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*)
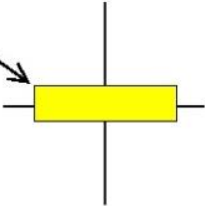 ➪ Interpretive Models (*Why*)

An Example: Models of "Receptive Fields"

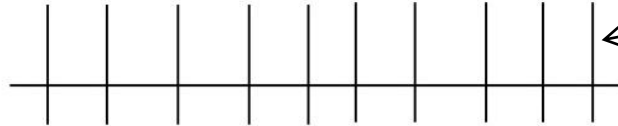## Responses of a Neuron in an Intact Cat Brain
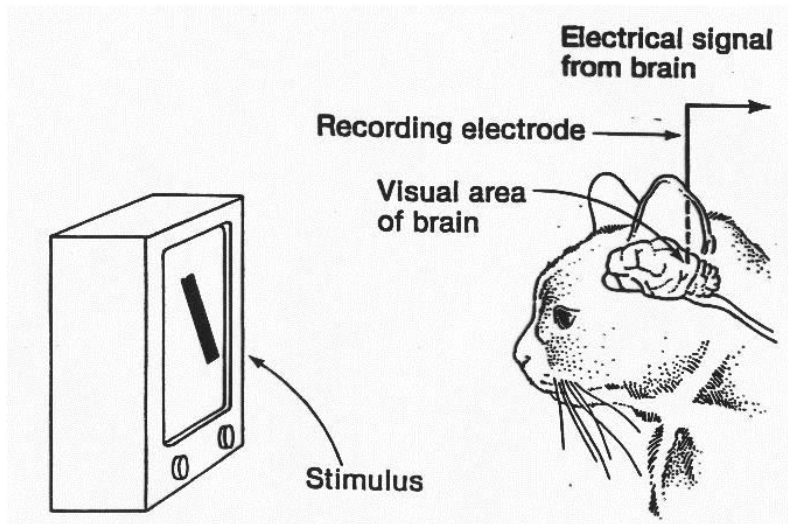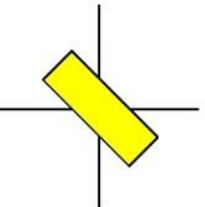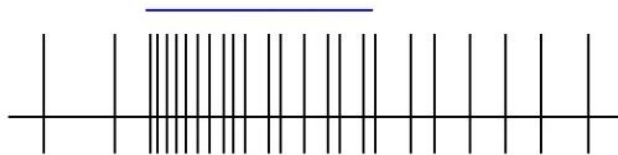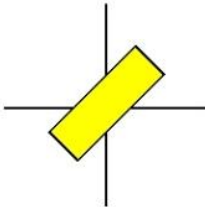

(Hubel and Wiesel, c. 1965)

Bar of
Light

Light on

A "spike" from the
recorded neuron

0.5 seconds

3

Receptive Field

✦ <u>Definition</u>: *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
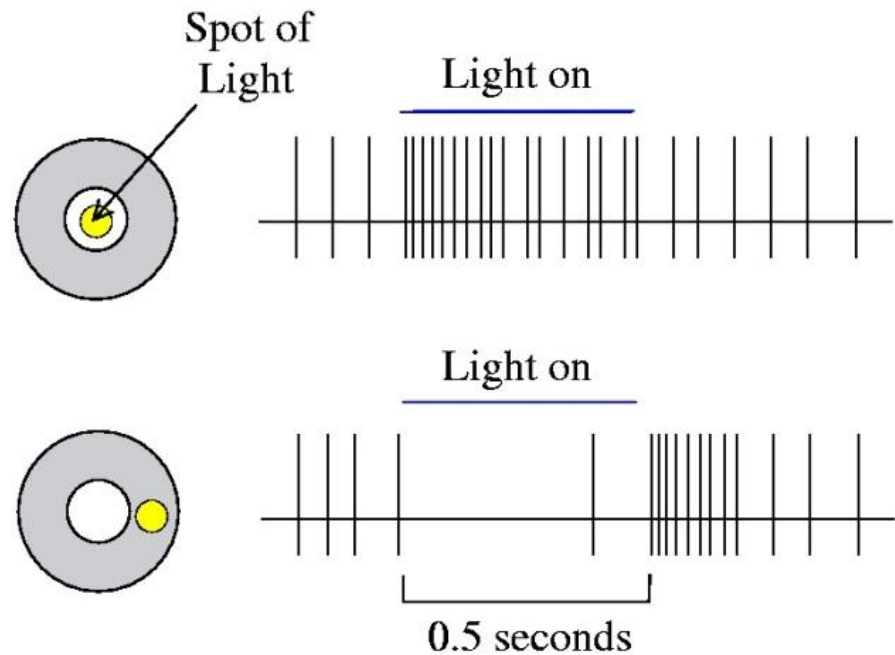
Receptive Field Models

