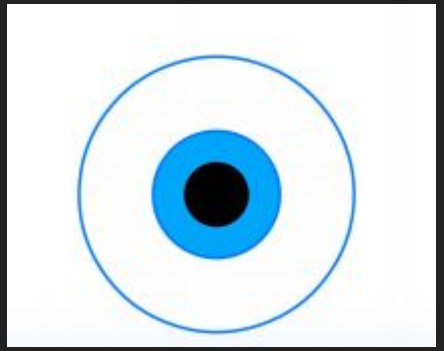


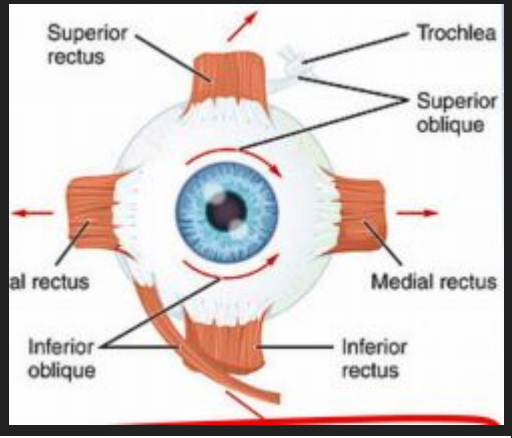


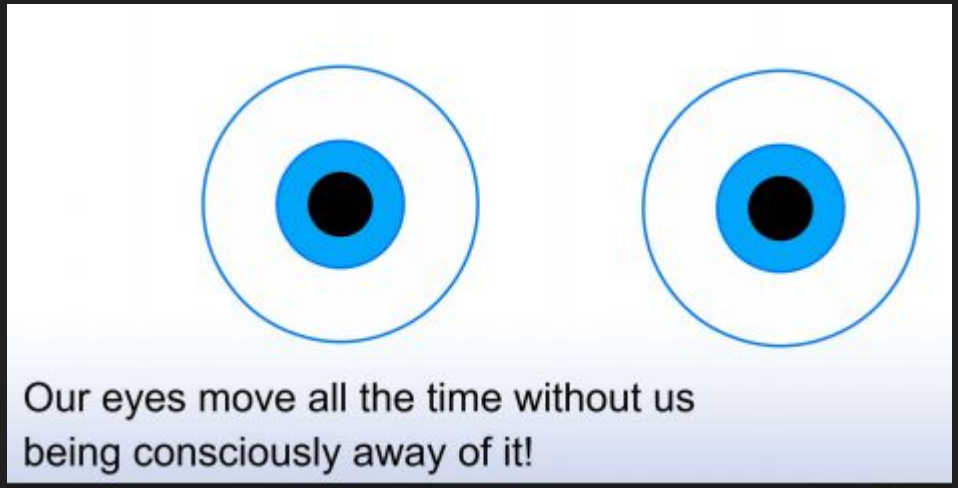




Sanity Check: DOFs







Sanity Check: DOFs

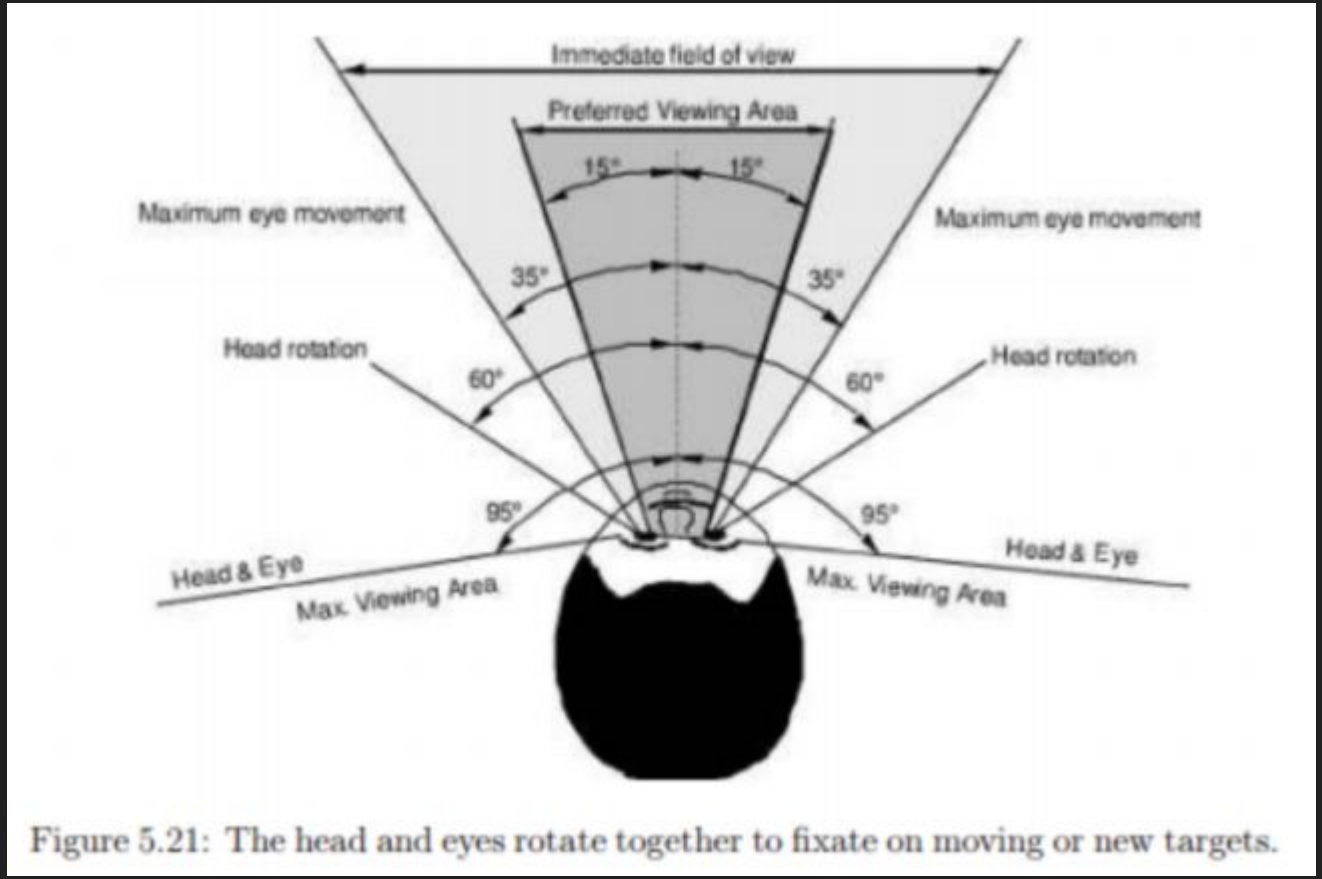


Figure 5.21: The head and eyes rotate together to fixate on moving or new targets.

