CHAPTER 6: THE VISUAL SYSTEM

Cortical Vision - How we see

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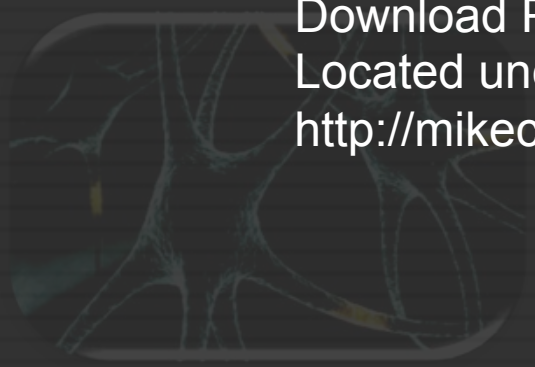
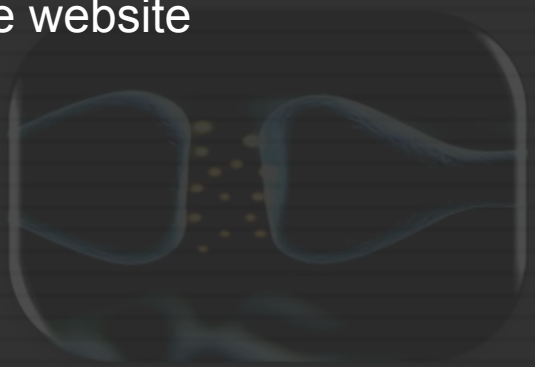
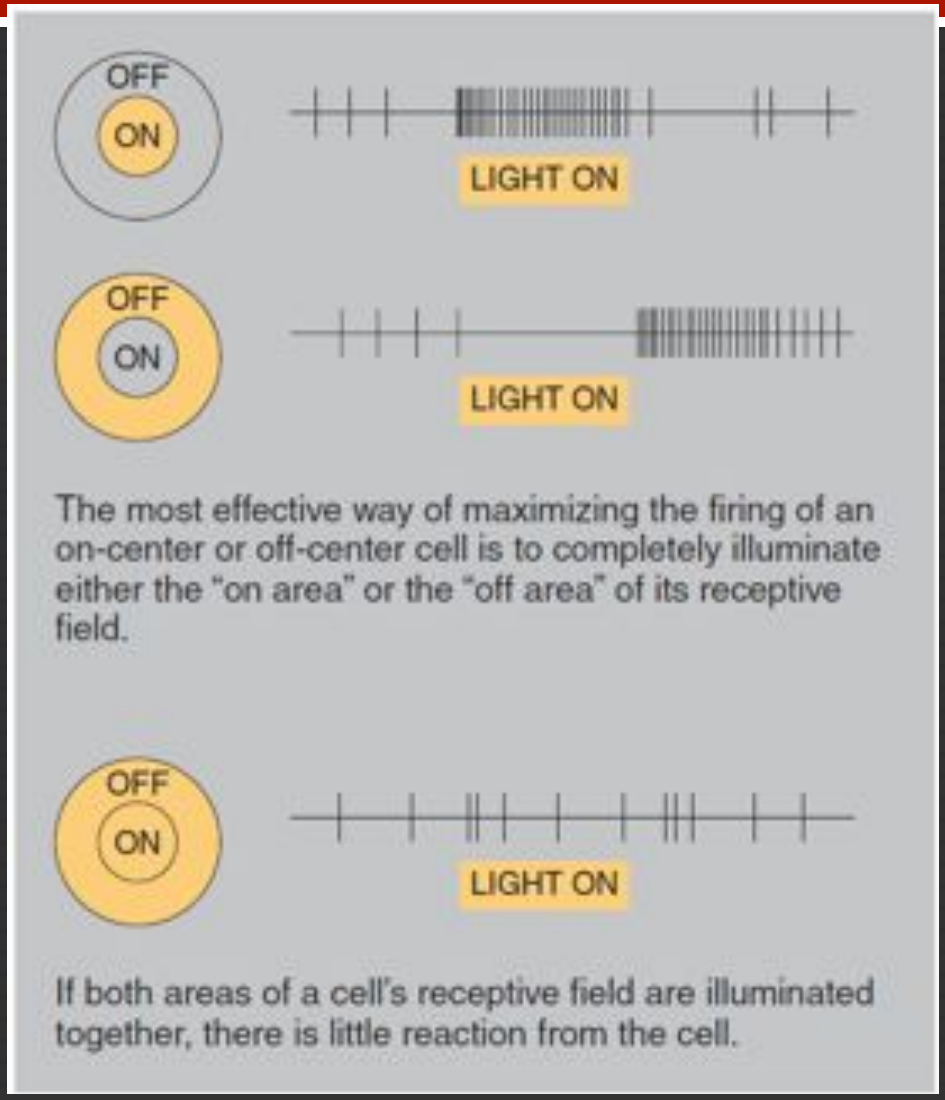
http://mikeclaffey.com/psyc2/

