Vision: From Eye to Brain (Chap 3, Part II)

Lecture 7

Jonathan Pillow
Sensation & Perception
(PSY 345 / NEU 325)
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lateral geniculate nucleus (LGN): one on each side of the brain

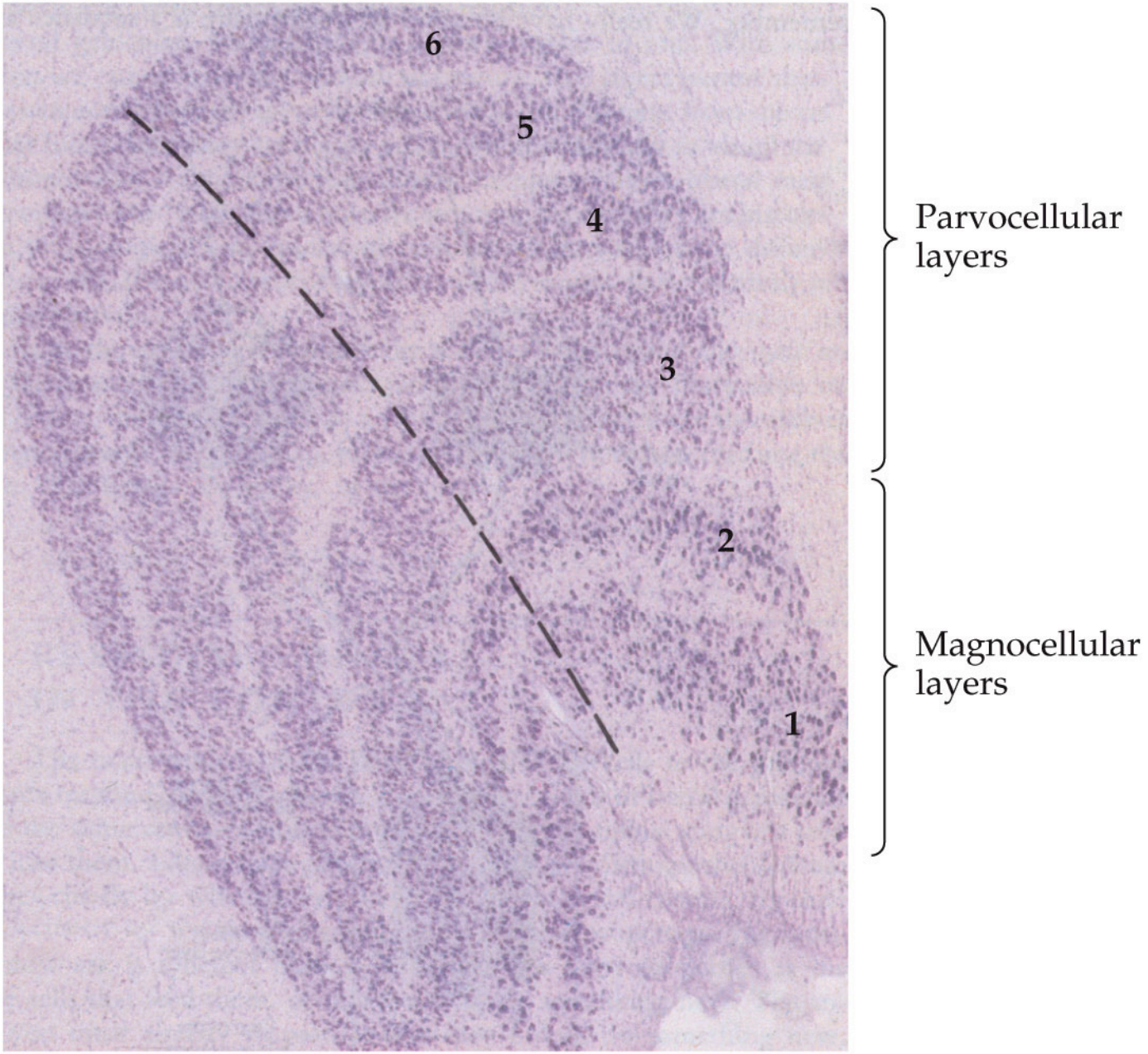
- this is where axons of retinal ganglion cells synapse

Organization:

- represents contralateral visual field
- segregated into **eye-specific** layers
- segregated into M and P layers