Eye Motion Modes

	Conjugate	Disjunctive
Voluntary	Saccades Pursuit	Vergence (Convergence + divergence)
Involuntary	Vestibulo-ocular reflex (VOR) Optokinetic Microsaccades	N/A

Eye Motion Modes

Eye Motion Modes: Saccades

Saccades are rapid “jerks” motions

- Last for < 45ms, and 900^{o}/s

Saccadic masking is

- Transsaccadic memory
- Perceptual constancy

Examples: Reading, looking at pics, faces or movies

Purpose: maintain high resolution and wide FOV

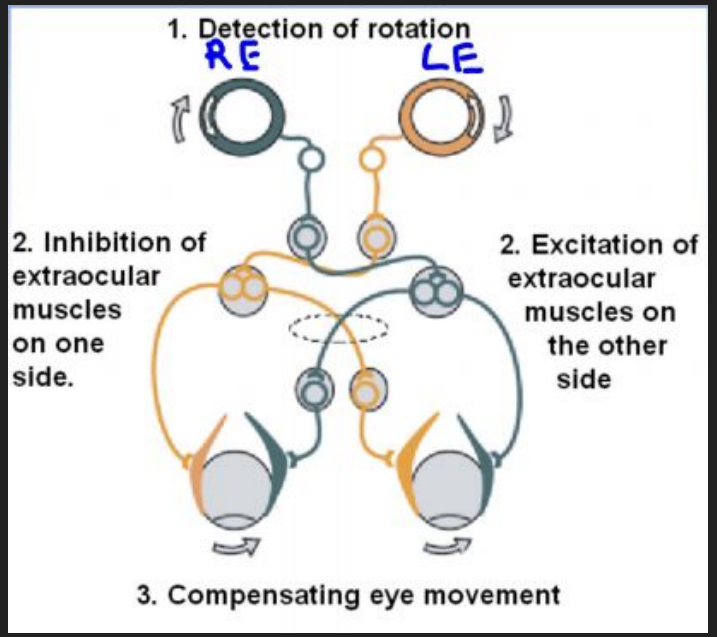
Relevance to VR: Diagnosing ADHD, Schizophrenia and other eye problems.

Eye Motion Modes: Saccades

Eye Motion Modes: Smooth Pursuit

- Smooth Pursuit is < 30 degrees per second, otherwise saccades are inserted
- Examples: Watching a car or a bicycle move
- Purpose: Keep object motionless on retina to reduce blur
- Relevance to VR: Blurring behind moving objects.

Eye Motion Modes: VOR



VOR = Vestibulo-Ocular reflex

Delay: 10ms

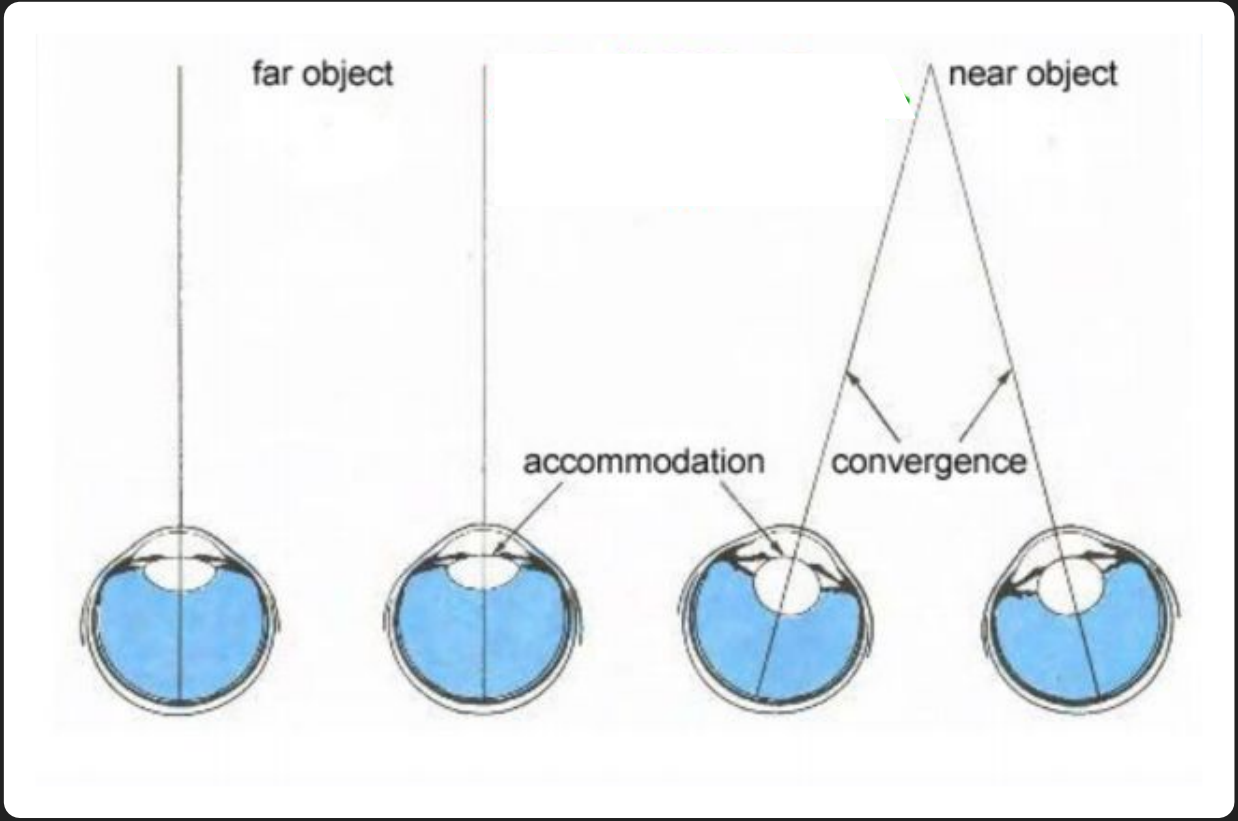
Purpose: Keep image stability when head moves

