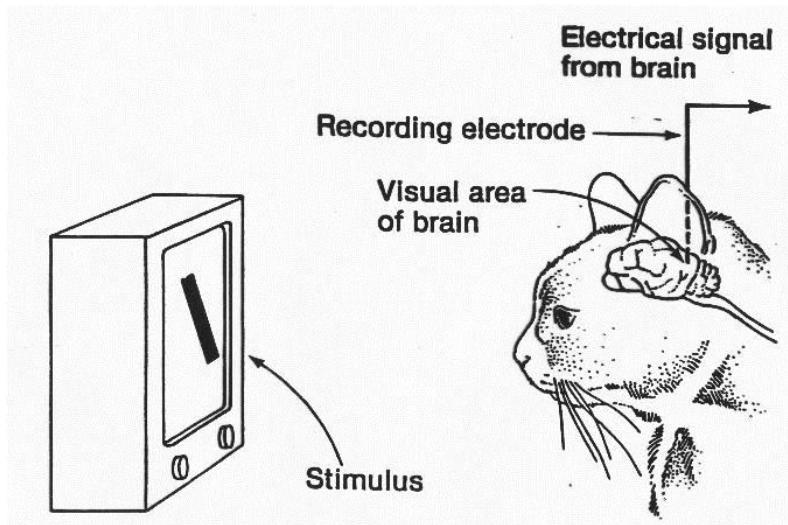


What is Computational Neuroscience?

- ♦ “The goal of computational neuroscience is to explain in computational terms *how brains generate behaviors*” (T. Sejnowski)
- ♦ Computational neuroscience provides tools and methods for “characterizing *what* nervous systems do, determining *how* they function, and understanding *why* they operate in particular ways” (P. Dayan and L. Abbott)
 - ⇒ Descriptive Models (*What*)
 - ⇒ Mechanistic Models (*How*)
 - ⇒ Interpretive Models (*Why*)

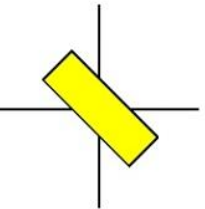
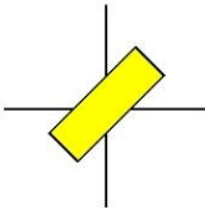
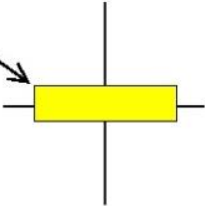
An Example: Models of “Receptive Fields”

Responses of a Neuron in an Intact Cat Brain

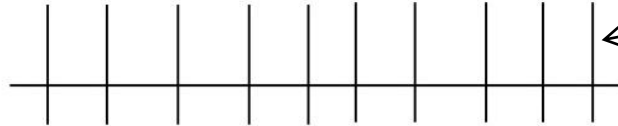


(Hubel and Wiesel, c. 1965)