Ipsilateral: Referring to the same side of the body

Contralateral: Referring to the opposite side of the body



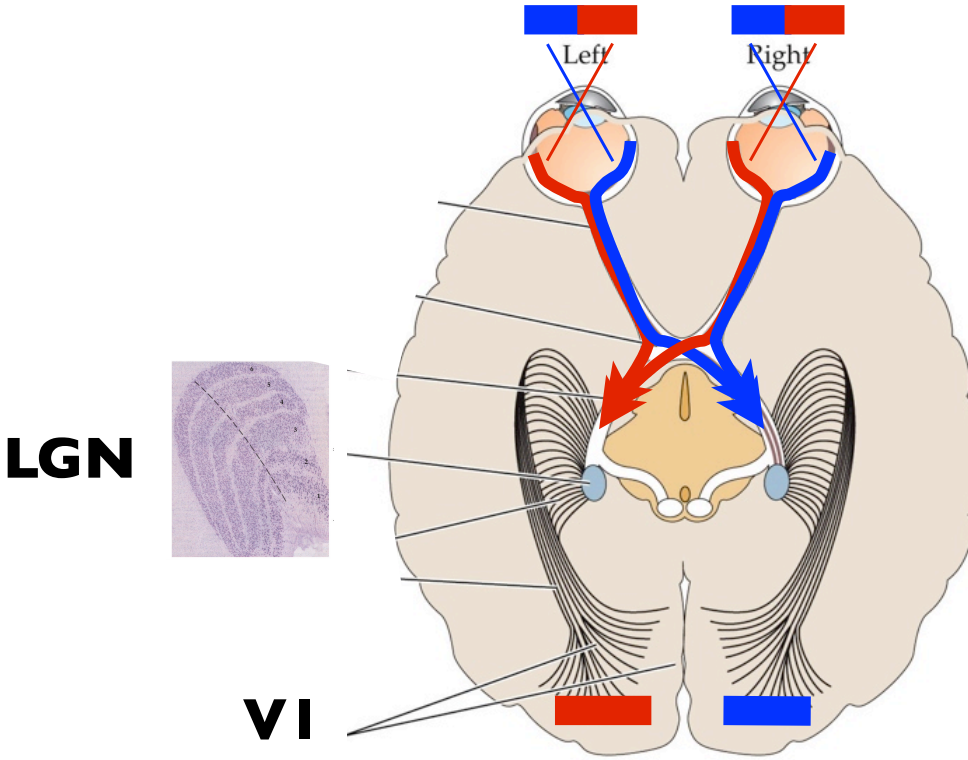
Primary Visual Cortex

- Striate cortex: known as primary visual cortex, or V1
- "Primary visual cortex" = first place in cortex where visual information is processed

  (Previous two stages: retina and LGN are pre-cortical)

Receptive Fields: monocular vs. binocular

- LGN cells: responds to one eye or the other, ***never both***



- V1 cells: can respond to input from **both eyes**

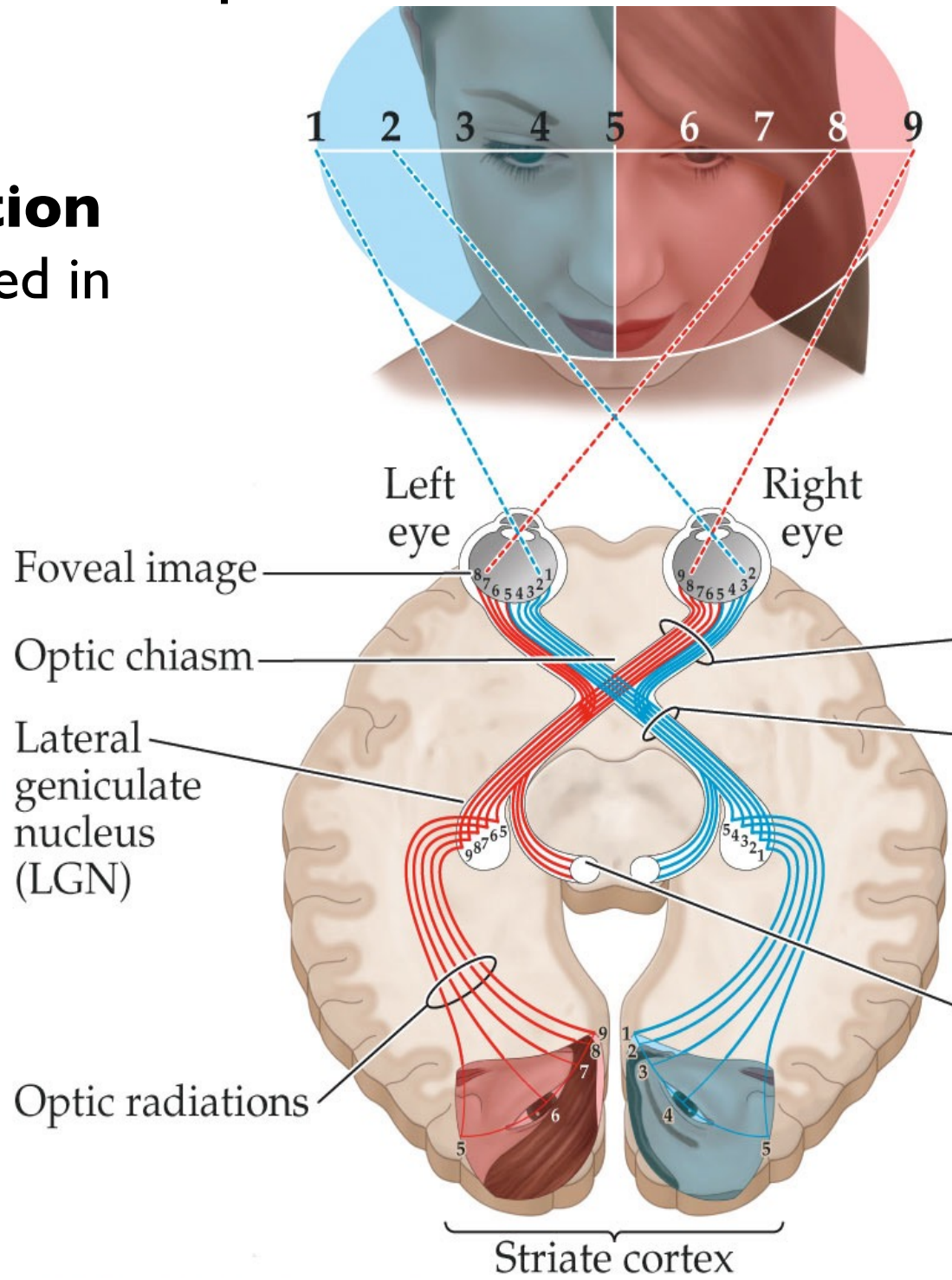
(but V1 neurons still tend to have a ***preferred* eye** - they spike more to input from one eye)