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
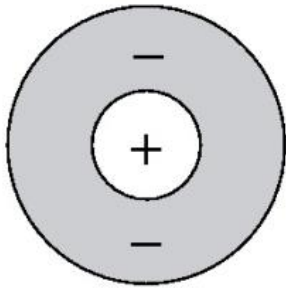
I. Descriptive Model of Receptive Fields

Retina

Retinal Ganglion Cells

Receptive Fields in the Retina

Spot of Light

Light on

Light on
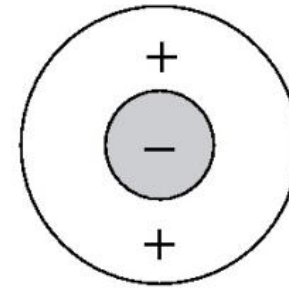
0.5 seconds

George Eade
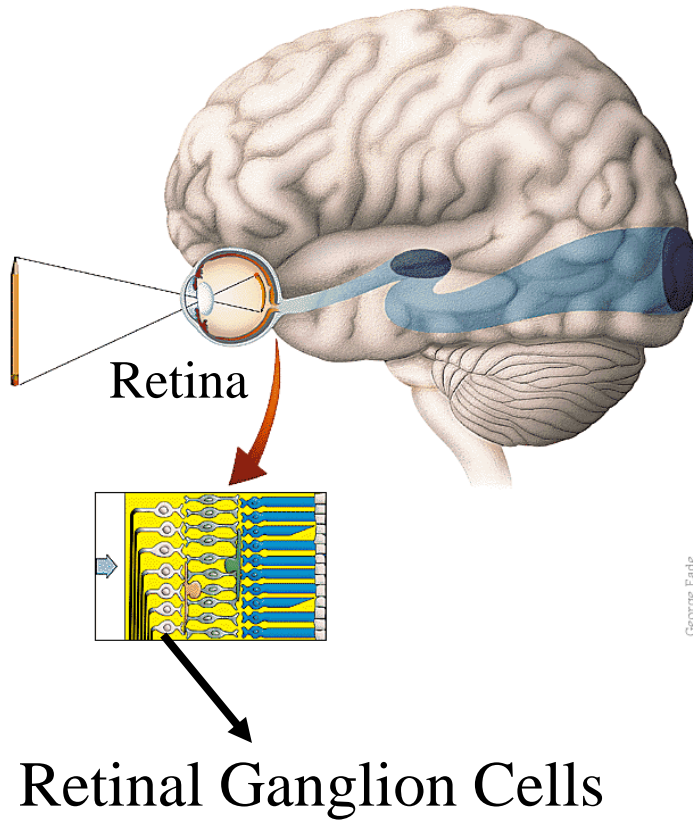
I. Descriptive Model of Receptive Fields