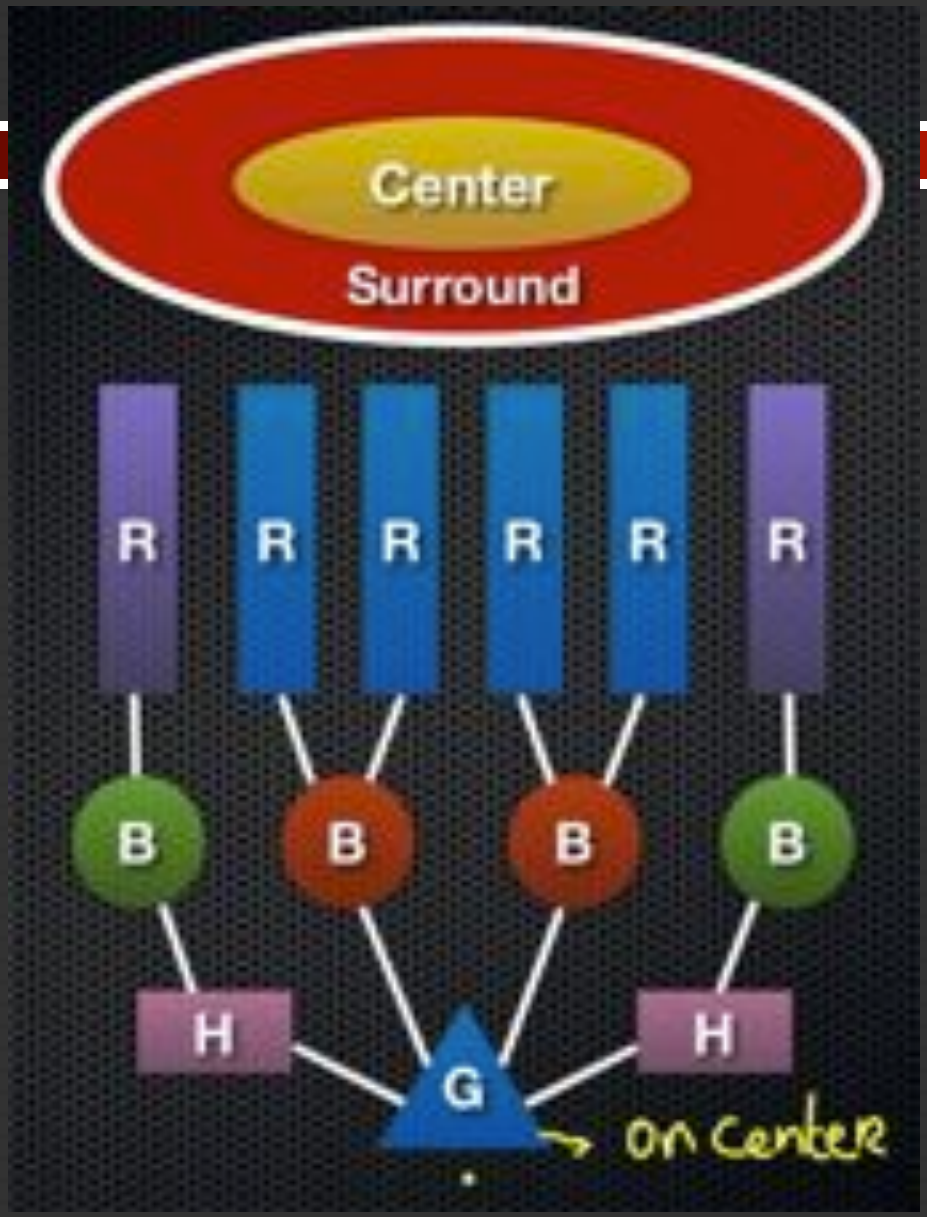




The flow of information processing in the visual system

Receptive Fields



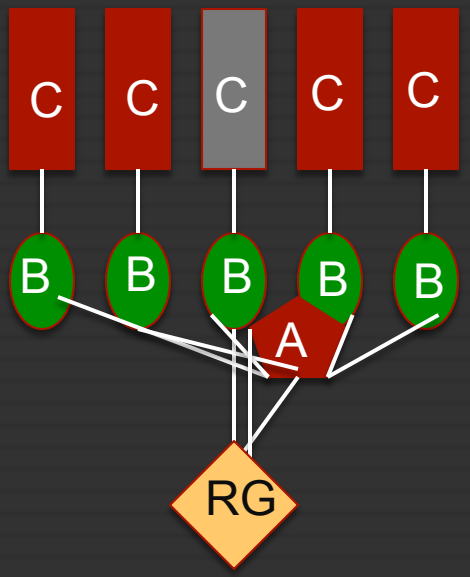


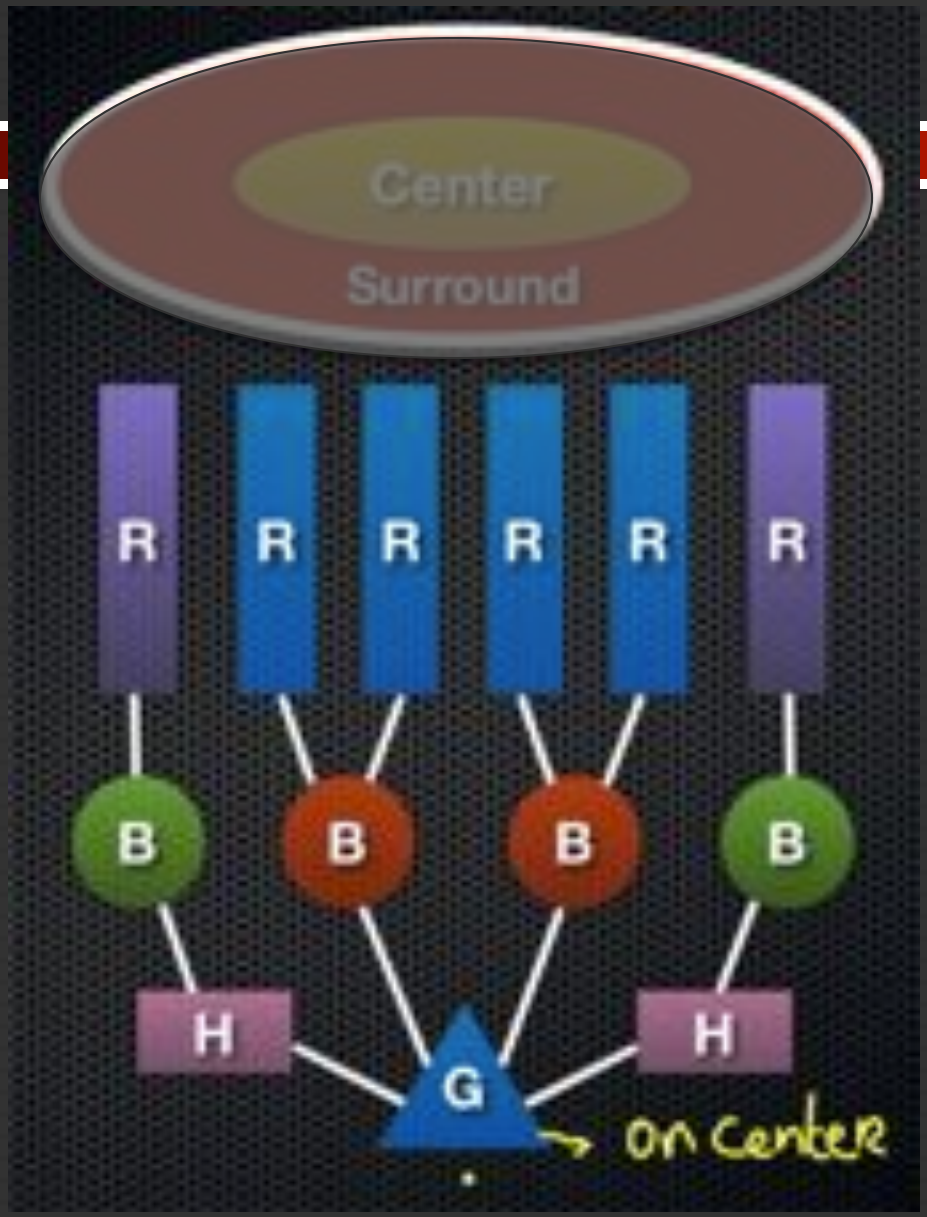
Rods

Bipolar cells

Horizontal / Amacrine cells

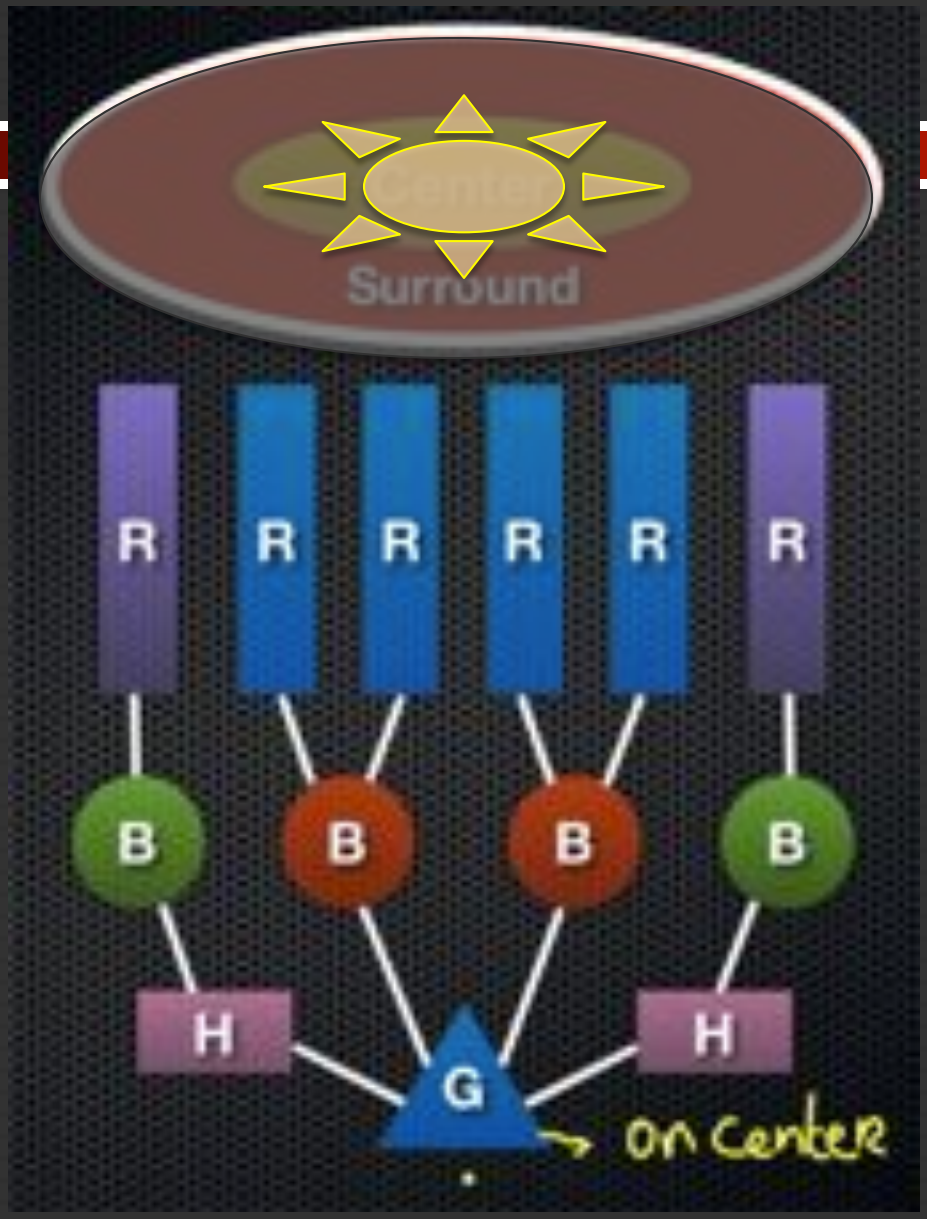
Retinal Ganglion cells → LGN


C
C
C
C
C
B
B
B
B
B
A
RG



Spike Rate