Topography: mapping of visual space onto visual cortex

- **contralateral representation**
  - each visual field (L/R) represented in opposite hemisphere

- **cortical magnification**
  - unequal representation of fovea vs. periphery in cortex

- **but this is a misnomer!**



Acuity in V1

Visual acuity declines in an orderly fashion with ***eccentricity***—distance from the fovea (in deg)

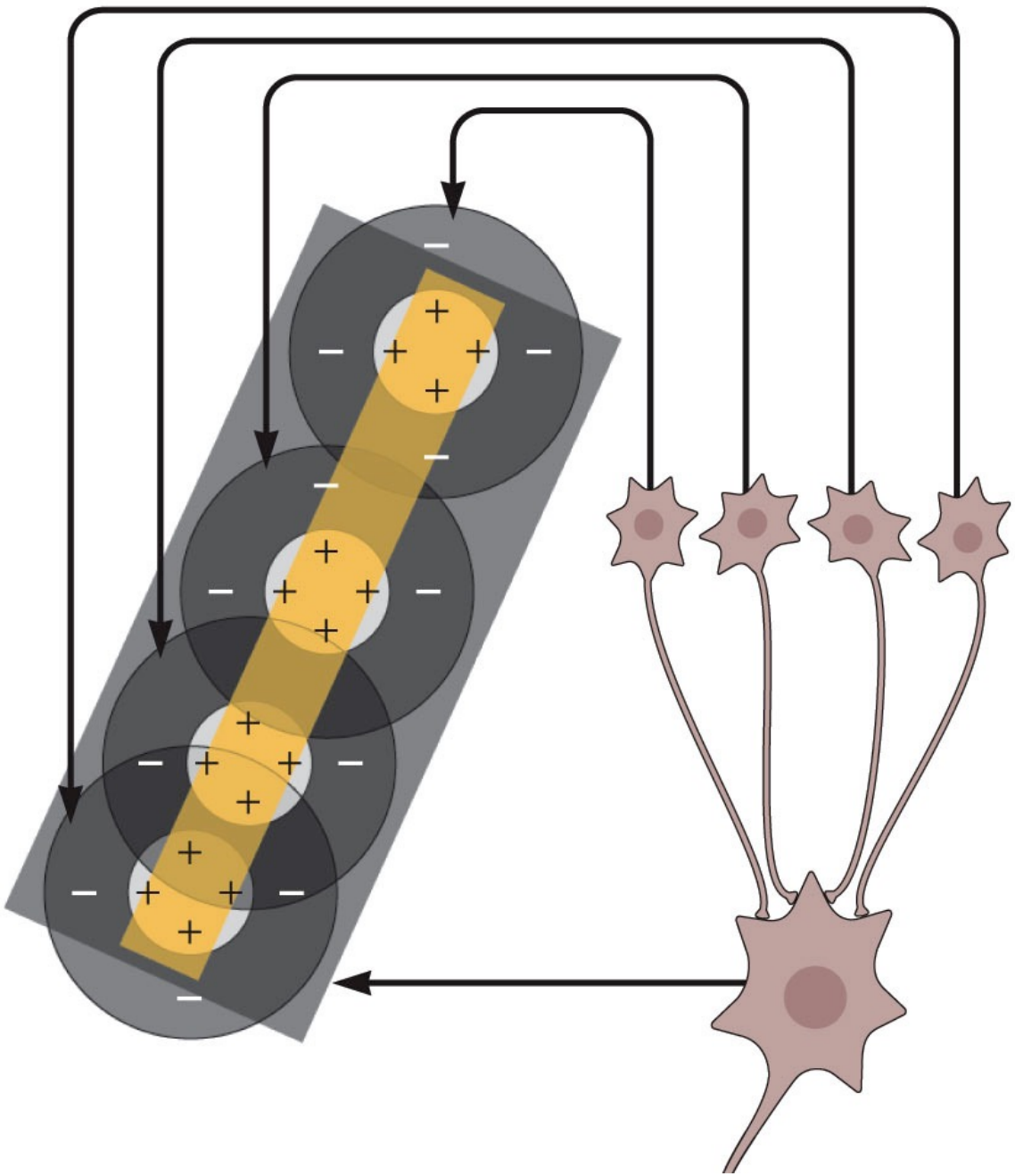
major change in sensory representation in V1

retina & LGN:

- circular RFs
- 1M fibers (from RGCs)

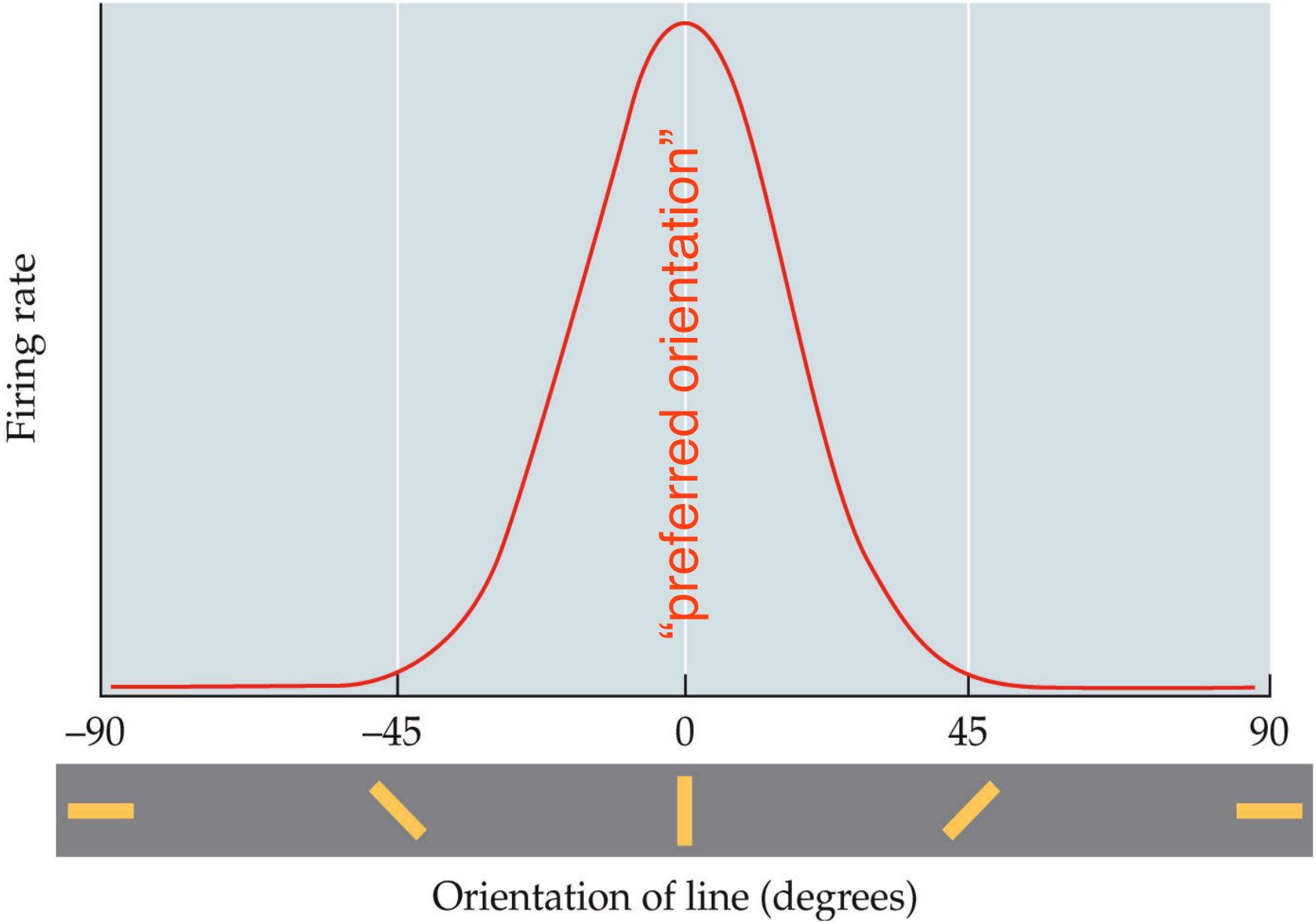
V1

- elongated, oriented RFs
- 200M cells!