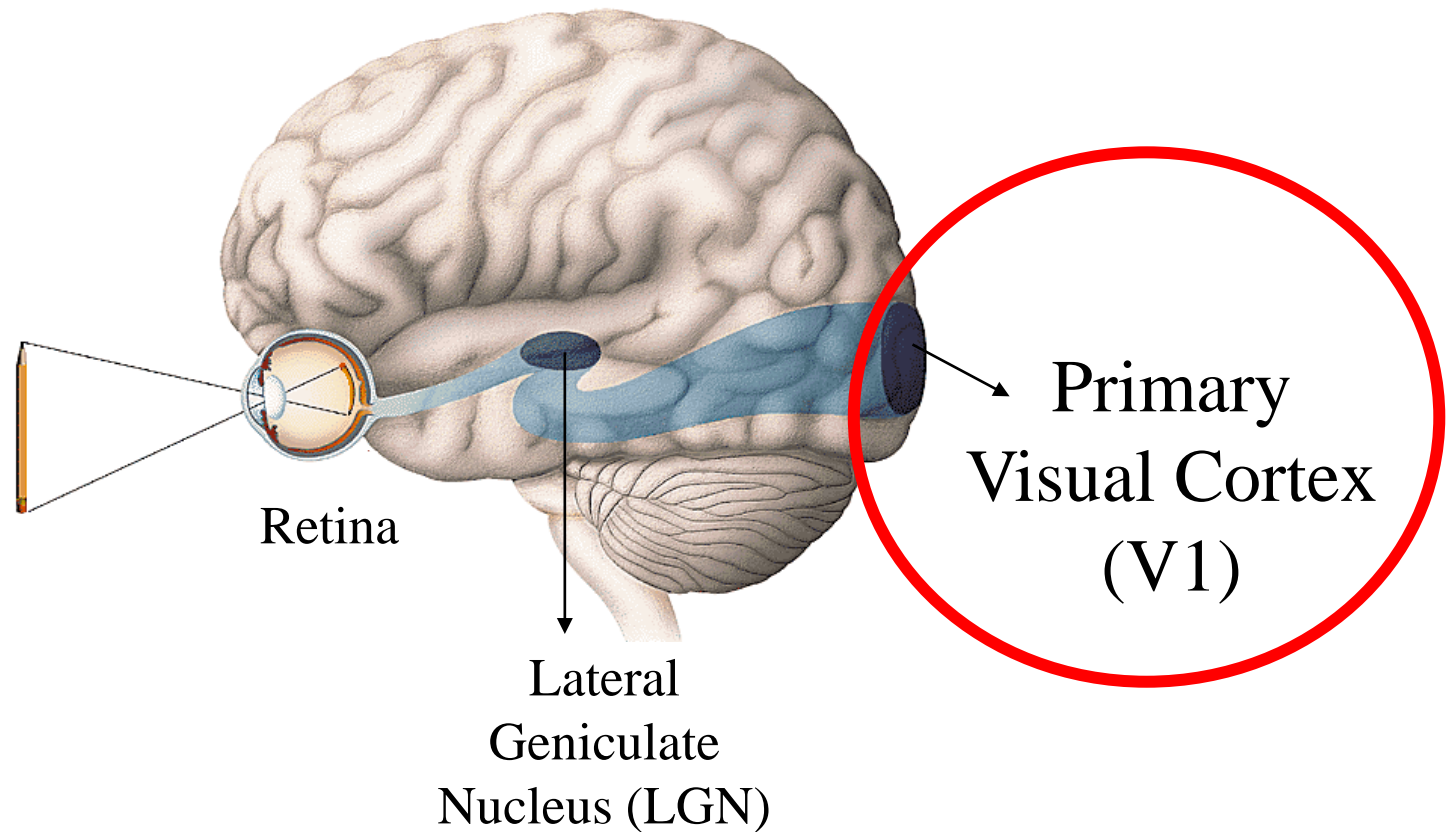## Center-Surround Receptive Fields in the Retina