Eye Motion Modes: Optokinetic

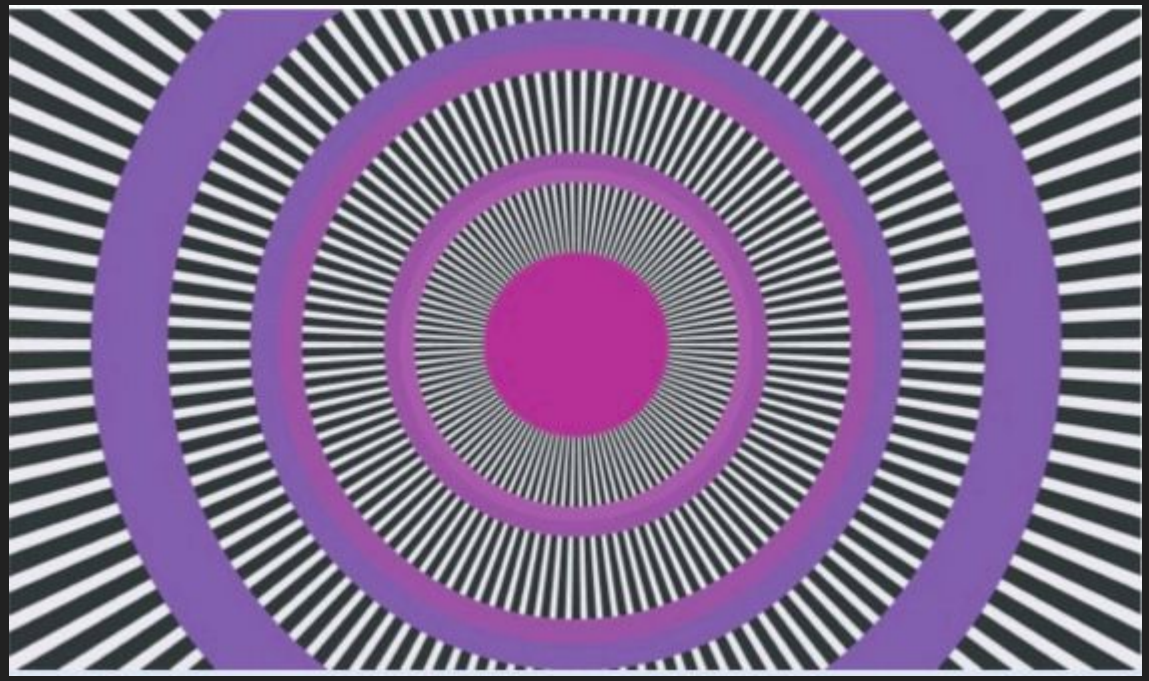
Example: Train
Purpose: Image stability, alternation between Smooth Pursuit and Saccades

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

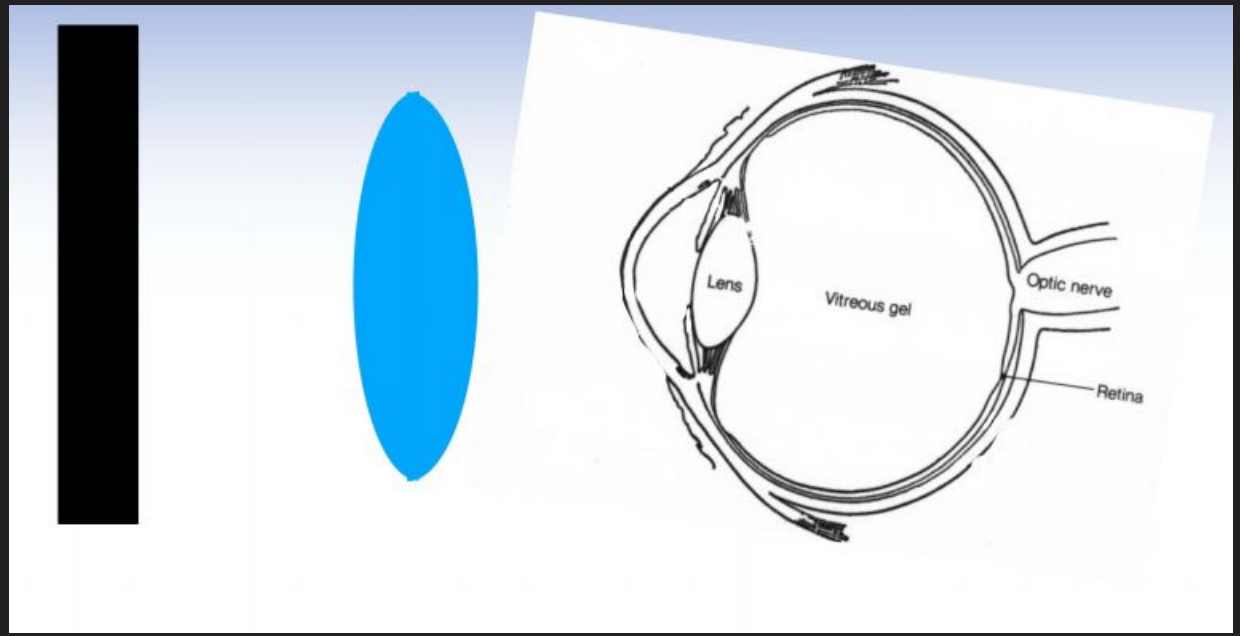
Eye Motion Modes: Convergence/Divergence