Orientation tuning:

- neurons in V1 respond more to bars of certain orientations
- response rate falls off with difference from preferred orientation



Receptive Fields in V1

Many cortical cells respond especially well to:

- Moving lines
- Bars
- Edges
- Gratings
- Direction of motion

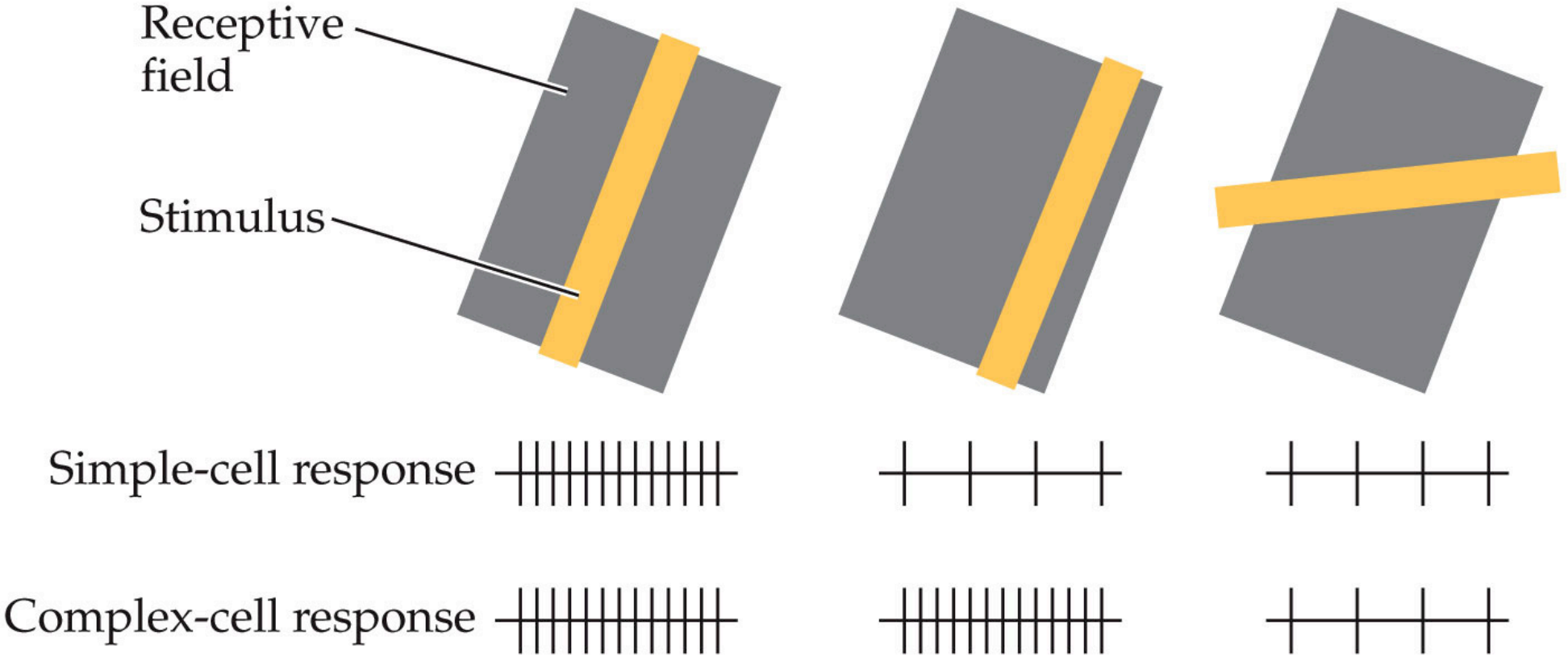
Ocular dominance:

• Cells in V1 tend to have a “preferred eye” (respond better to inputs from one eye than the other)

Simple vs. Complex Cells

Cells in V1 respond best to bars of light rather than to spots of light

- **"simple" cells**: prefer bars of light, or prefer bars of dark
- **"complex" cells**: respond to both bars of light and dark

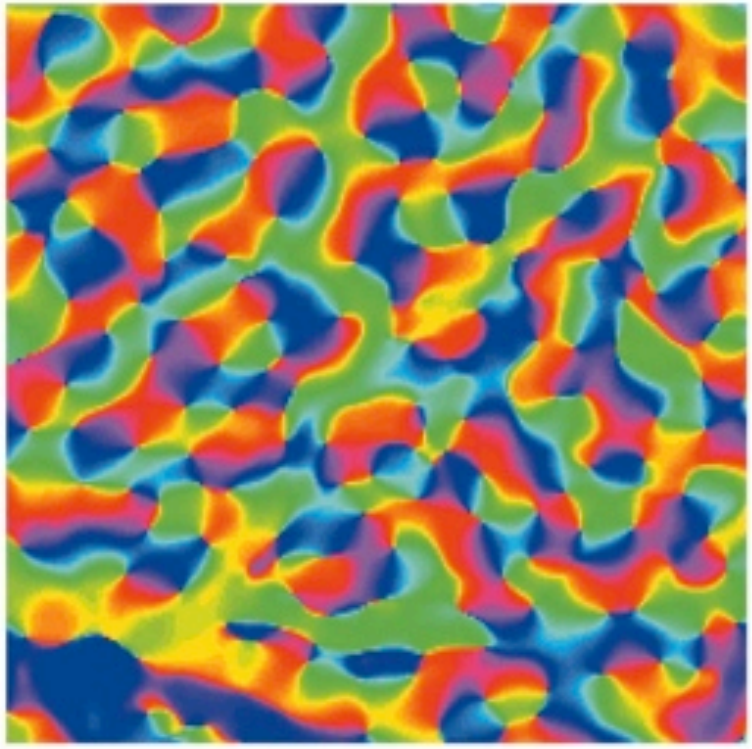


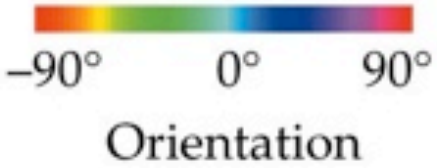
Receptive Fields in V1

[see link to Hubel & Weisel movie]