On-Center
Off-Surround
Receptive Field

Off-Center
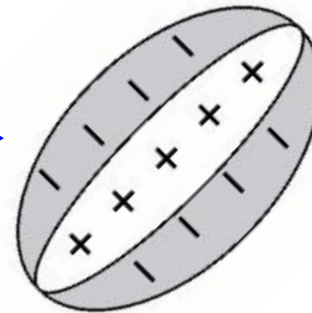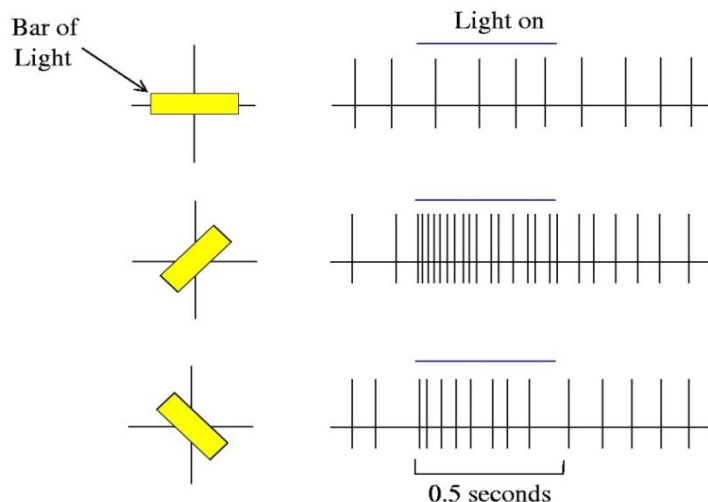On-Surround
Receptive Field

Descriptive Models: Cortical Receptive Fields

Retina

Lateral
Geniculate
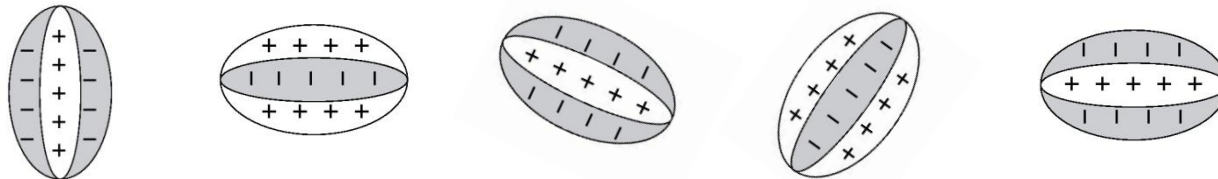Nucleus (LGN)

Primary
Visual Cortex
(V1)

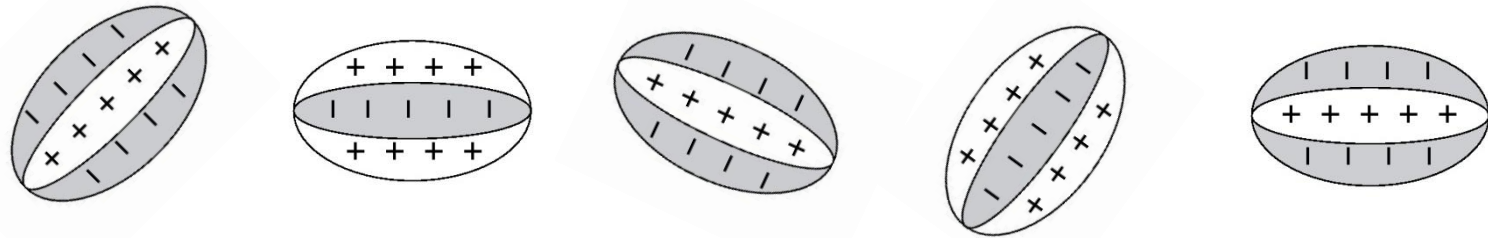# Descriptive Models: Cortical Receptive Fields

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