Eye Motion Modes: Microsaccades

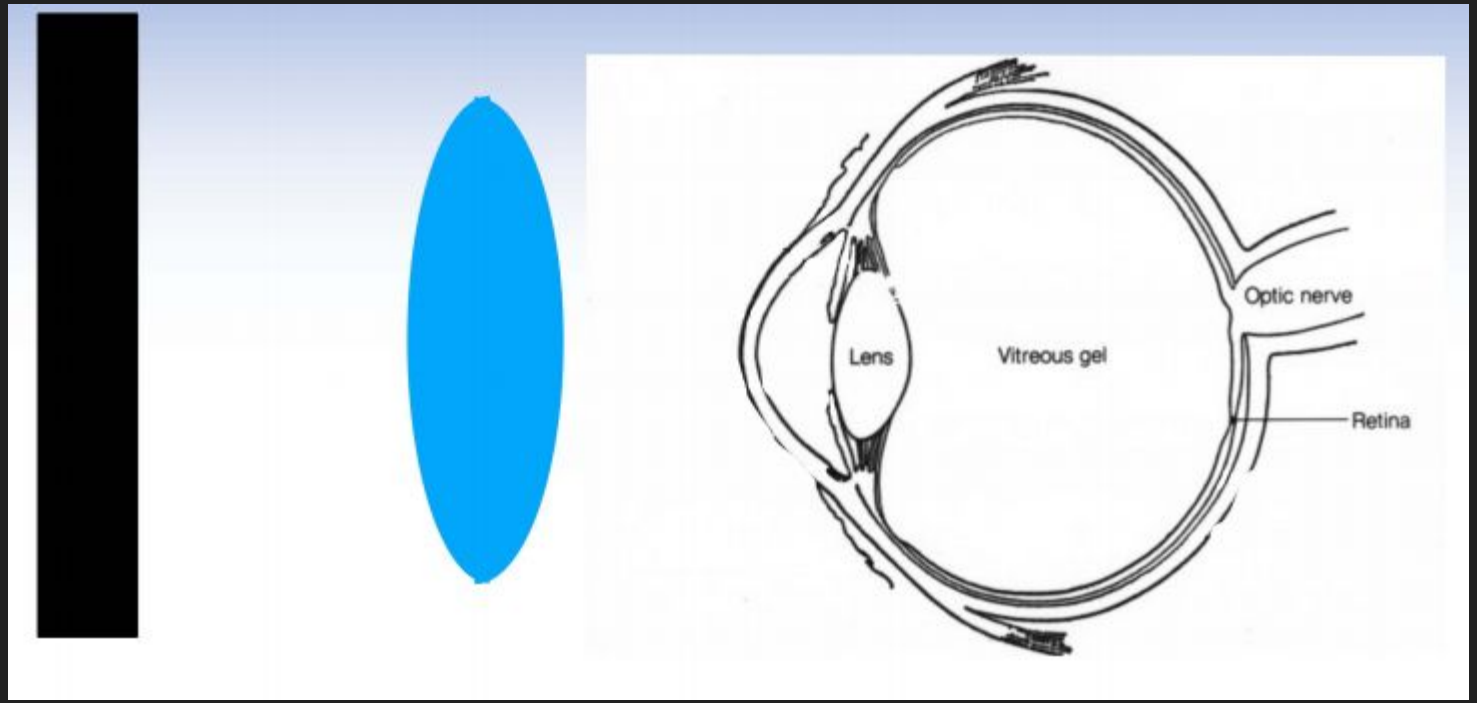


Eye Motion & VR: 1, Lens Aberration

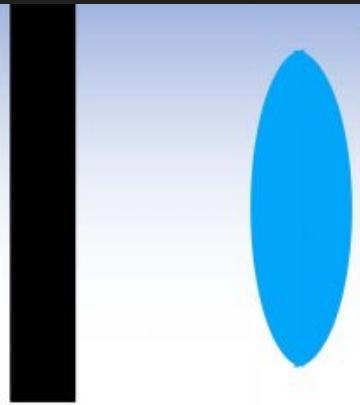


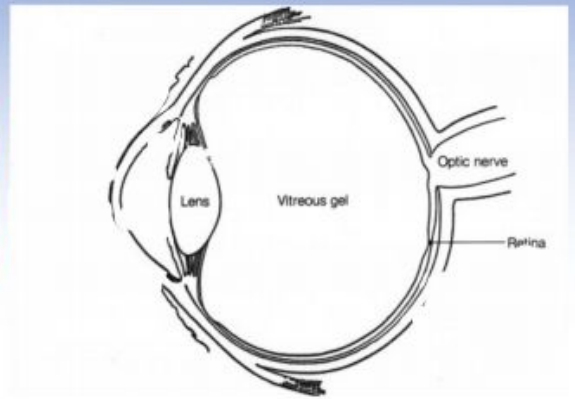
- Focus
- Optical distortion

Eye Motion & VR: 2, VOR Gain Adaption



Eye Motion & VR: 3, Interaction with Photoreceptors



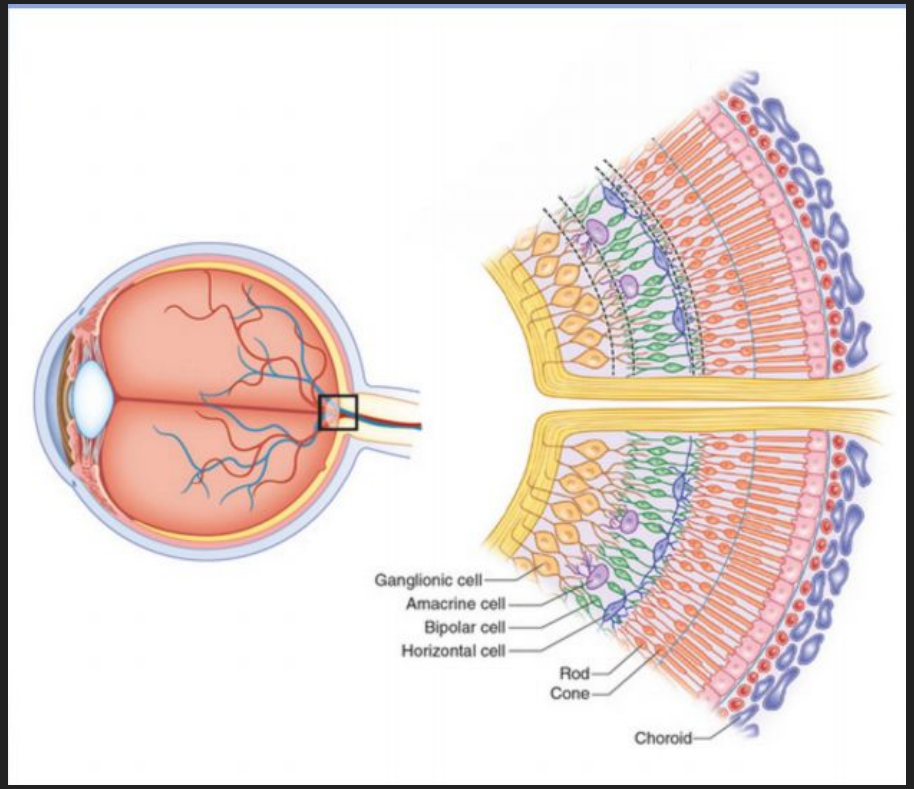


1. Pixels on the display switch their color/intensity at some non-zero rate.
2. There is RGB sub pixel structure.
3. Frames might be off (black) at particular times.
4. Asynchronous (line-by-line) display scan out.

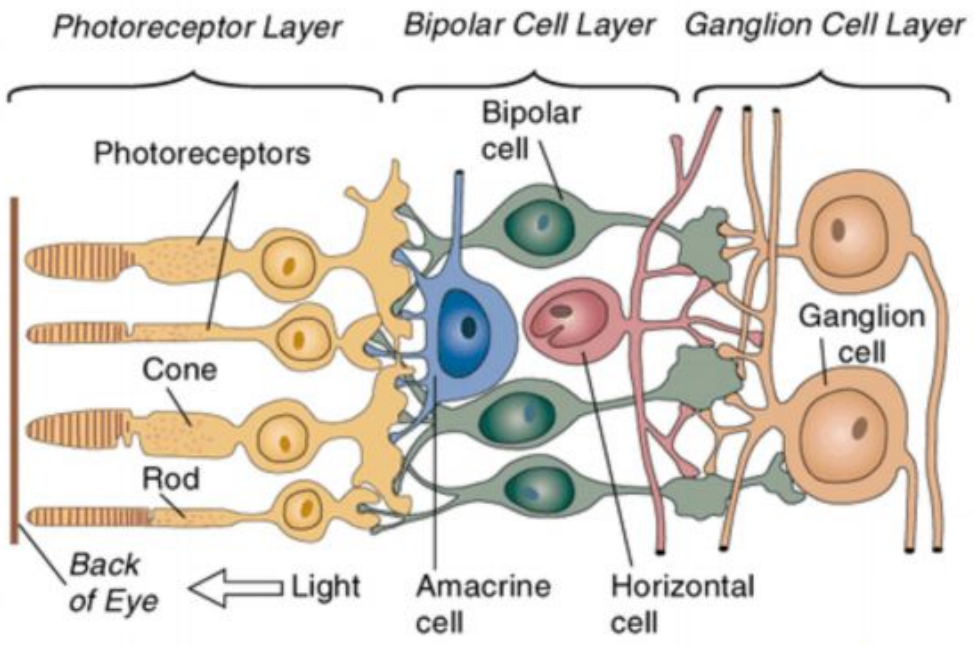
5. Photoreceptors are slow to respond. It takes them about 0.1-0.2 seconds to respond.
6. All of the eye movements shift the image on the retina.

