The optic nerve carries the output of the eye.

Finding the “receptive field”

- Record the action potentials of an axon in the optic nerve
- Present visual stimuli at various locations
- Find the location at which a stimulus can cause changes in the firing rate.
ON-center cell

- There is a background firing rate.
- The rate increases when the stimulus is in the receptive field (drawn circle).

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The cornea is more refractive than the lens of the eye

Refraactive Power (Diopters) = \( \frac{1}{\text{Focal Distance (m)}} \)

Five classes of cells

• Vertical elements
  – photoreceptors
  – bipolar cells
  – ganglion cells

• Horizontal elements
  – horizontal cells
  – amacrine cells
The retina has layers

Image removed due to copyright restrictions.

Retinal circuitry

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The retina, as viewed through an ophthalmoscope.
Figure 9.5 in Bear, Mark F., Barry W. Connors, and Michael A. Paradiso.
Variation in acuity with retinal position

Anstis, 1974
The density of photoreceptors decreases in the periphery.
Rods and cones

Scotopic/night vision 1000 x more light sensitive

Photopic/day vision
Color vision

Membranous disks containing photopigment

Cell bodies

Synaptic terminals

Inner segments

Cone photoreceptor

Outer segments

Light causes photoreceptors to hyperpolarize

- Dark current due to open sodium channels
- Light depletes cGMP, closing sodium channels

ON and OFF bipolar cells

• Light has different effects on bipolar cells
• ON cells depolarize
• OFF cells hyperpolarize
Transient vs. sustained responses

- Stimulus

- Response

- time
Temporal antagonism

- Stimulating the center causes a transient increase.
- Removal of the stimulus causes a transient decrease (relative to background).

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Center-surround antagonism

- **OFF-center prefers:**
  - dark spot in center
  - light annulus

- **ON-center prefers:**
  - light spot in center
  - dark annulus

Horizontal cells are coupled by gap junctions

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Xin and Bloomfield
Resistive network model

Silicon retina

- Neuromorphic VLSI
- K. Zaghloul and K. Boahen, 2004

Chevreul’s illusion
Light: reality vs. perception

physical stimulus → subjective perception
Receptive field model