

MIT OpenCourseWare  
<http://ocw.mit.edu>

## 9.35 Sensation And Perception

Spring 2009

For information about citing these materials or our Terms of Use, visit: <http://ocw.mit.edu/terms>.



# 9.35 Recitation 1

Eye and Retina



# Hello, my name is...

- And I've worked on...

- And you?

# Early Ideas

- **"In man, soul and body touch each other only at a single point, the pineal gland in the head."**
  - Renee Descartes



# Early Ideas

Figures removed due to copyright restrictions.



# Early Ideas

- Is there really a homunculus?

# Rays are not Colored

- “And if at any time I speak of Light and Rays as coloured or endued with Colours, I would be understood to speak not philosophically and properly... **For the Rays to speak properly are not coloured.** In them there is nothing else than a certain Power and Disposition to stir up a Sensation of this or that Colour.”
  - Sir Isaac Newton, *Opticks*, 1730



# Better Ideas

- Neurons, not the soul, process light!

Figures removed due to copyright restrictions.



# But Wait!

- What's a neuron??

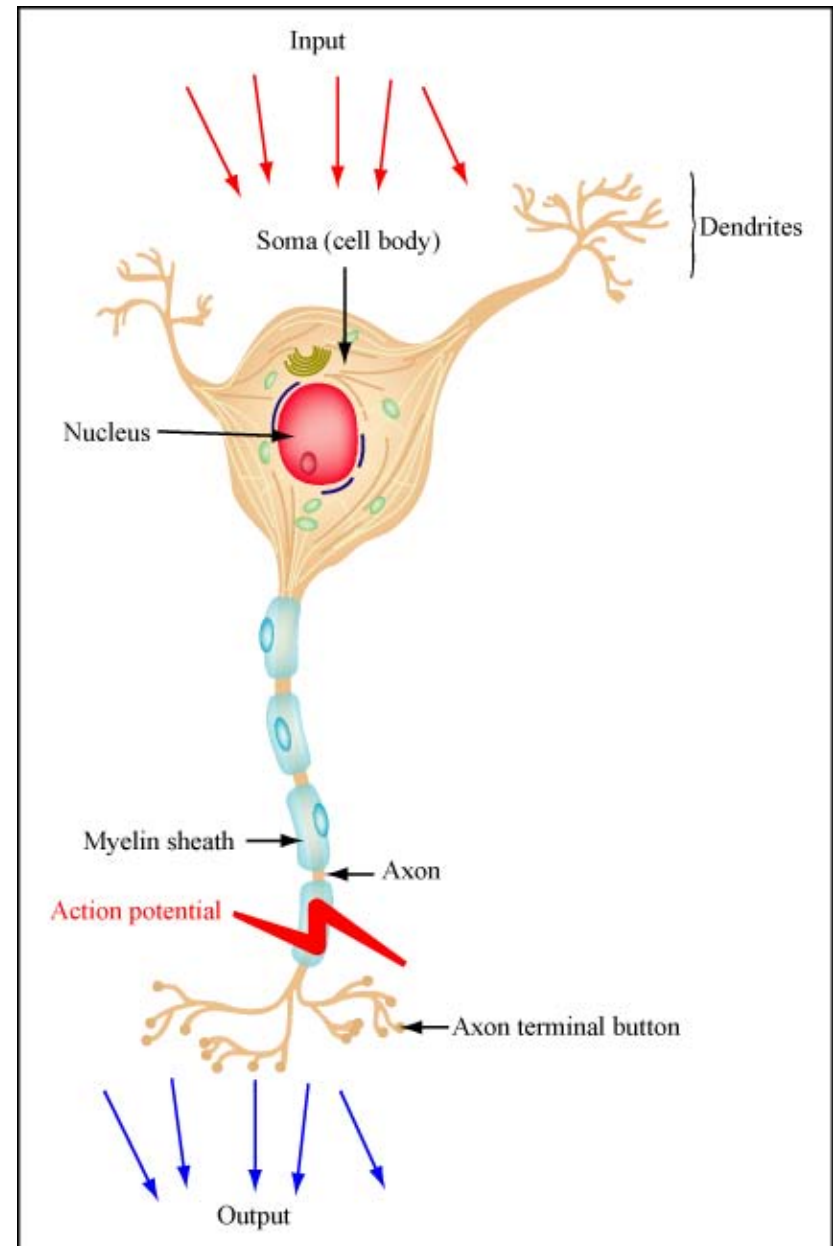


Figure by MIT OpenCourseWare.