7. Perception

Switching Gears: Human Perception

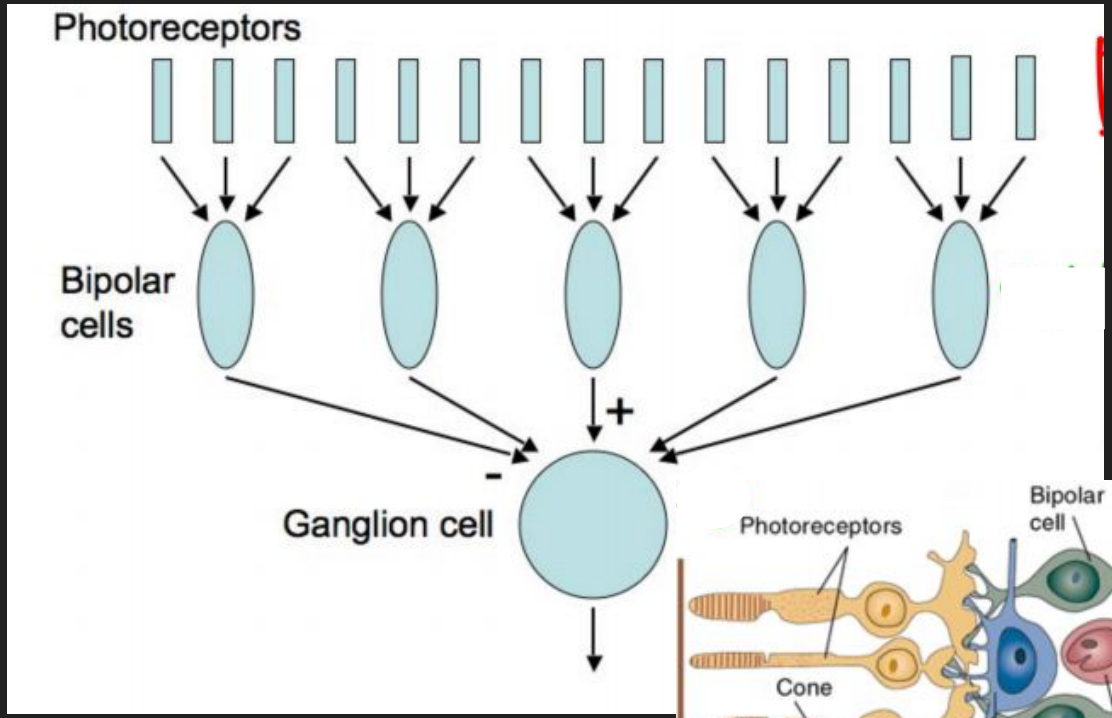


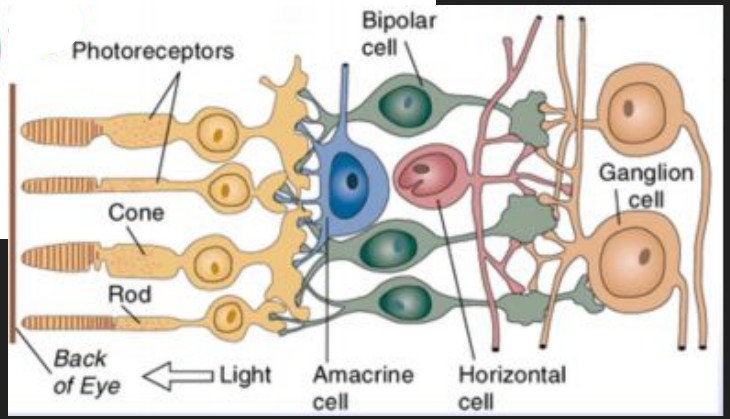
Retinal Circuitry



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

Hierarchical Processing: Receptive Field Model