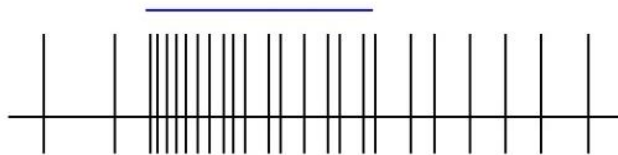
Bar of
Light



Light on



A "spike" from the
recorded neuron



0.5 seconds

Receptive Field

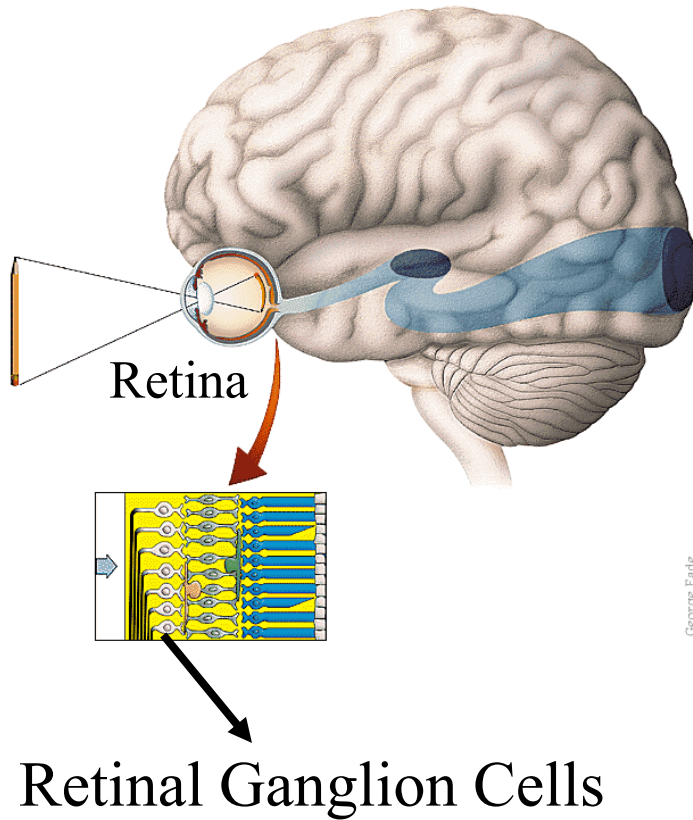
- ♦ Definition: *Specific properties* of a sensory stimulus that generate a strong response from the cell
- ♦ Examples:
 - ⇒ Spot of light that turns on at a particular location on the retina
 - ⇒ Bar of light that turns on at a particular orientation and location on the retina

Receptive Field Models

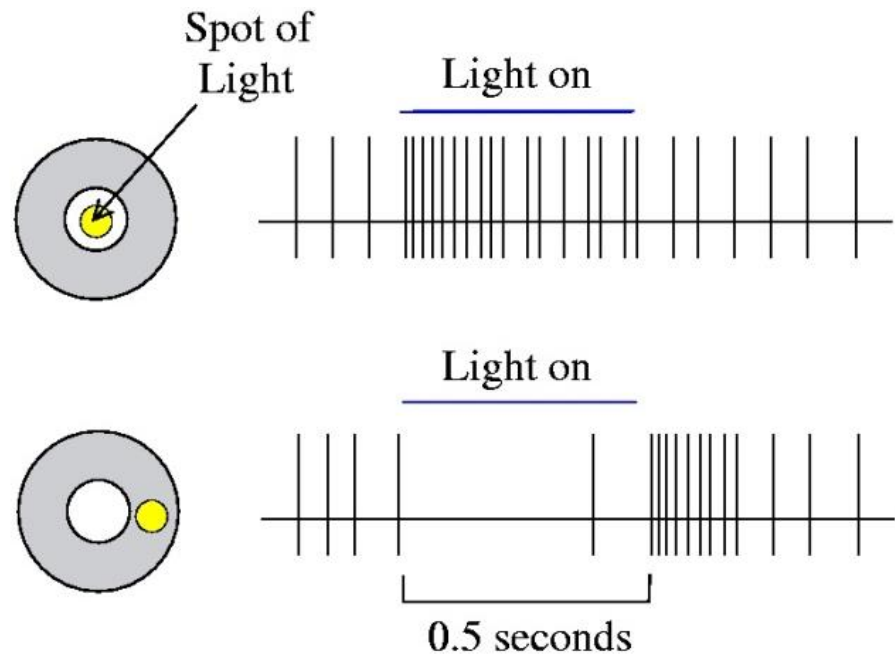
Let's look at:

- I. A *Descriptive Model* of Receptive Fields
- II. A *Mechanistic Model* of Receptive Fields
- III. An *Interpretive Model* of Receptive Fields

I. Descriptive Model of Receptive Fields



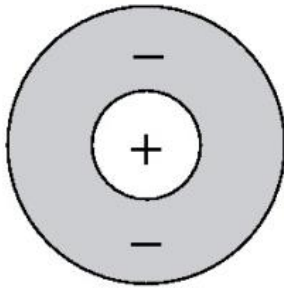
Receptive Fields in the Retina



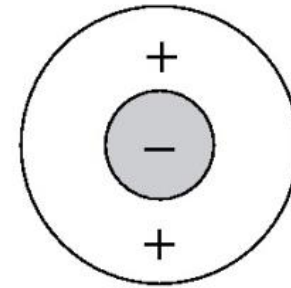
**ganglion cells convey info about the image
to the lateral geniculate nucleus (LGN)**

I. Descriptive Model of Receptive Fields

Center-Surround Receptive Fields in the Retina



On-Center
Off-Surround
Receptive Field



Off-Center
On-Surround
Receptive Field

When a cell has an "on-center, off-surround" receptive field, which center is being referred to?