# But Wait!

- What's a neuron?

- A neuron knows nothing but it's input

- NT's change electrical potential across membrane of neuron
    - Neuron can then release NT's on other neurons

- Receptive Field

- Really, just the input to a neuron
    - By extension, the properties of the world that influence firing

# But Wait!

- What's a neuron?

- Nothing magic, but our senses/thoughts can only be conveyed through electricity!

- Law of Specific Nerve Energy

# But Wait!

- We will discuss recordings:

Figure removed due to copyright restriction.



# Retina

Figures removed due to copyright restrictions.



# Photoreceptors

Figures removed due to copyright restrictions.

# Bipolars

- ON/OFF

Figures removed due to copyright restrictions.

# Horizontal Cells

- 1<sup>st</sup> step of lateral inhibition

Figures removed due to copyright restrictions.





# Lateral Inhibition

- Wolfe *et al*: Ambient light invariance
- But, this is really about *edge detection*

# Ganglion Cells

- RGC's have the most lateral inhibition
  - Depolarization -> AP's
  - Almost perfect inhibition
  - Linear Summation
  - Difference of Gaussians

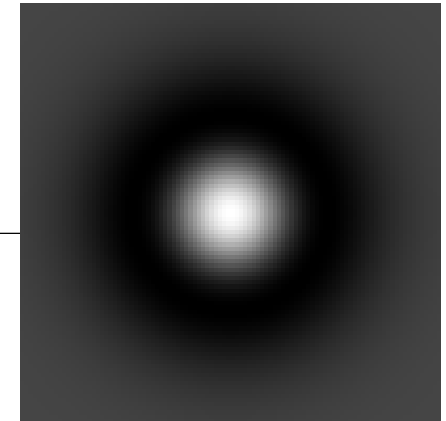
Figures removed due to copyright restrictions.

# Sombbrero Function

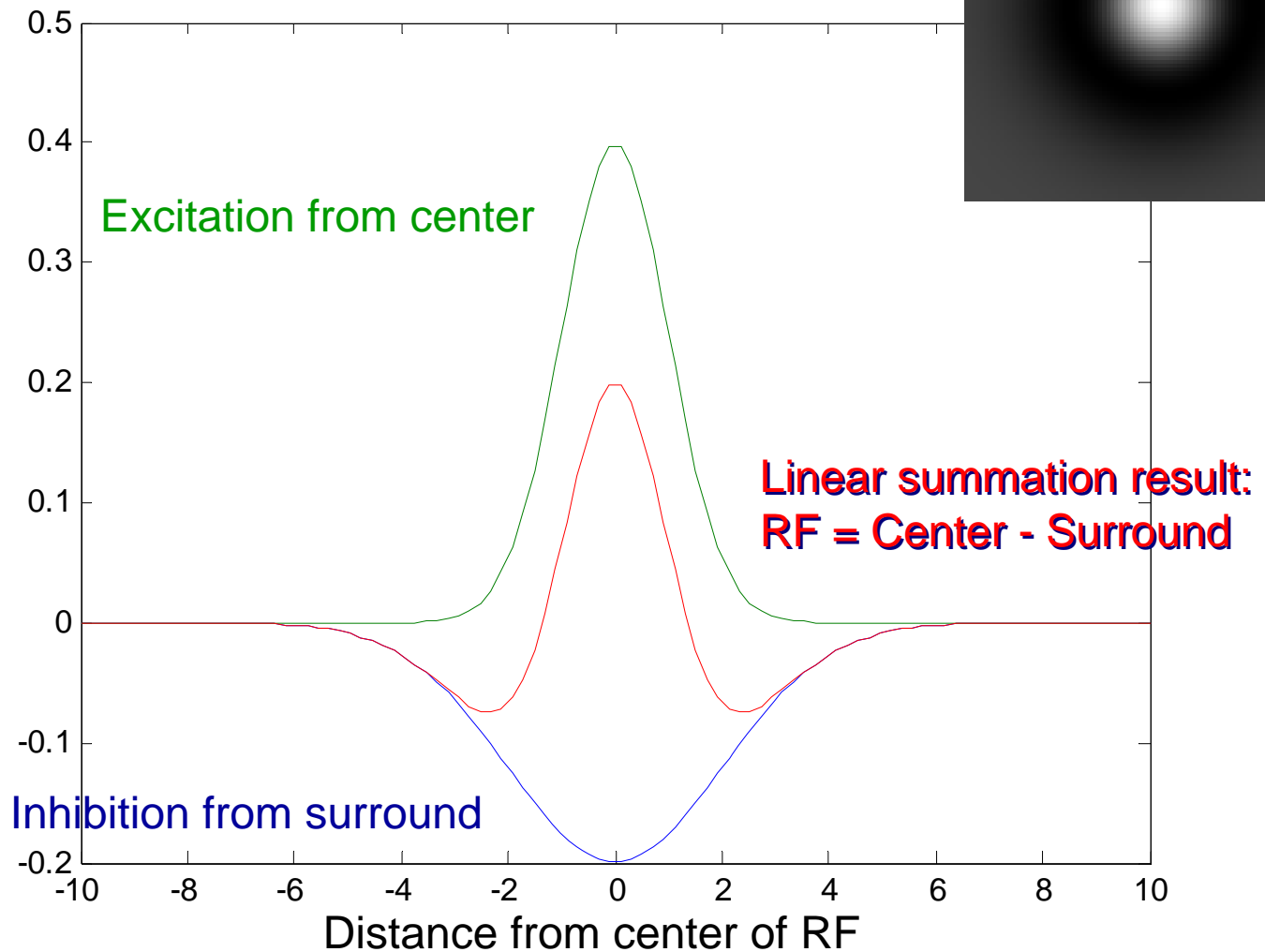
- How does this RF detect edges?