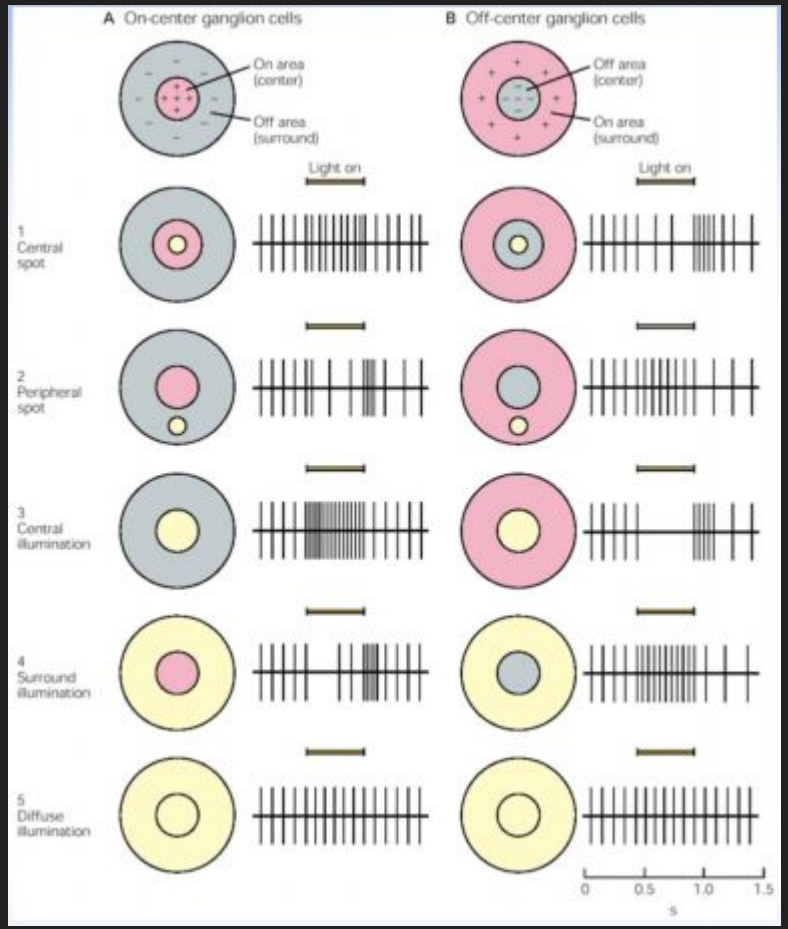
Ganglion Cells Response to Edges

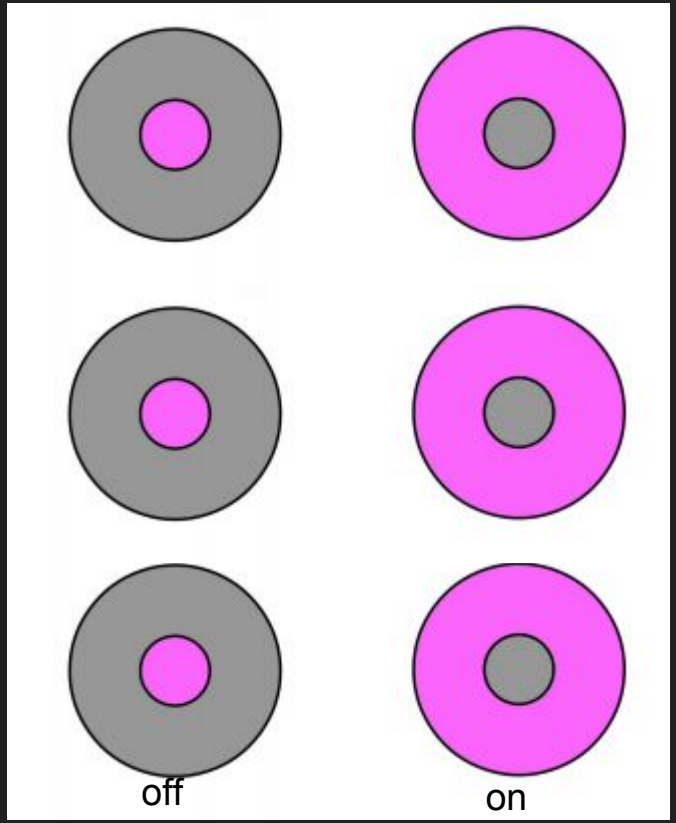
Input image
(cornea)

"Neural image"
(retinal ganglion cells)

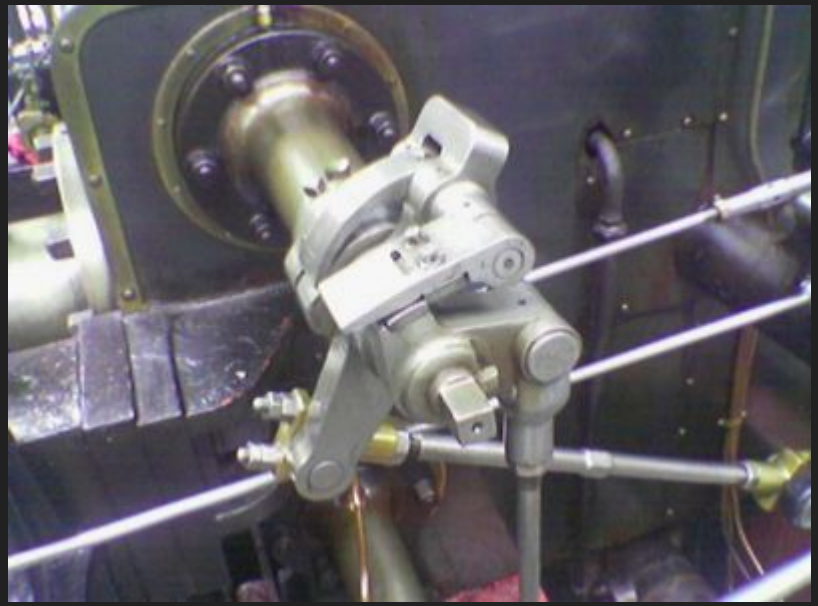
Center-surround receptive fields: emphasize edges.