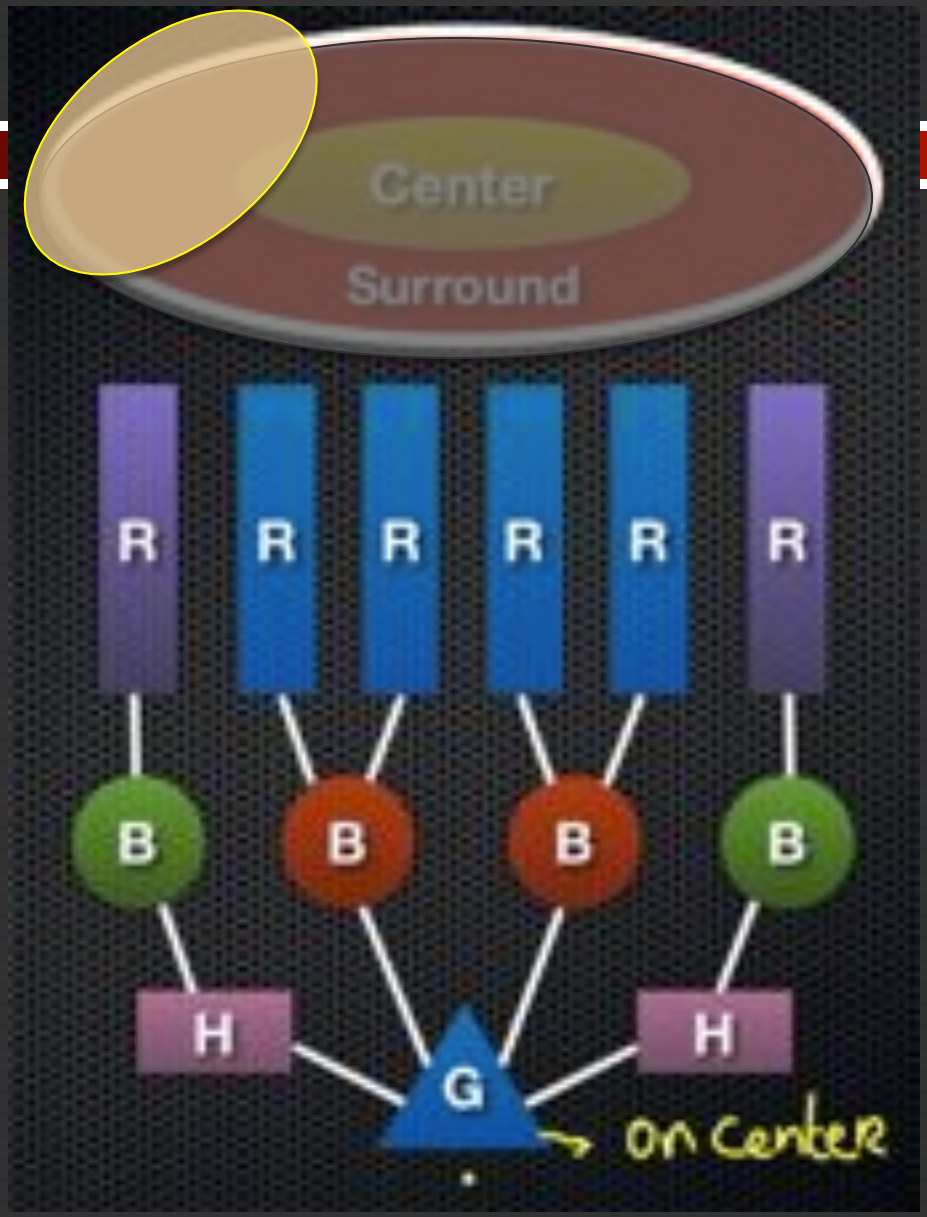
Baseline



Spike Rate

Baseline

Center

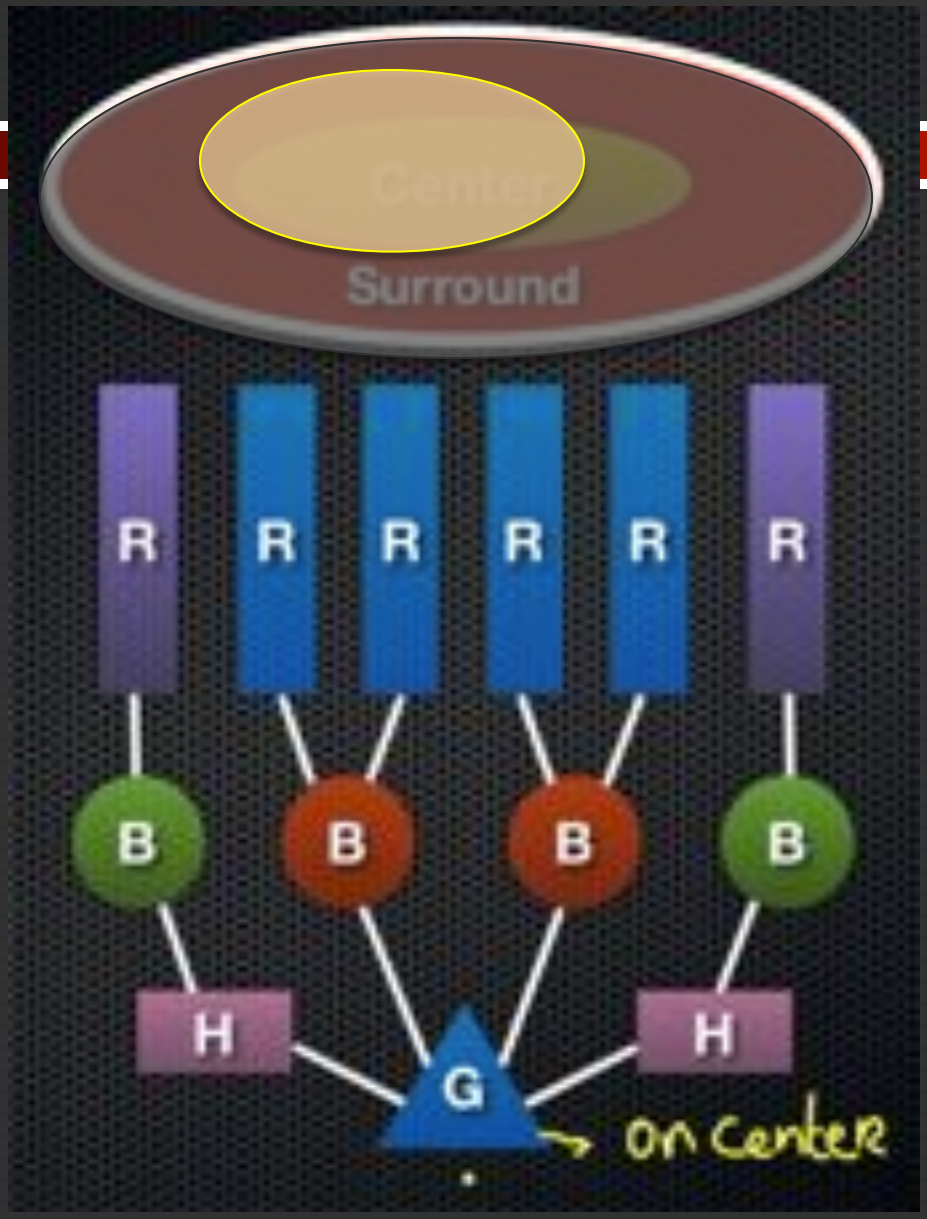


Spike Rate

Baseline

Center

Surround



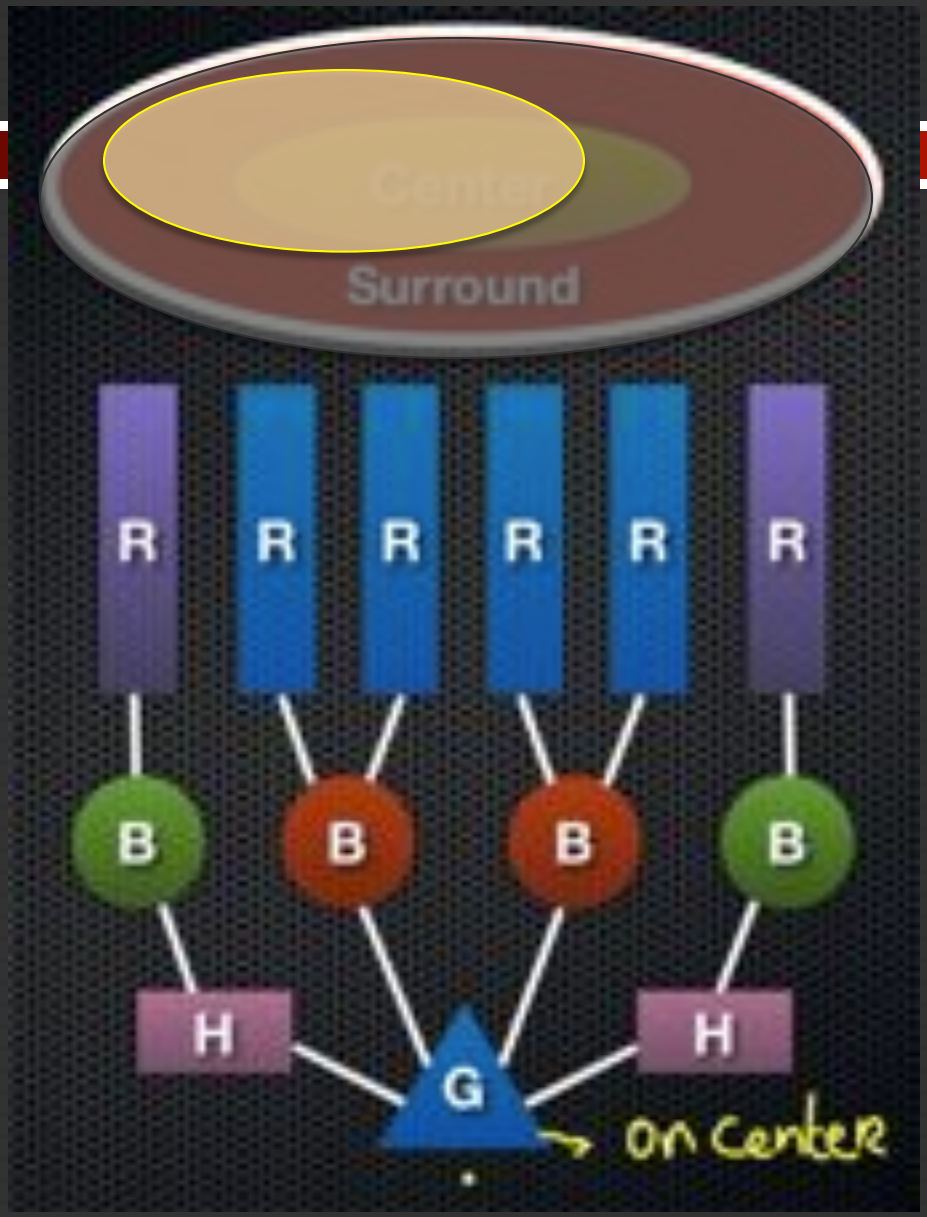
Spike Rate

Baseline

Center

Surround

on:off
80:20



Spike Rate

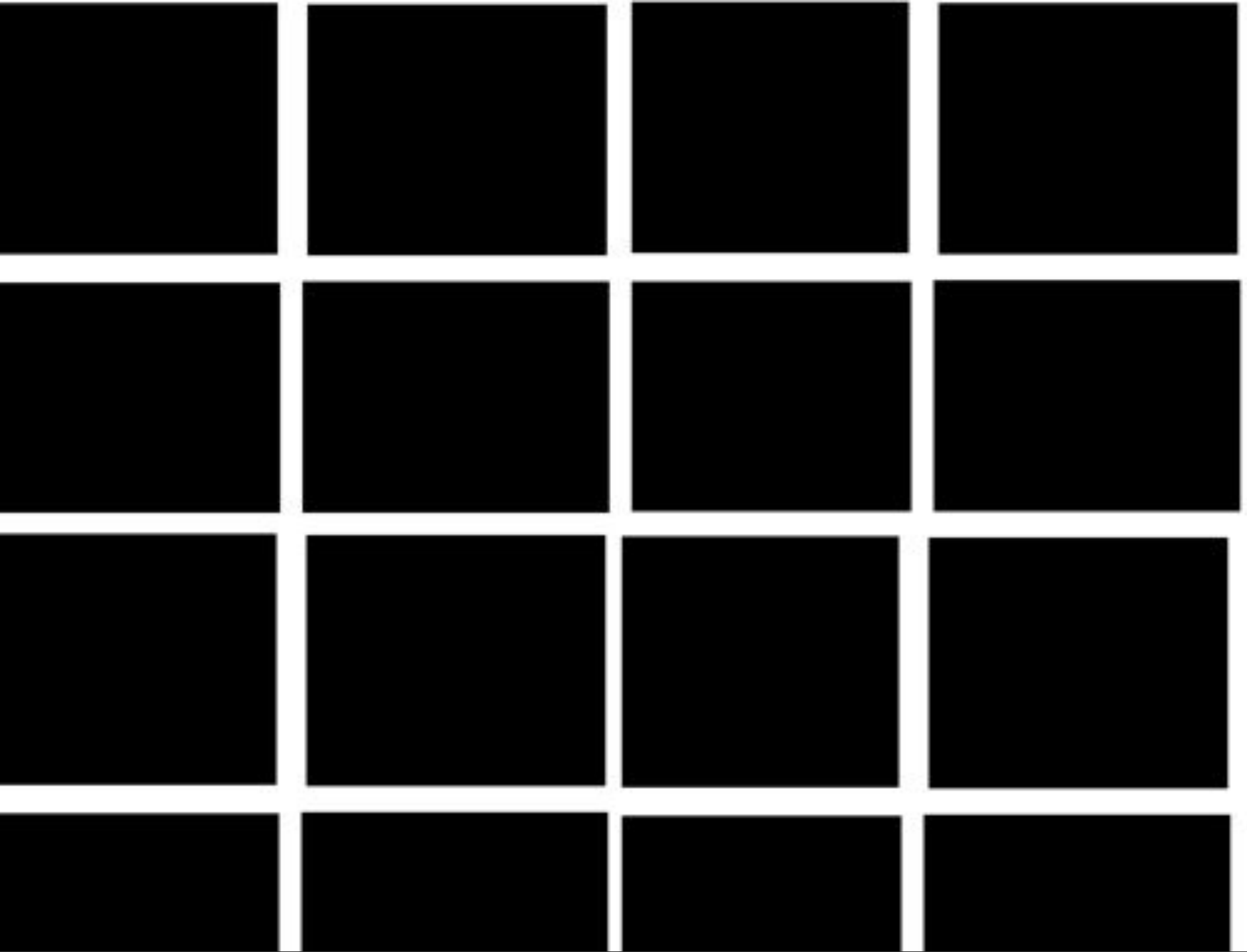
Baseline

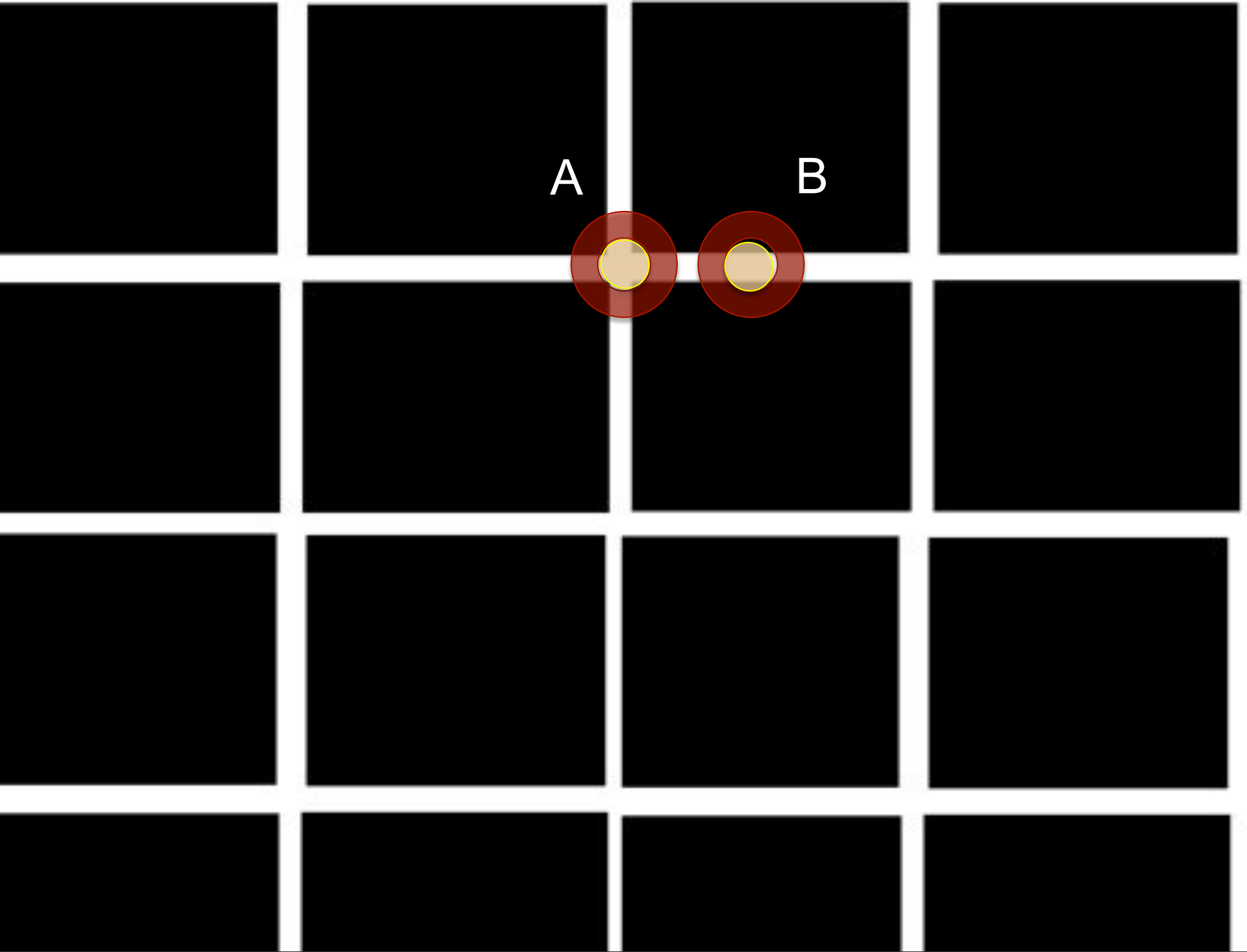
Center

Surround

on:off
80:20

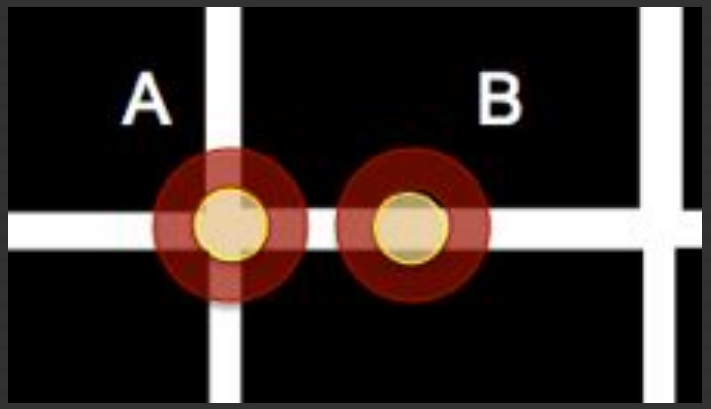
on:off
60:40




A
B

Clicker Question

- Why would the white area within the receptive field of "A" be perceived as less bright than "B"
  - a) more on-center rods are being activated in "A"
  - b) more off-surround rods are being activated in "A"
  - c) there is less total light hitting "A"