Figures removed due to copyright restrictions.

# Sombbrero Function



Cell Response





# Convolution

Figures removed due to copyright restrictions.



# Mach Bands

Figures removed due to copyright restrictions.

# Grids

- DOG's explain some effects...

Figures removed due to copyright restrictions.



# Grids

- But not others!

Figures removed due to copyright restrictions.





# Midgets and Parasols

- In addition to ON/OFF pathways, there is a second parallel system

# Midgets and Parasols

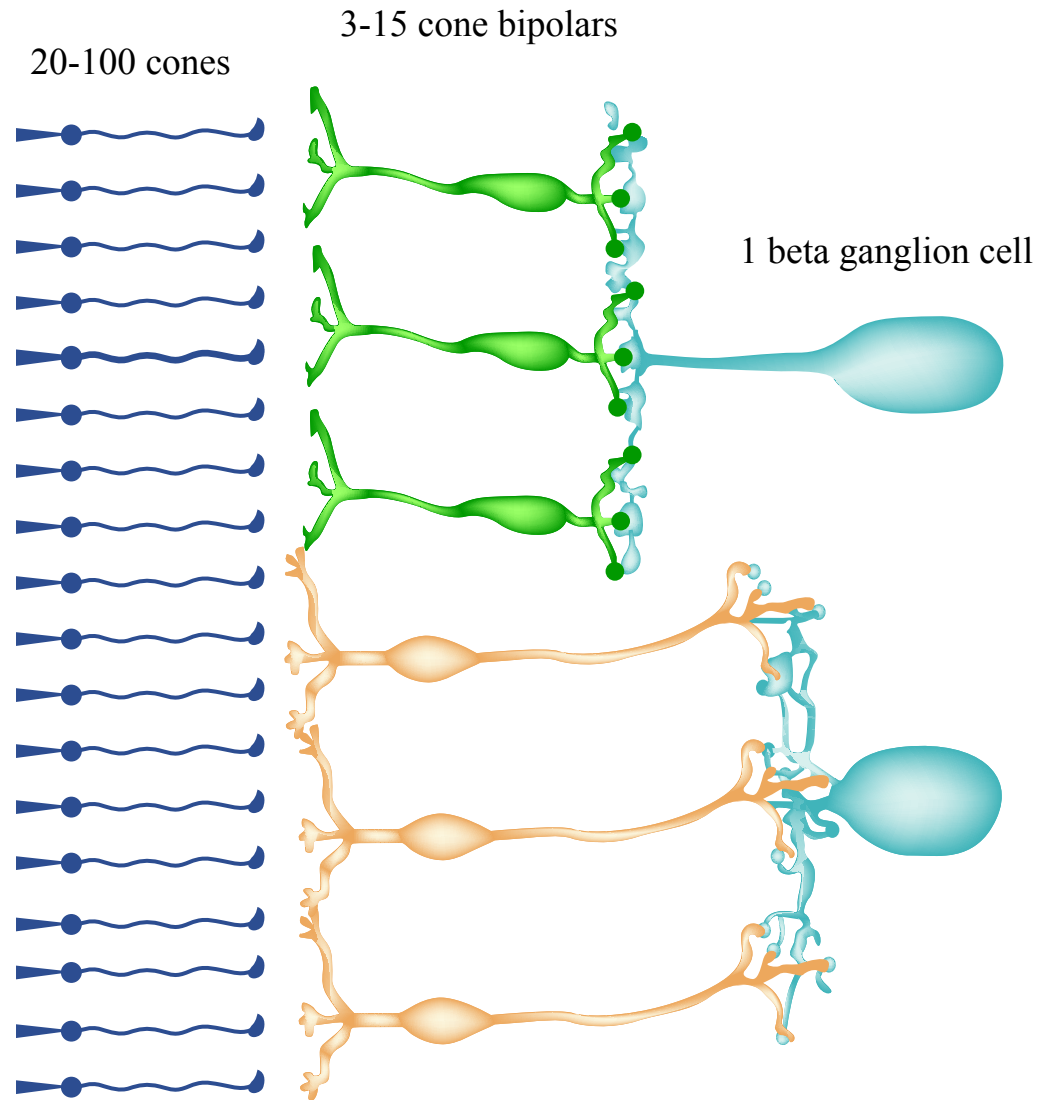
- Midgets/beta/X ganglion cells
  - Small, slow AP's, small RF, colored, linear
- Parasols/alpha/Y ganglion cells
  - Large, fast AP's, large RF, nonlinear, motion sensitive
- Names depend on species and method of discovery, assumed homologous

# Midgets

- Small RF's

- (1 cone center near fovea)