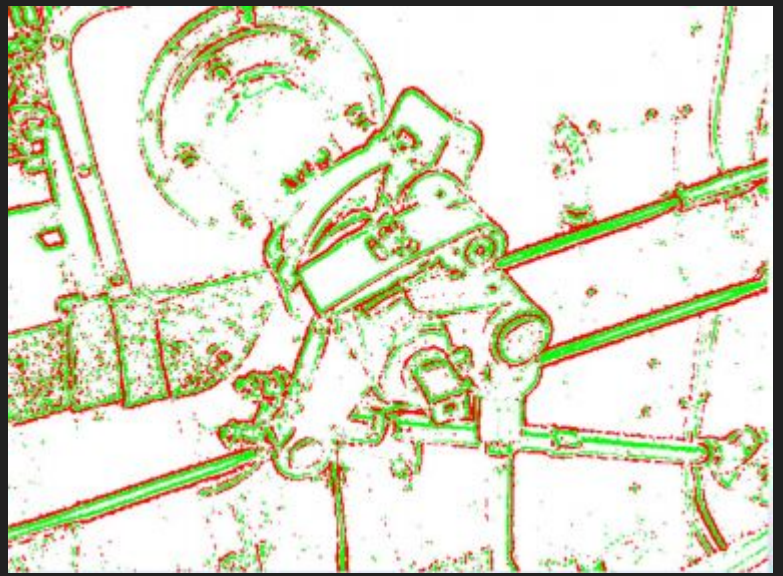
Receptive Fields of Ganglion Cells



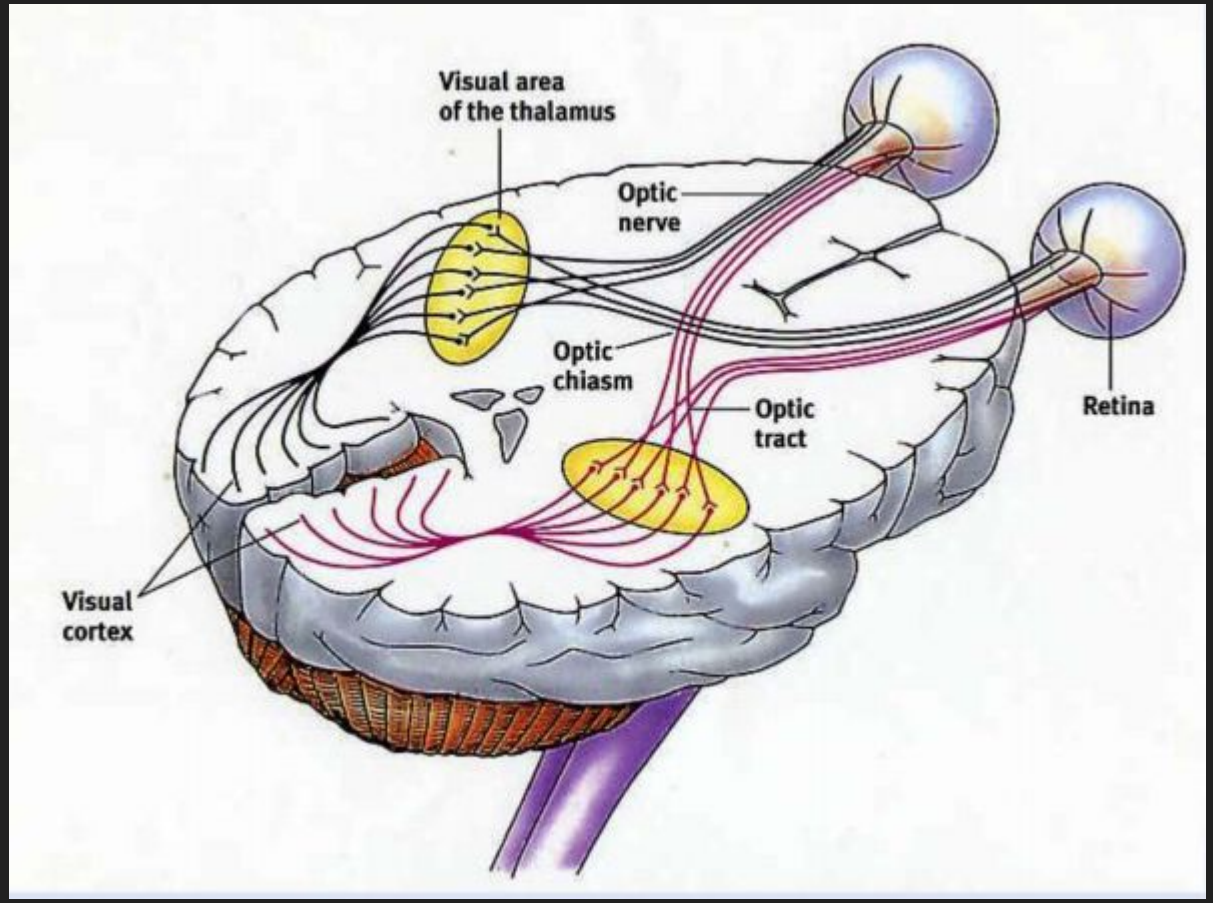


Ganglion Cells Preprocessing of an Image

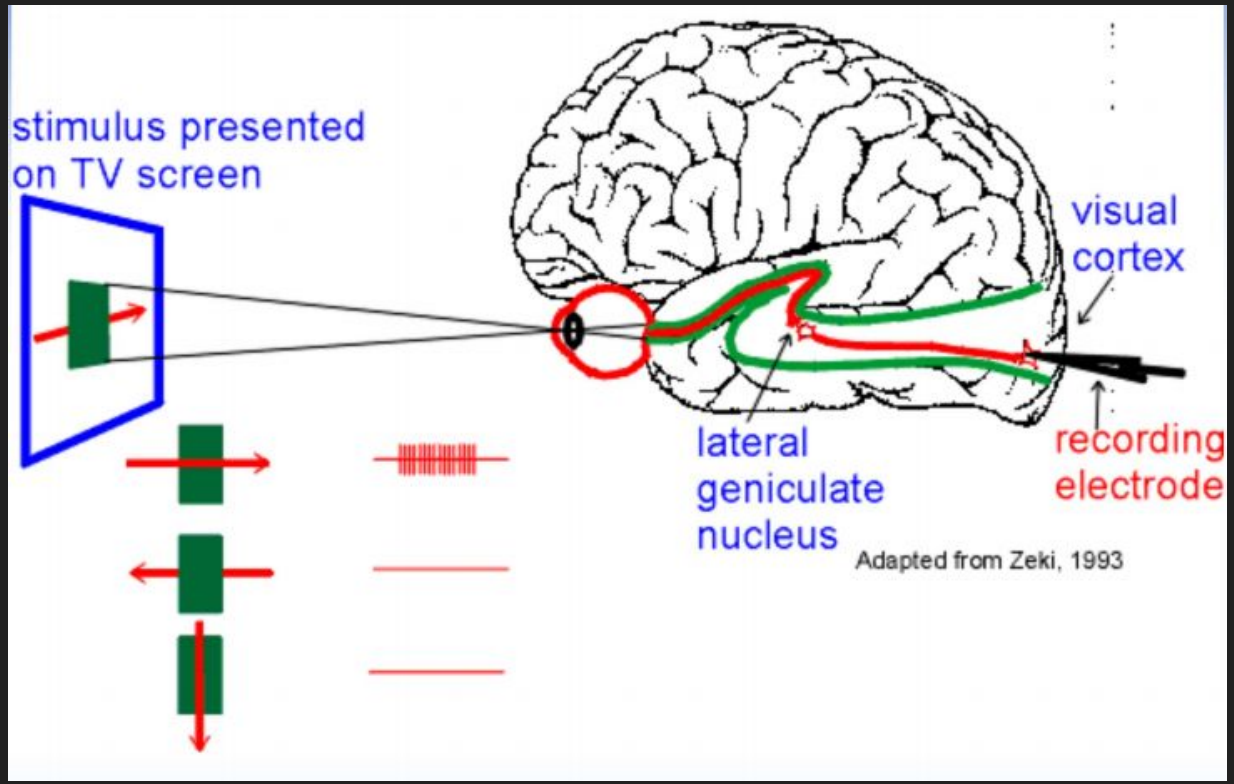




Hierarchical Processing: Visual Pathways



Single Unit Recording



Single Unit Recording