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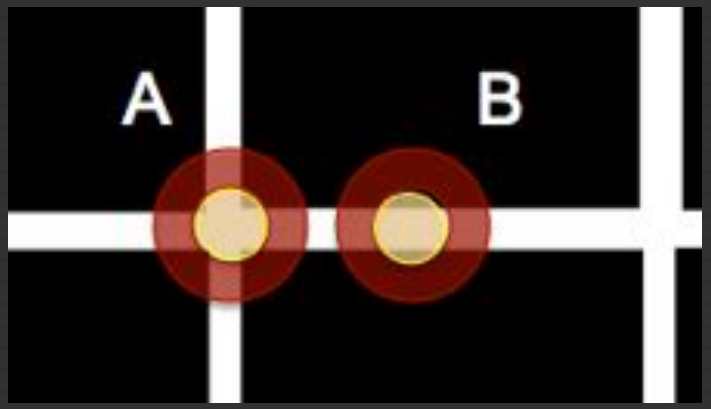
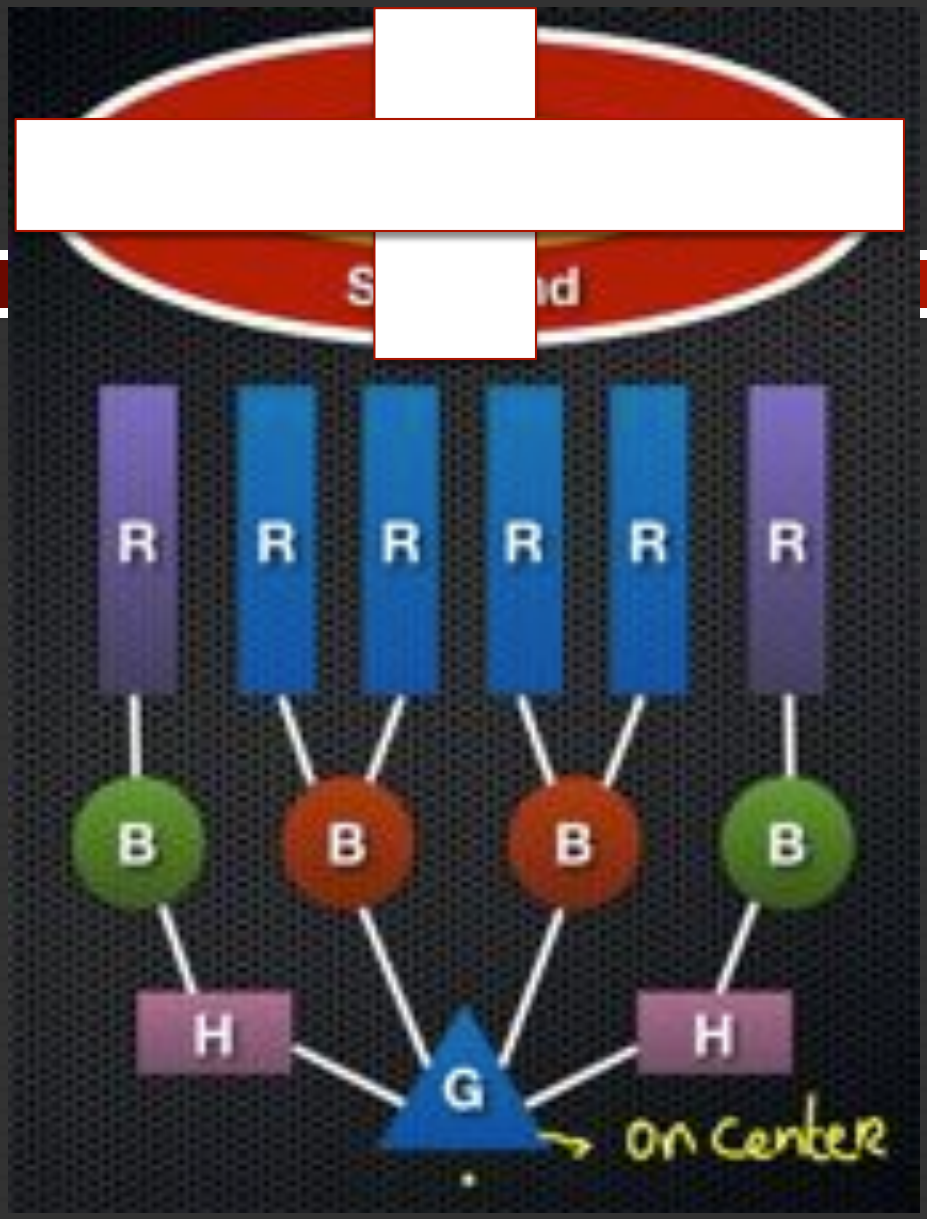
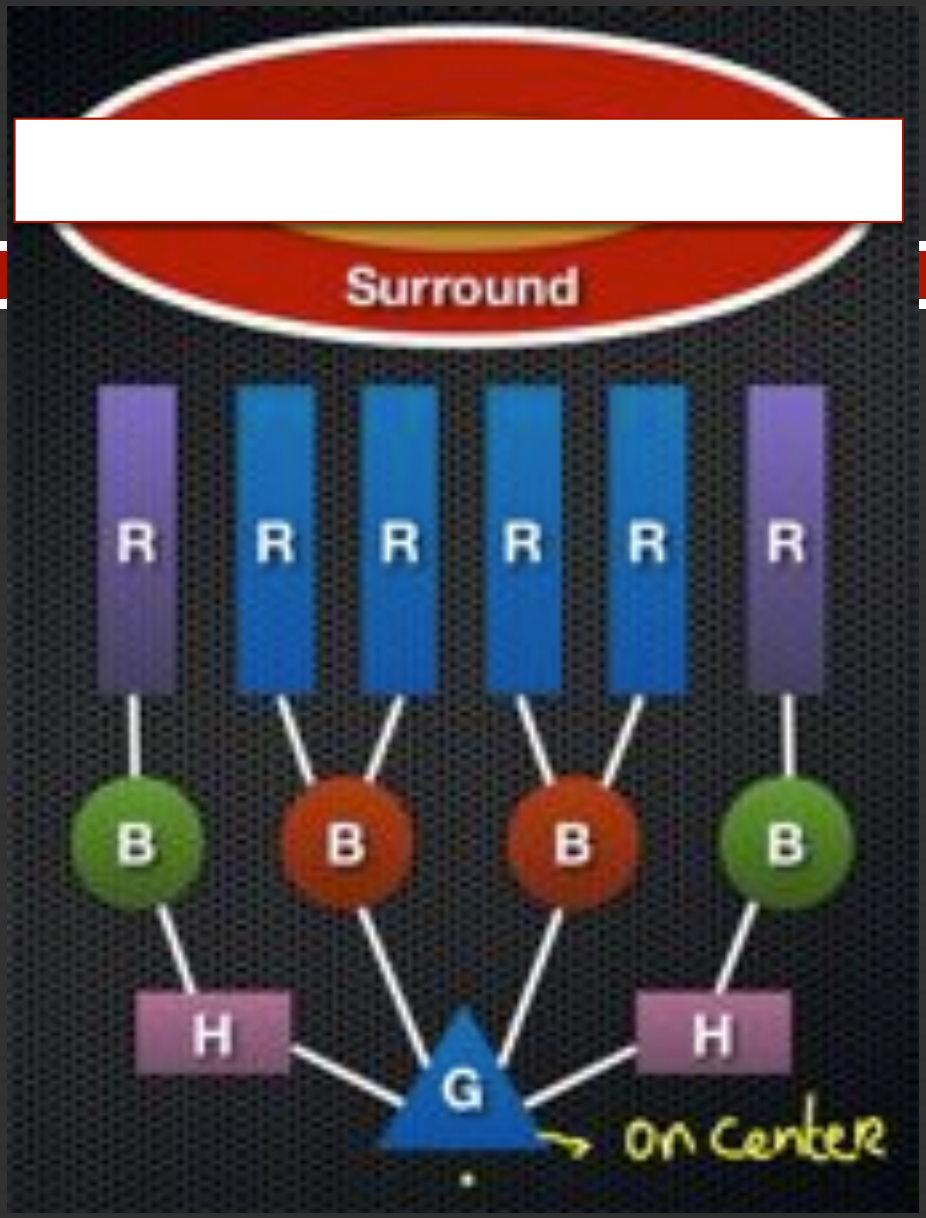




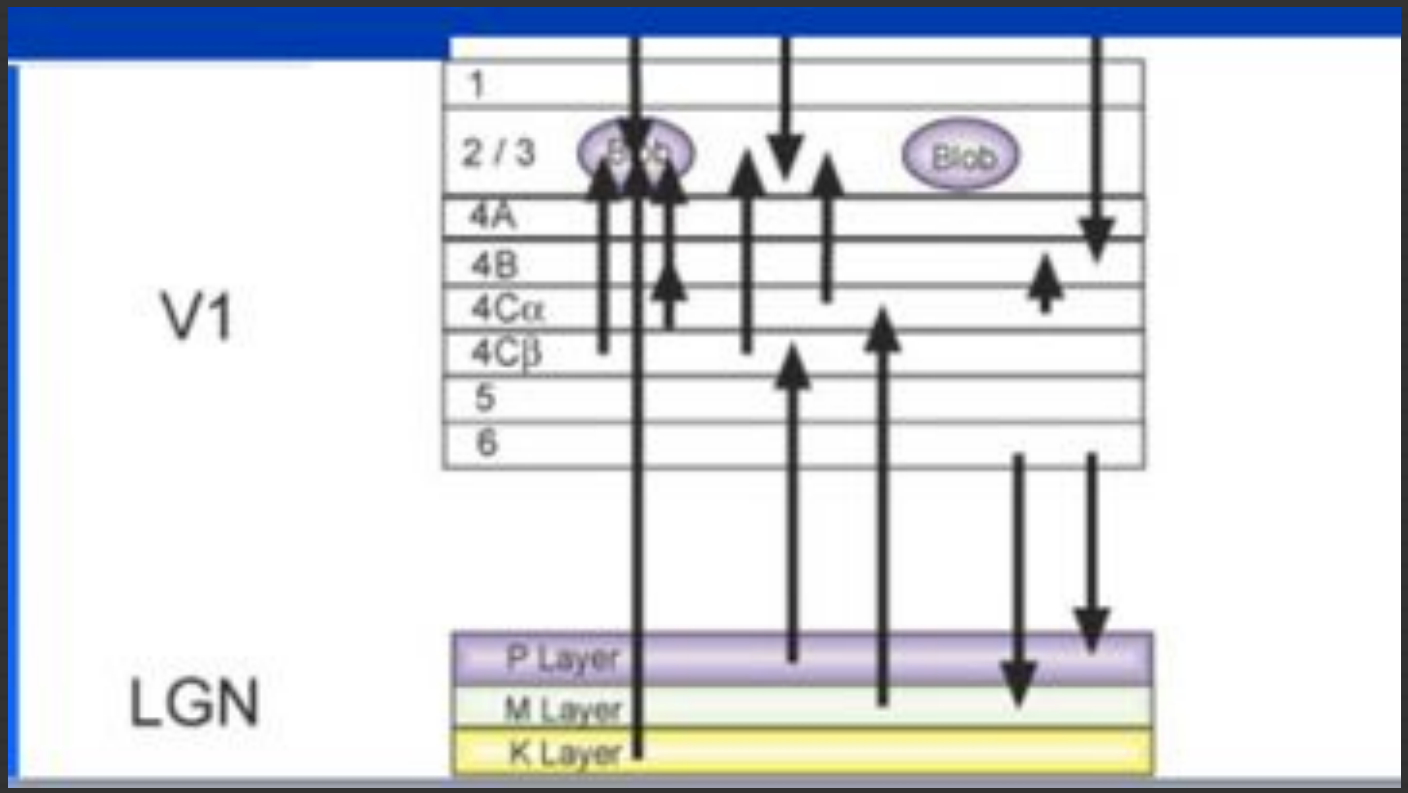
on:off
60:40



on:off
80:20

Receptive fields in the cortex

- In the primary visual cortex, neurons with circular receptive fields are rare
  - unlike LGN or striate layer IV neurons

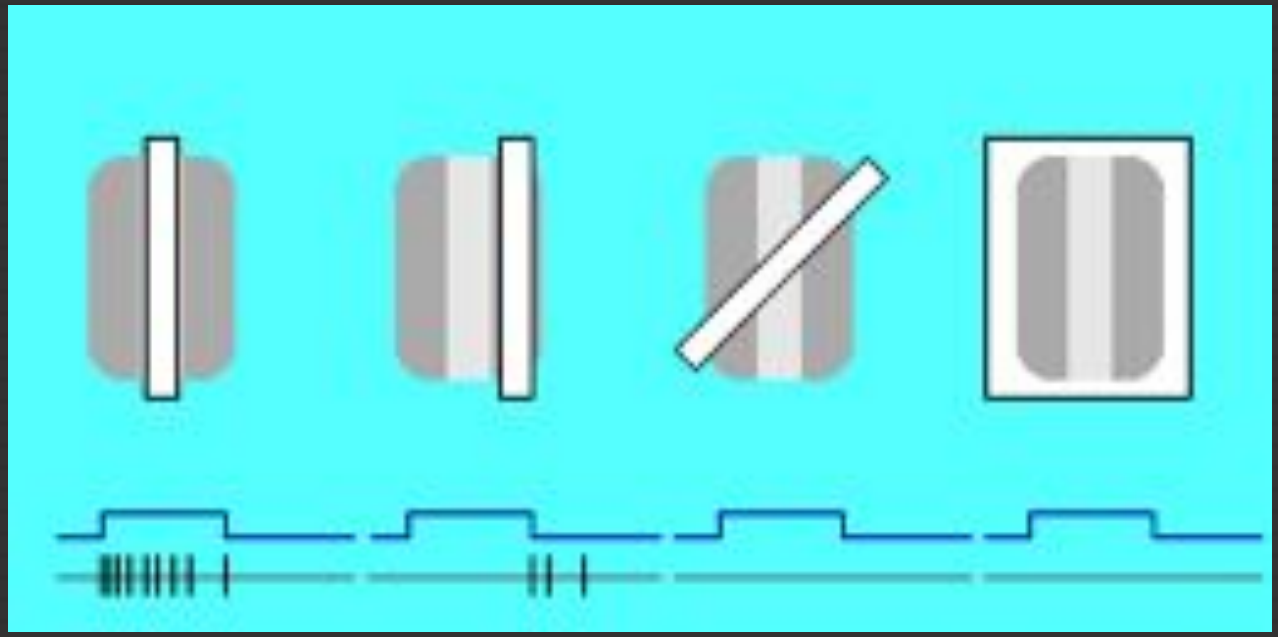


Receptive fields in the cortex

- Most neurons in V1 are either
  - Simple - small rectangular on/off receptive fields
  - Complex - large rectangular, respond to stimuli anywhere in receptive field