webvision



**Convergence of cones and bipolar cells upon ON- and OFF-center beta cells.**

# Midgets

## ■ Small RF's

webvision

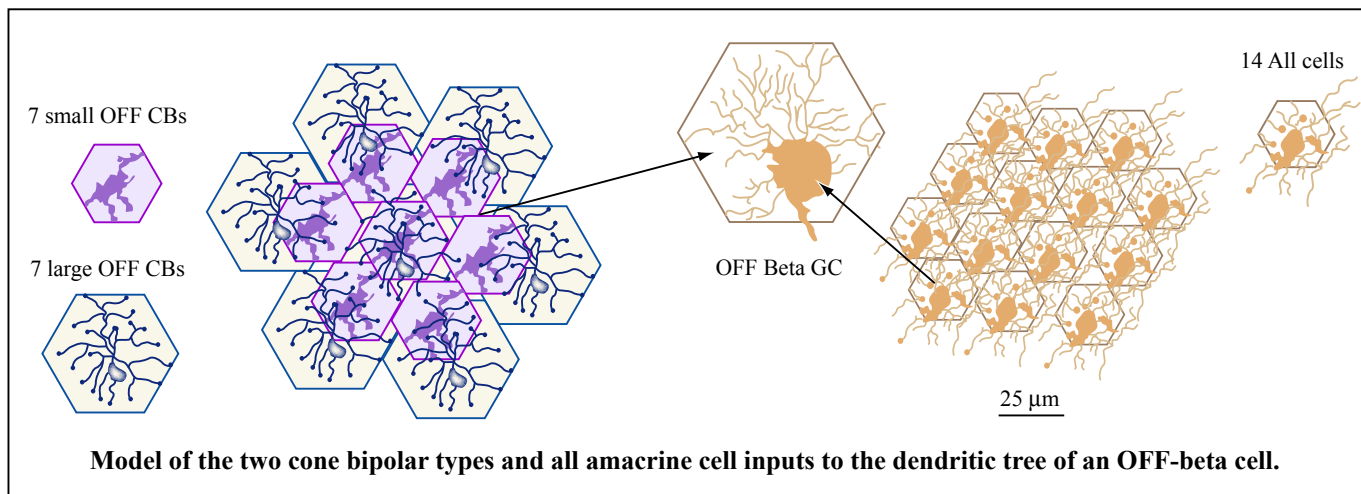


Figure by MIT OpenCourseWare.

# Midgets

## ■ Linear summation responses

- Because they have few cone inputs, can also be color opponents (ie Red Center, Green Surround)

webvision

Figure removed due to copyright restriction.

# Parasols

## ■ HUGE RF's!

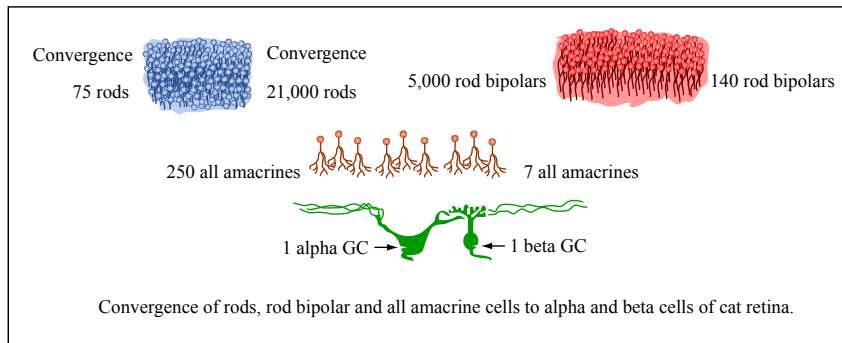


Figure by MIT OpenCourseWare.

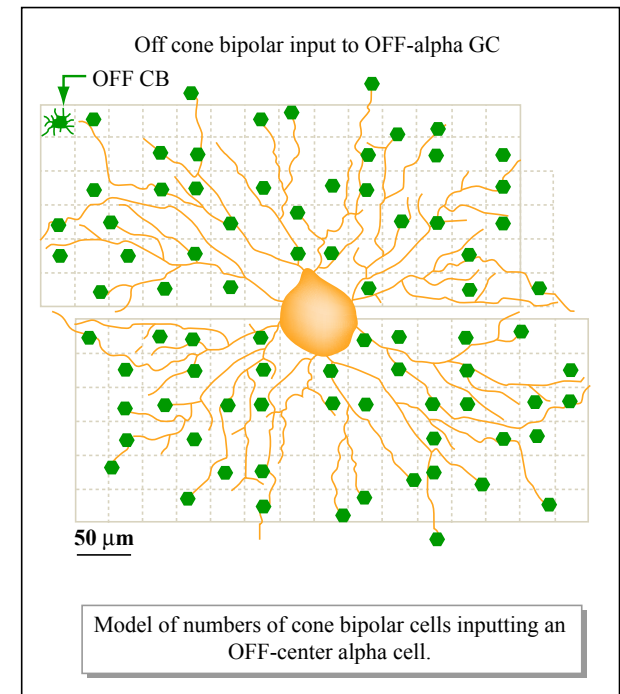


Figure by MIT OpenCourseWare.

# Midgets and Parasols

## ■ Midgets

- High SF, -> Parvocellular LGN -> 'What' pathway/ventral visual stream
- If I say 'Ganglion Cell,' this is what I mean!

## ■ Parasols

- Low SF, high temporal frequencies
- -> Magnocellular LGN -> 'What' and 'Where' pathways/dorsal and ventral visual streams

# Reading

- Kolb, *How the Retina Works* (online)
- Understand:
  - Eye structure, 5 basic cell types, adaptation, lateral inhibition, rod/cone, ON/OFF and midget/parasol pathways, receptive fields
- Ignore:
  - Neurotransmitters, rhodopsin, cell subtypes (e.g., All, A17 etc)





# Additional Resources

- <http://webvision.med.utah.edu>