- ☐ The center of the entire retina.
- ☒ The center of the small patch of retina associated with the cell.

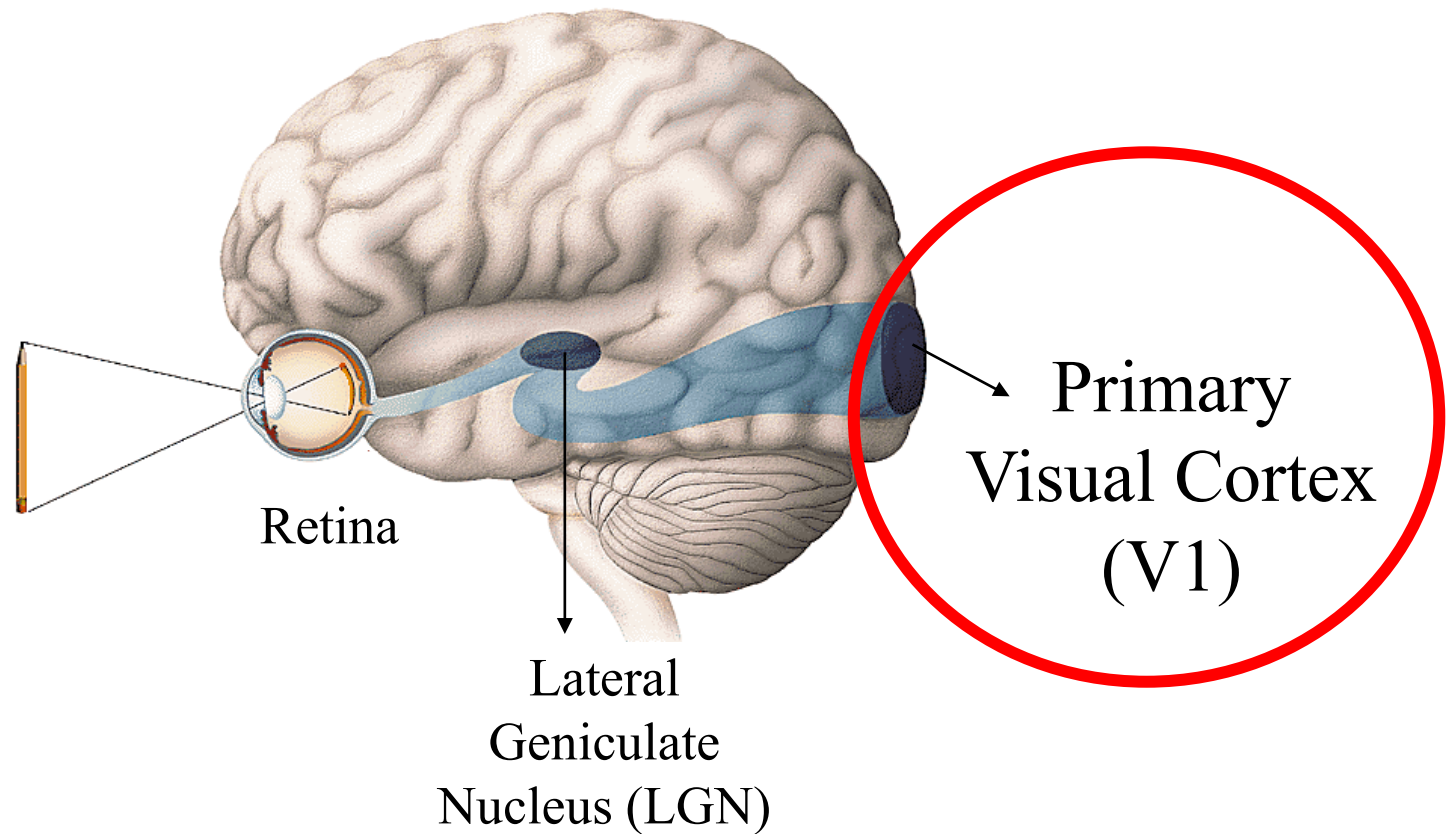
Correct

Each cell tends to respond to light input in only a small area of the retina and visual field. An on-center, off-surround cell becomes more active when only the center of this area is illuminated and less active when the only edges of this area (the surround) are illuminated. Generally a cell is not affected much by input in far away areas of the retina (although recent studies have begun to show that some subtle long-range communication may exist).