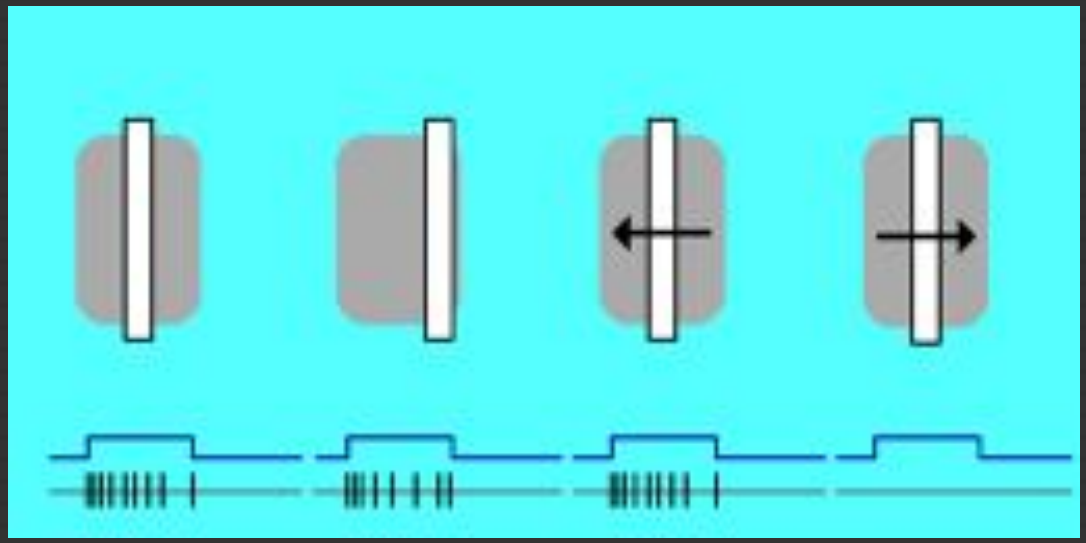
Simple Cells

- Have straight-line on/off regions
- Unresponsive to diffuse light
- Monocular



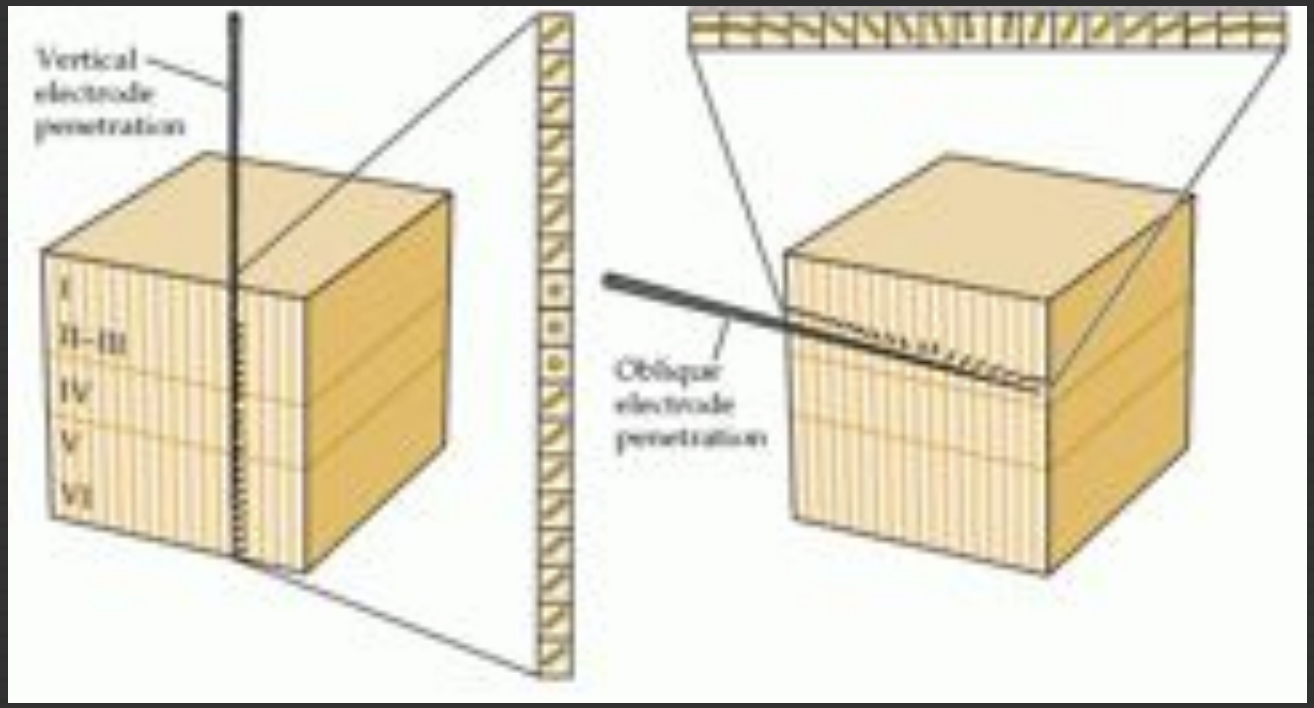
Complex Cells

- No on/off regions
  - A line with the appropriate orientation anywhere in the receptive field will activate cell
- Responsive to motion in a particular direction
- Involved with depth perception
- Binocular



Columnar Organization of PVC

- Neurons that respond similarly are grouped in vertical columns



Plasticity in the Visual Cortex

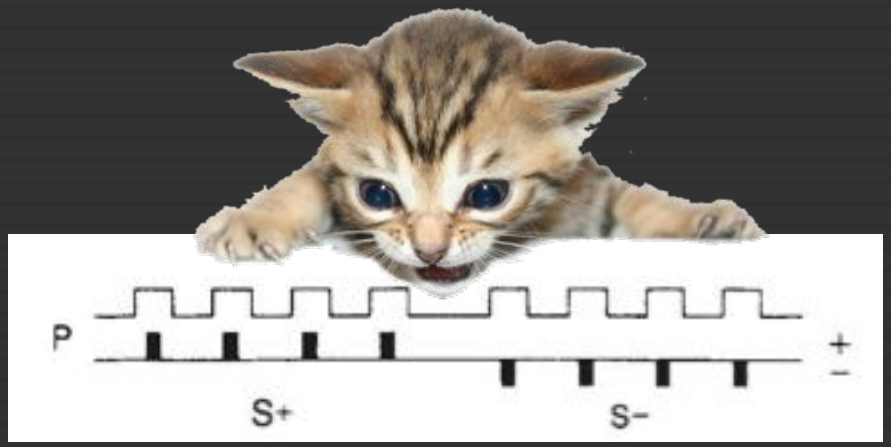
Plasticity in the Visual Cortex

- Hebbian plasticity
  - Neurons that fire together, wire together
  - Neurons that don't fire together lose potentiation

Experimental Design

Experimental Model

- Primary visual cortex
- cats



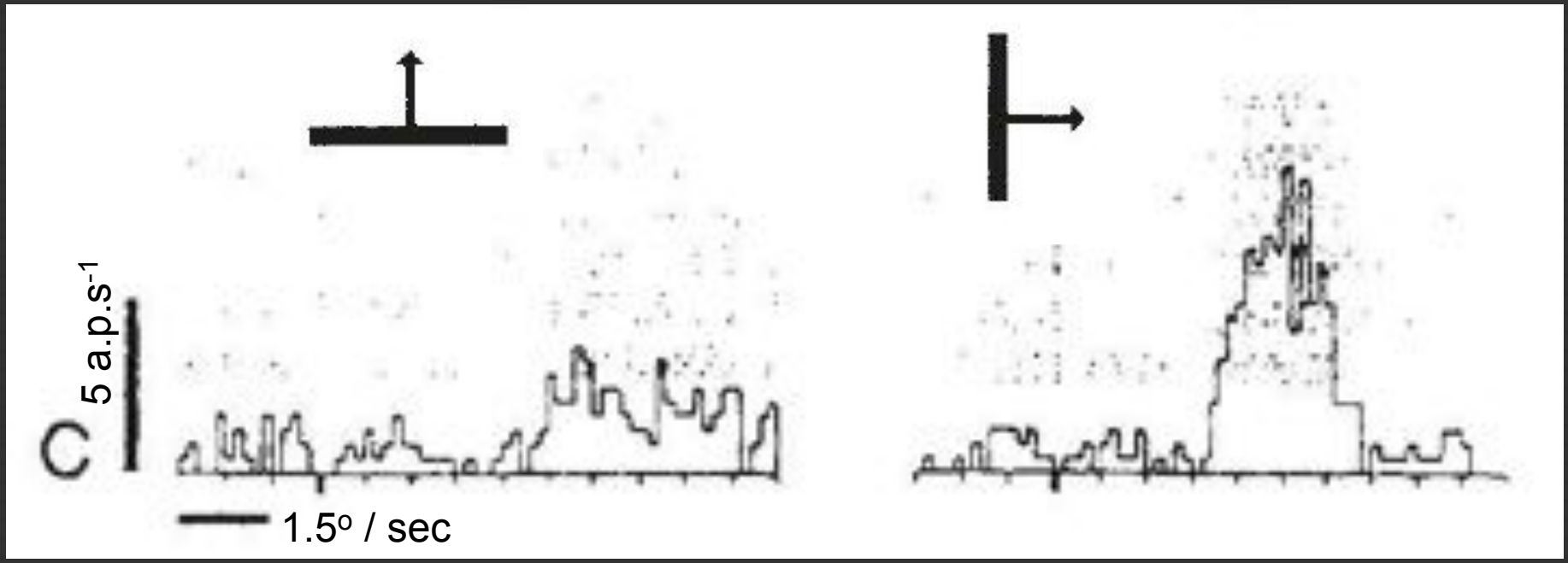
Recording and Stimulation

- ephys single unit electrodes
  - recorded action potentials
- iontophoresis
  - K+ stimulation
  - Cl- inhibition
- visual stimuli paired with
  - stimulation
  - inhibition