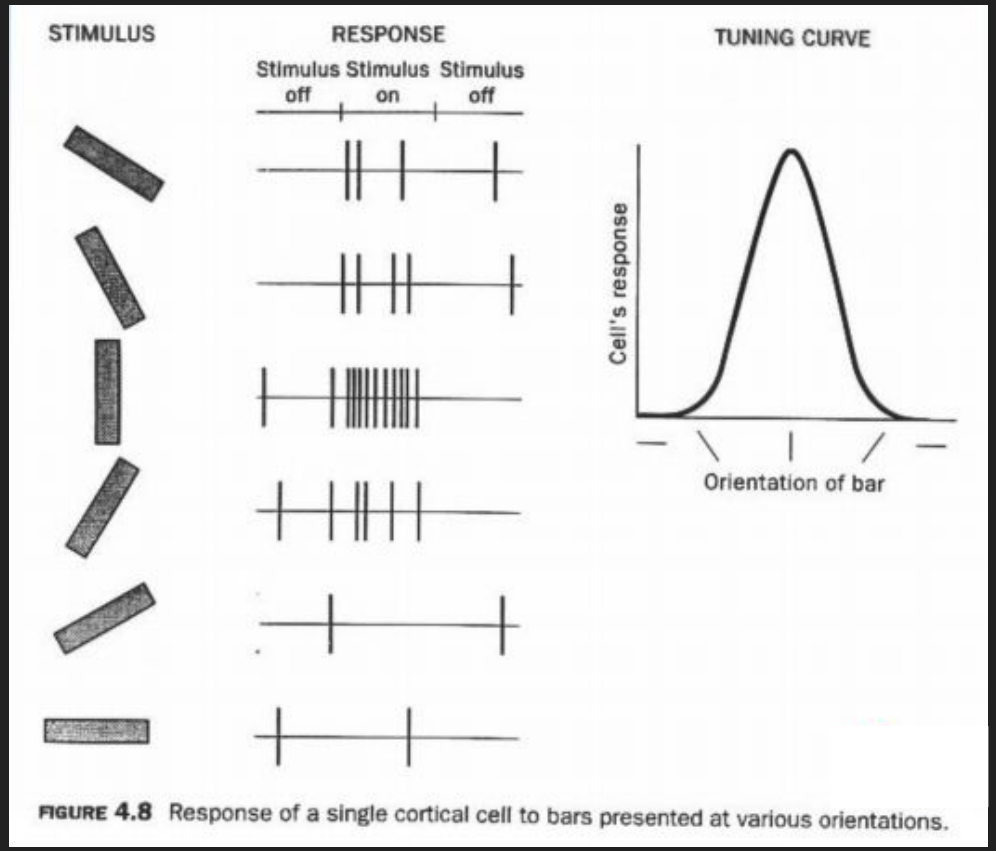


FIGURE 4.8 Response of a single cortical cell to bars presented at various orientations.

Hubel and Wiesel Experiments

Review

- What are the six kinds of eye movements?
- A single eye has how many DOF?
- What is Hubel and Wiesel’s experiment about?