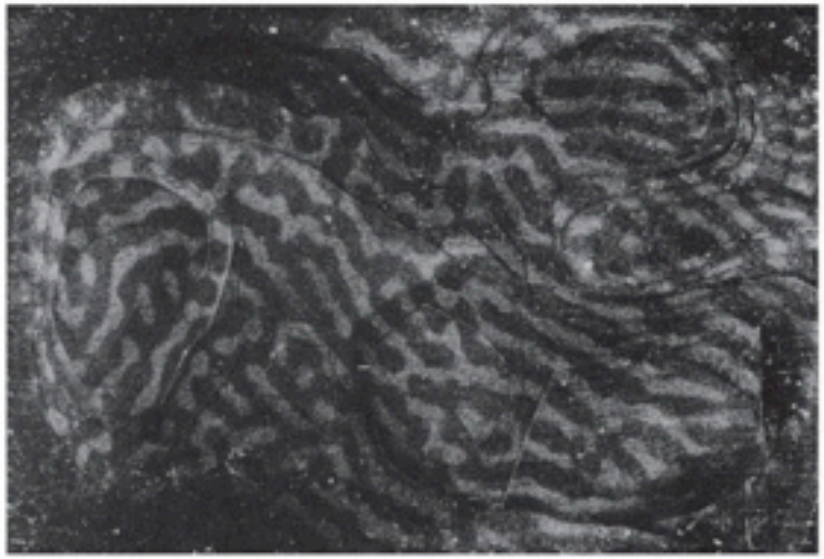
Column: a vertical arrangement of neurons

- **orientation column**: for a particular location in cortex, neurons have same preferred orientation



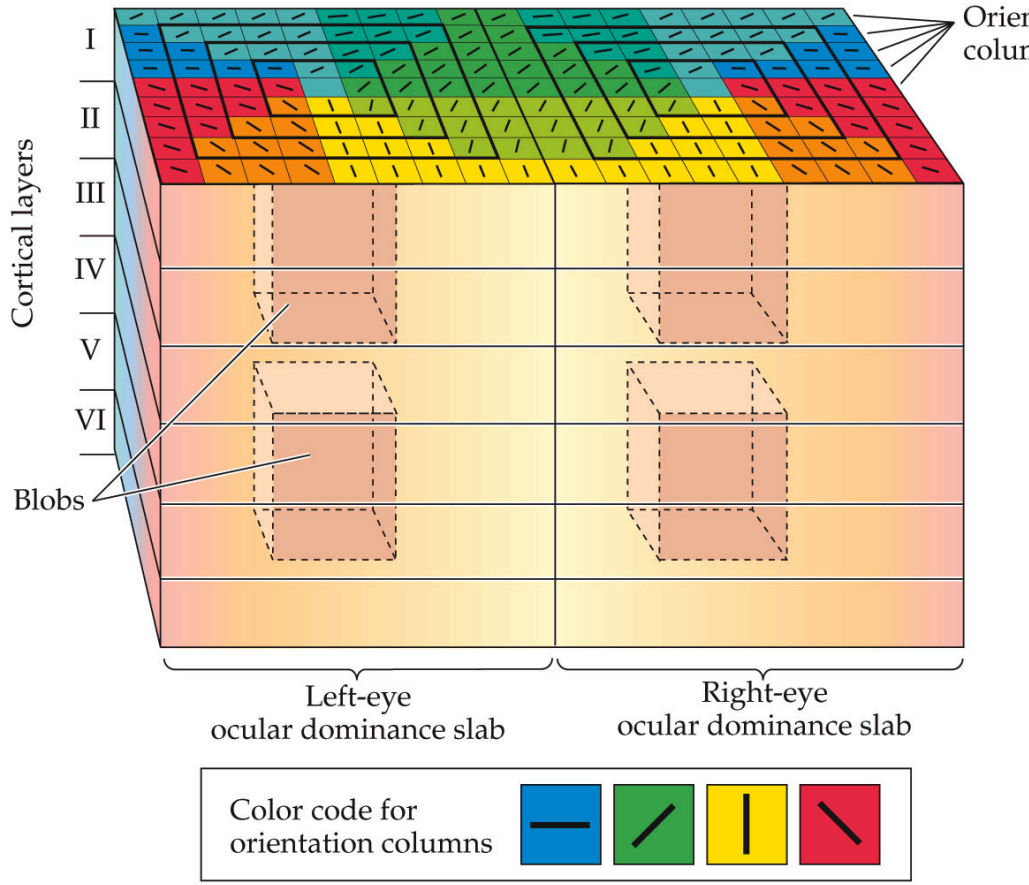


- **ocular dominance column:** for particular location in cortex, neurons have same preferred eye