Experiment 1
Orientation preference change

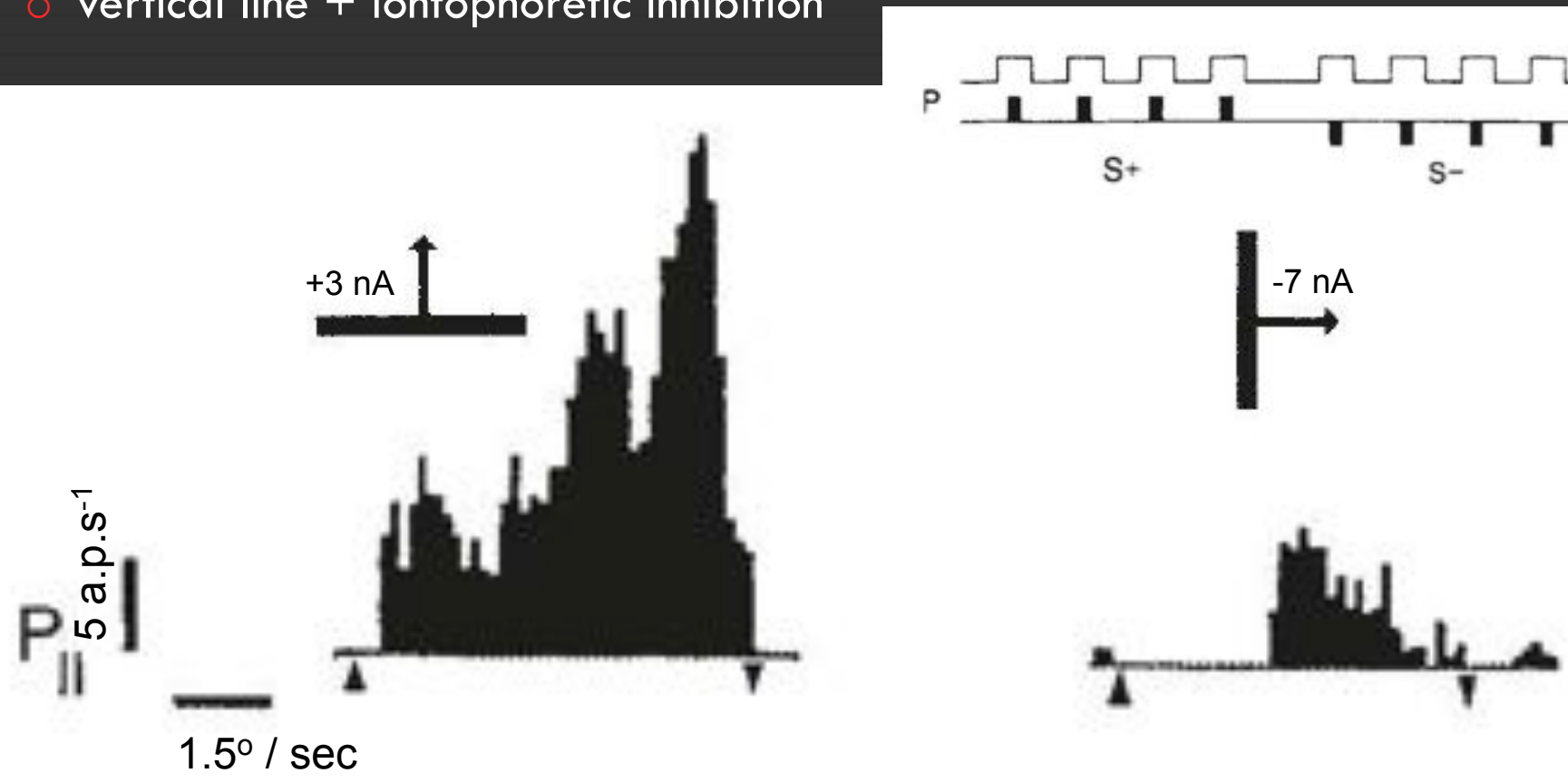
- Step 1 - Find the neuron
  - Find neuron that responds selectively to vertical but not horizontal stim
  - Stimuli: solid line swept across a visual field at 1.5° per second

Peristiumulus Time Histograms - action potentials per second per 1.5°



Experiment 1
Orientation preference change

- Step 2 - Train the neuron
  - horizontal line + iontophoretic activation
  - vertical line + iontophoretic inhibition



Plasticity in the Visual Cortex

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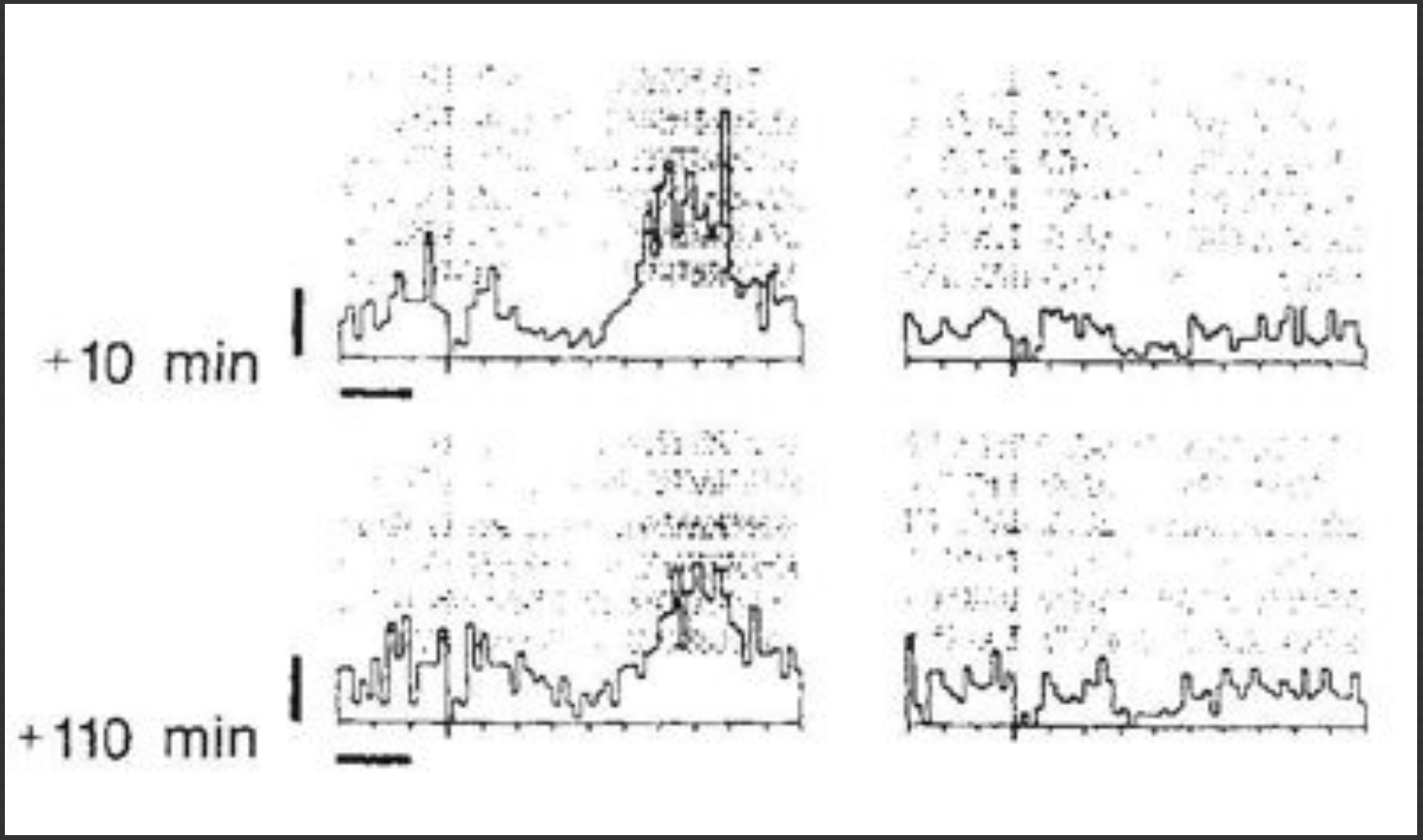
Experiment 1
Orientation preference change

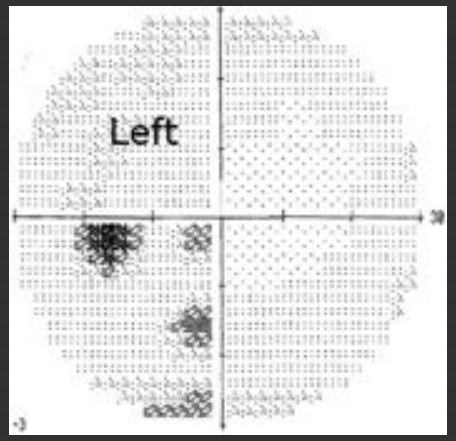
- Step 3 - Measure the effect
  - trained activation/inhibition response lasted at least 110 min



Damage to the Visual System

Damage to Primary Visual Cortex

- Scotomas
  - Areas of blindness in contralateral visual field due to damage to primary visual cortex
  - Detected by perimetry test