- ☐ The center of the visual field.
- ☐ None of these.

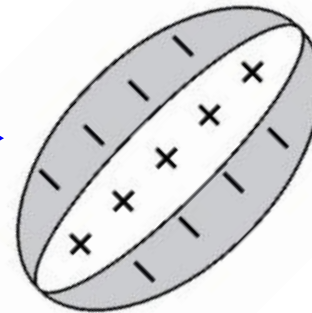
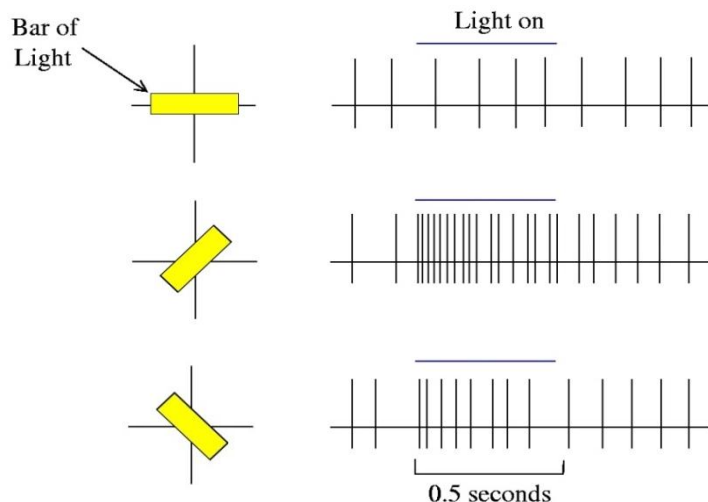
The On-Center / Off-Surround receptive field can be thought of as a filter, which is causing more activation when the light is concentrated in the center of the receptive field, and less when more light on the outside.

Descriptive Models: Cortical Receptive Fields



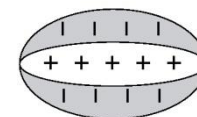
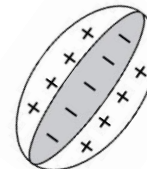
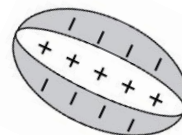
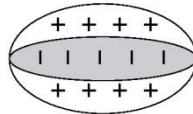
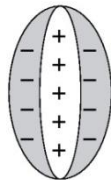
Descriptive Models: Cortical Receptive Fields

Orientation Preference

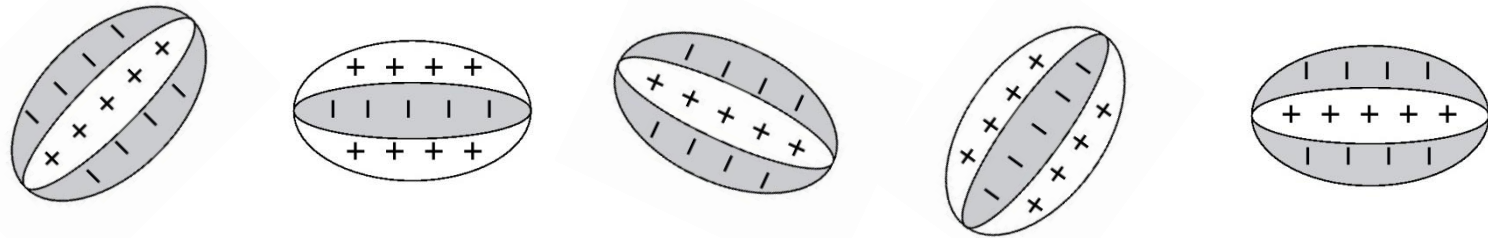


Oriented
receptive field
of a neuron in
primary visual
cortex (V1)

Other examples of oriented receptive fields



We will learn later how to quantify these using **reverse correlation**



How are these *oriented* receptive fields obtained from *center-surround* receptive fields?

Next Lecture: **Mechanistic** Model of Receptive Fields