Hypercolumn - contains all possible columns

- **Hypercolumn**: 1-mm block of V1 containing "all the machinery necessary to look after everything the visual cortex is responsible for, in a certain small part of the visual world" (Hubel, 1982



- Each hypercolumn contains a full set of columns
  - has cells responding to every possible orientation, and inputs from left right eyes

web demos

receptive fields

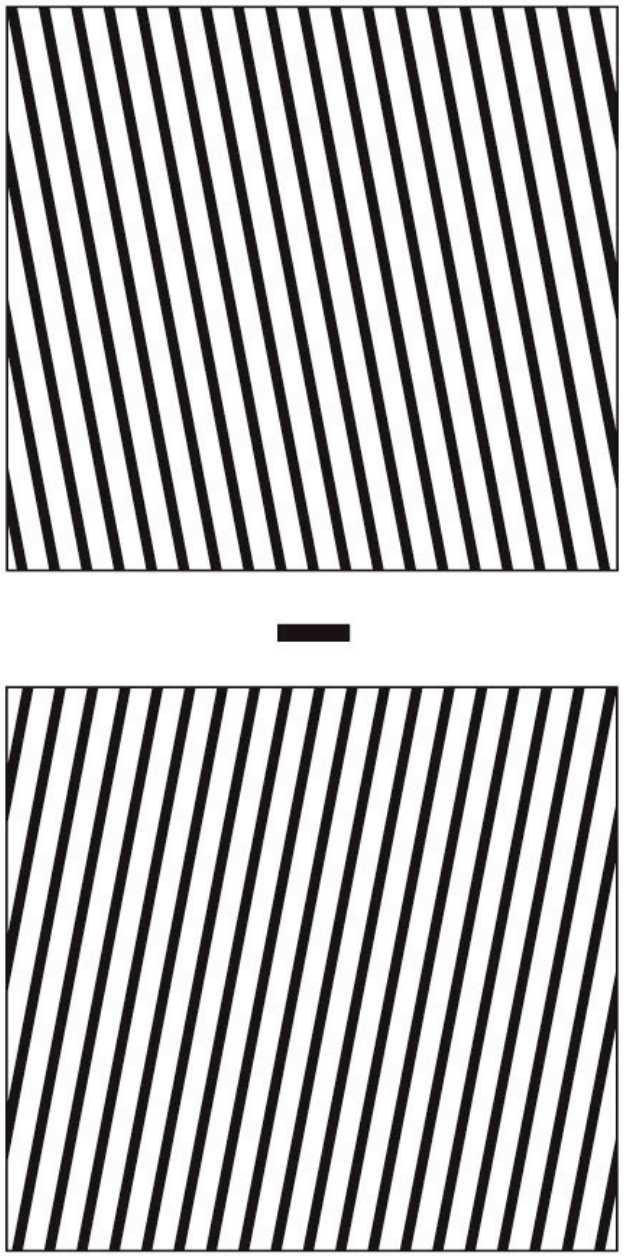
http://sites.sinauer.com/wolfe4e/wa03.04.html

columns

http://sites.sinauer.com/wolfe4e/wa03.05.html

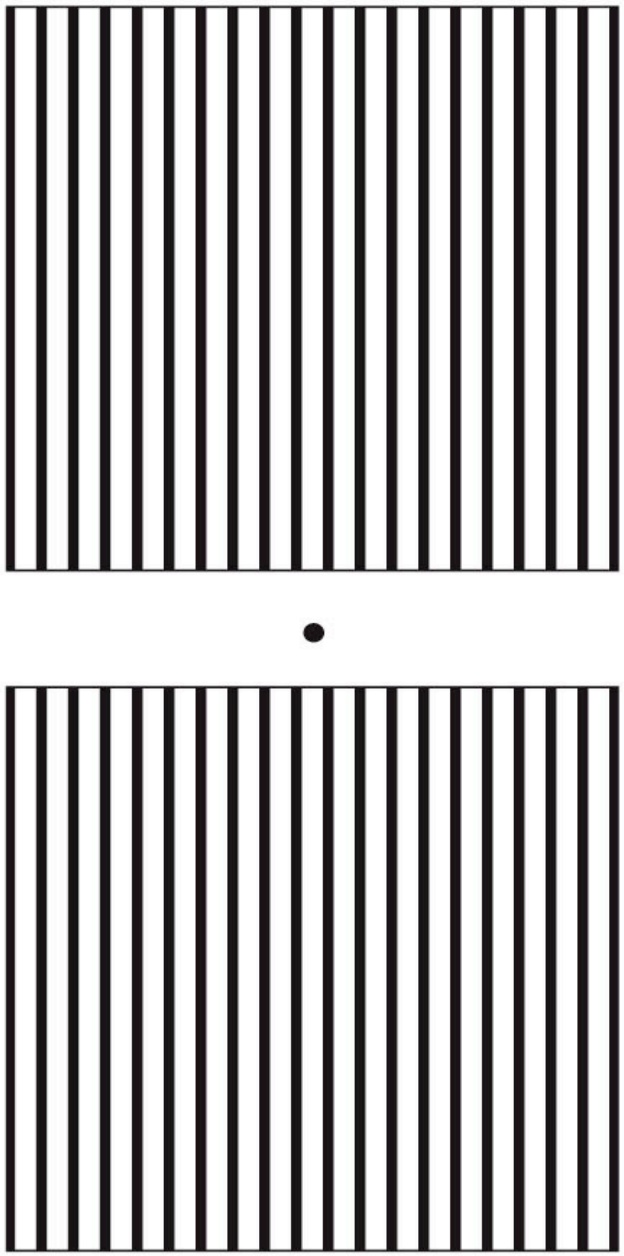
Adaptation

Adaptation: the Psychologist's Electrode



"tilt after-effect"