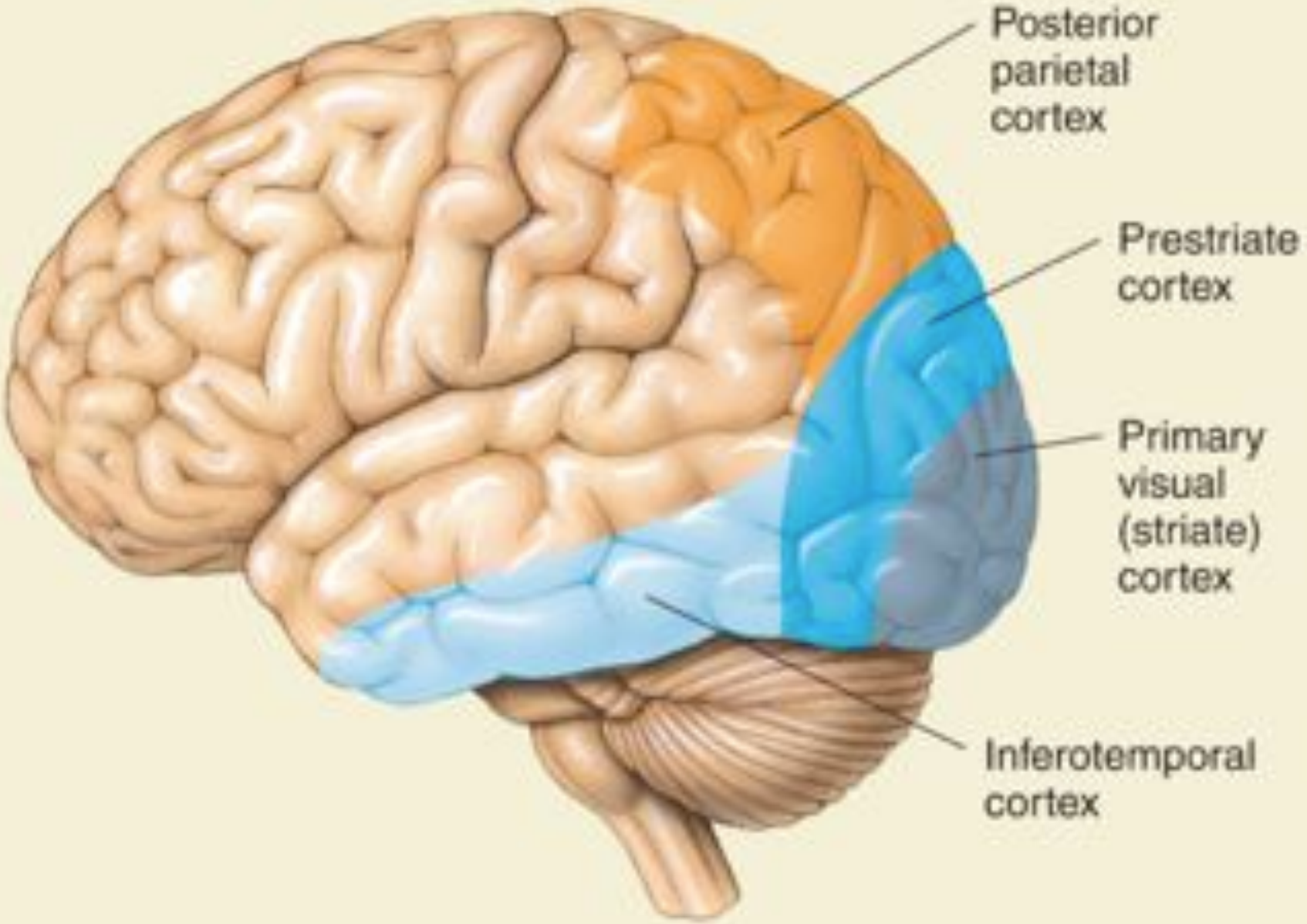


- Completion
  - Patients may be unaware of scotoma – missing details supplied by “completion”

Damage to primary visual cortex cont.

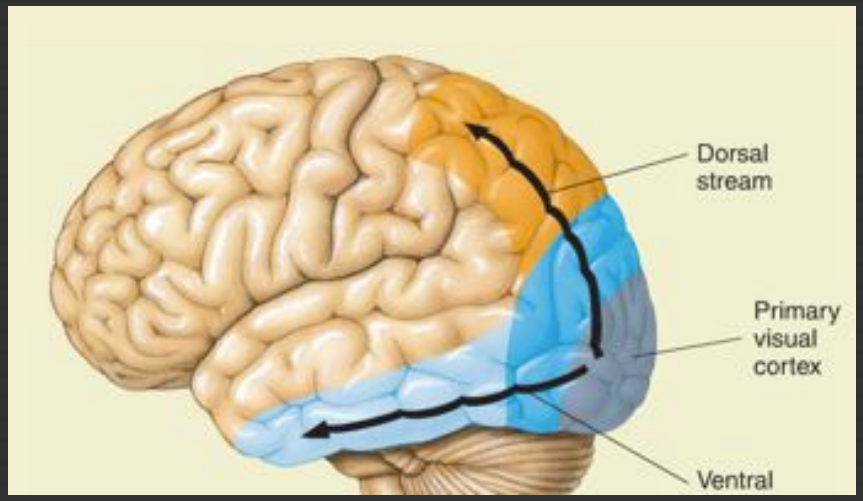
- Blindsight
  - Response to visual stimuli **outside conscious awareness**
  - Reaching to grab a moving object located in scotoma
  - Possible explanations of blindsight
    - Direct connections between subcortical structures and secondary visual cortex, not available to conscious awareness

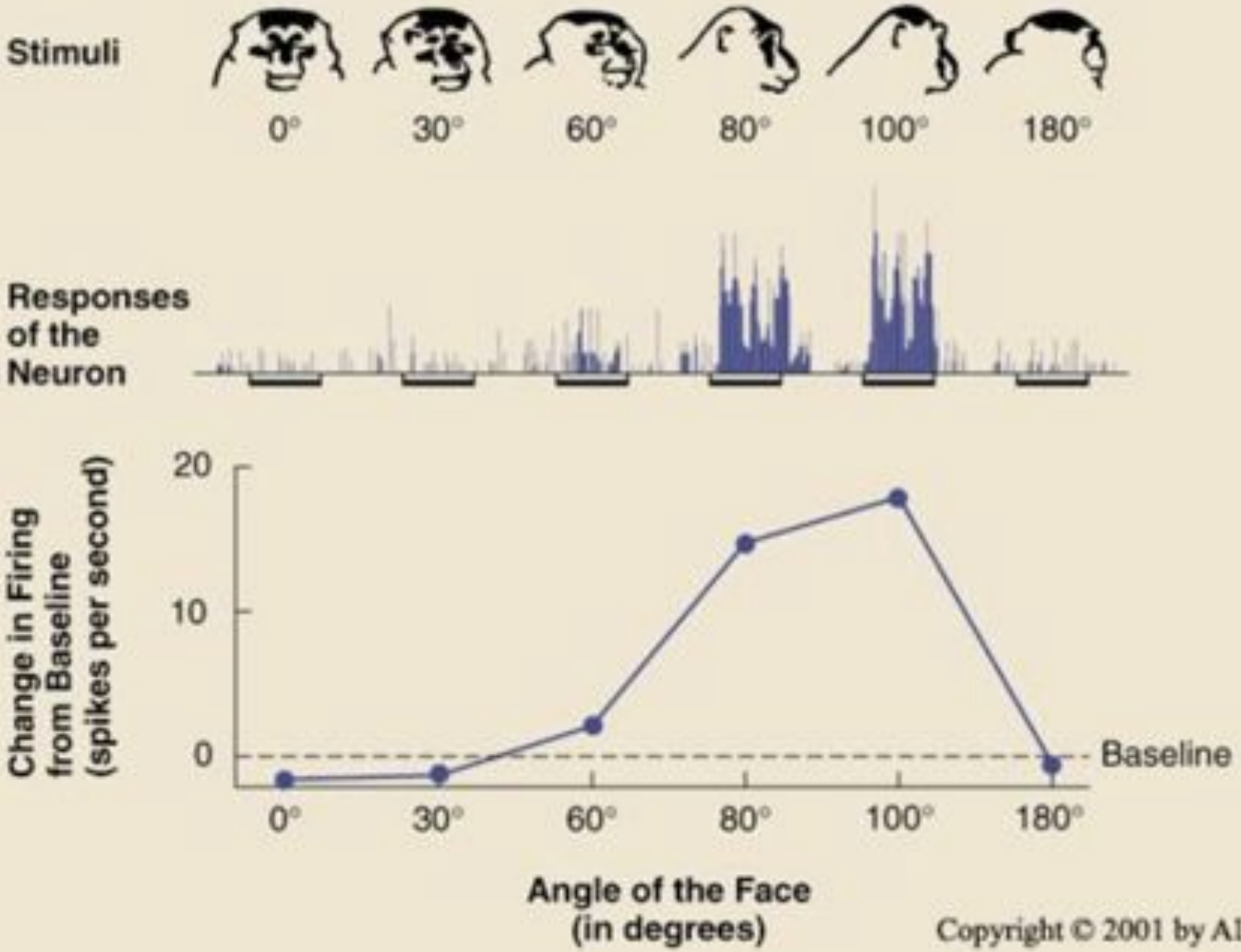
Cortical Mechanisms of Vision


Posterior parietal cortex
Prestriate cortex
Primary visual (striate) cortex
Inferotemporal cortex

Dorsal and Ventral Streams

- **Dorsal stream:**
  - dorsal prestriate cortex to posterior parietal cortex
  - The "where" pathway (location and movement), or
  - Pathway for control of behavior (e.g. reaching)
- **Ventral stream:**
  - ventral prestriate cortex to inferotemporal cortex
  - The "what" pathway (color and shape), or
  - Pathway for conscious perception





Ventral Stream Damage - Prosopagnosia

- Inability to distinguish among faces
- Prosopagnosia is associated with damage to the ventral stream between the occipital and temporal lobes
  - Fusiform face area
- Indicates a specialized function for “What” processing

Conclusion

- Questions?