Adaptation: the Psychologist's Electrode



"tilt after-effect"

- perceptual illusion of tilt, provided by adapting to a pattern of a given orientation

- supports idea that the human visual system contains individual neurons selective for different orientations

Adaptation: the Psychologist's Electrode

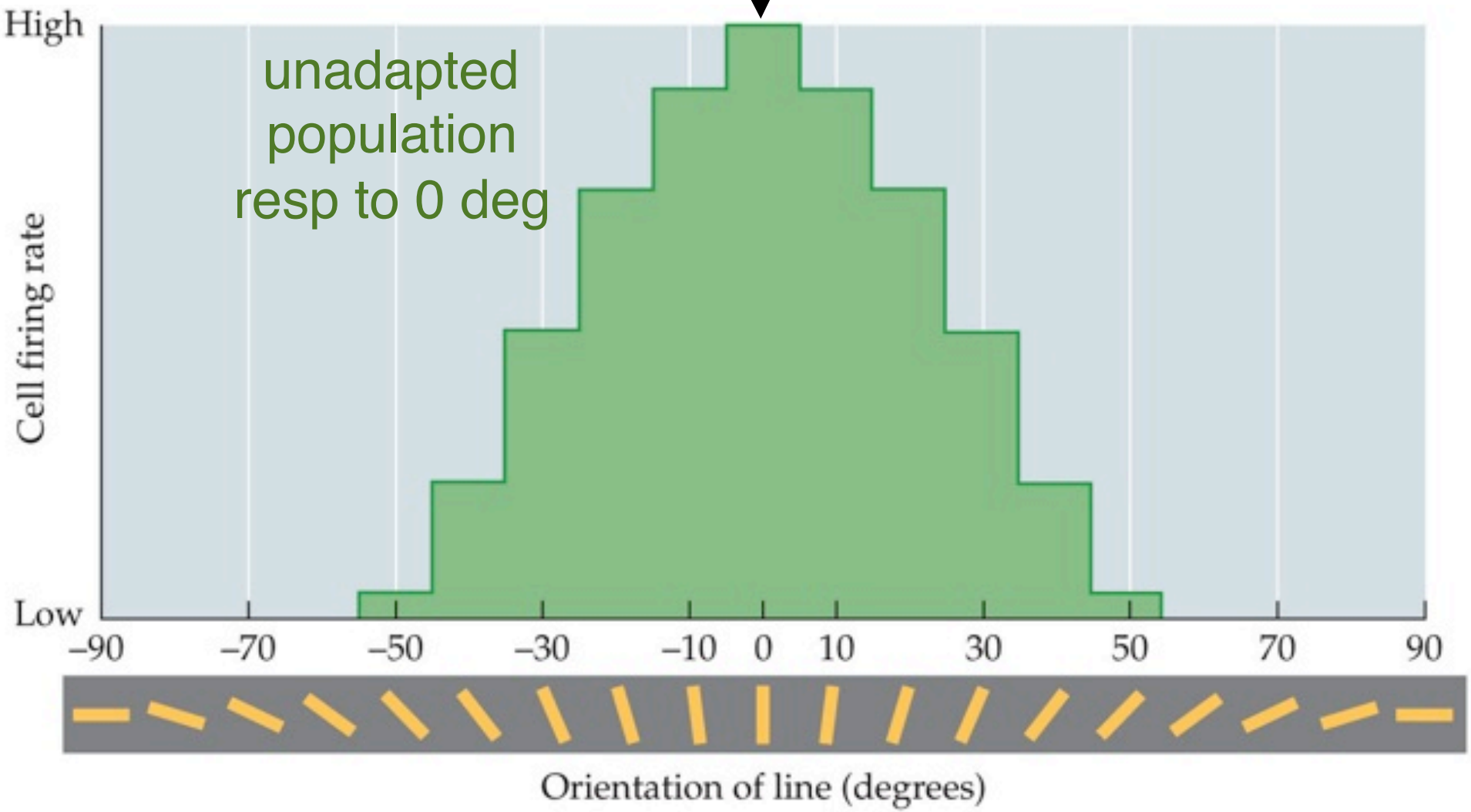
Adaptation: the diminishing response of a sense organ to a sustained stimulus

- An important method for deactivating groups of neurons without surgery
- Allows selective temporary "knock out" of group of neurons by activating them strongly

Effects of adaptation on population response and perception

Before Adaptation

0 degree stimulus

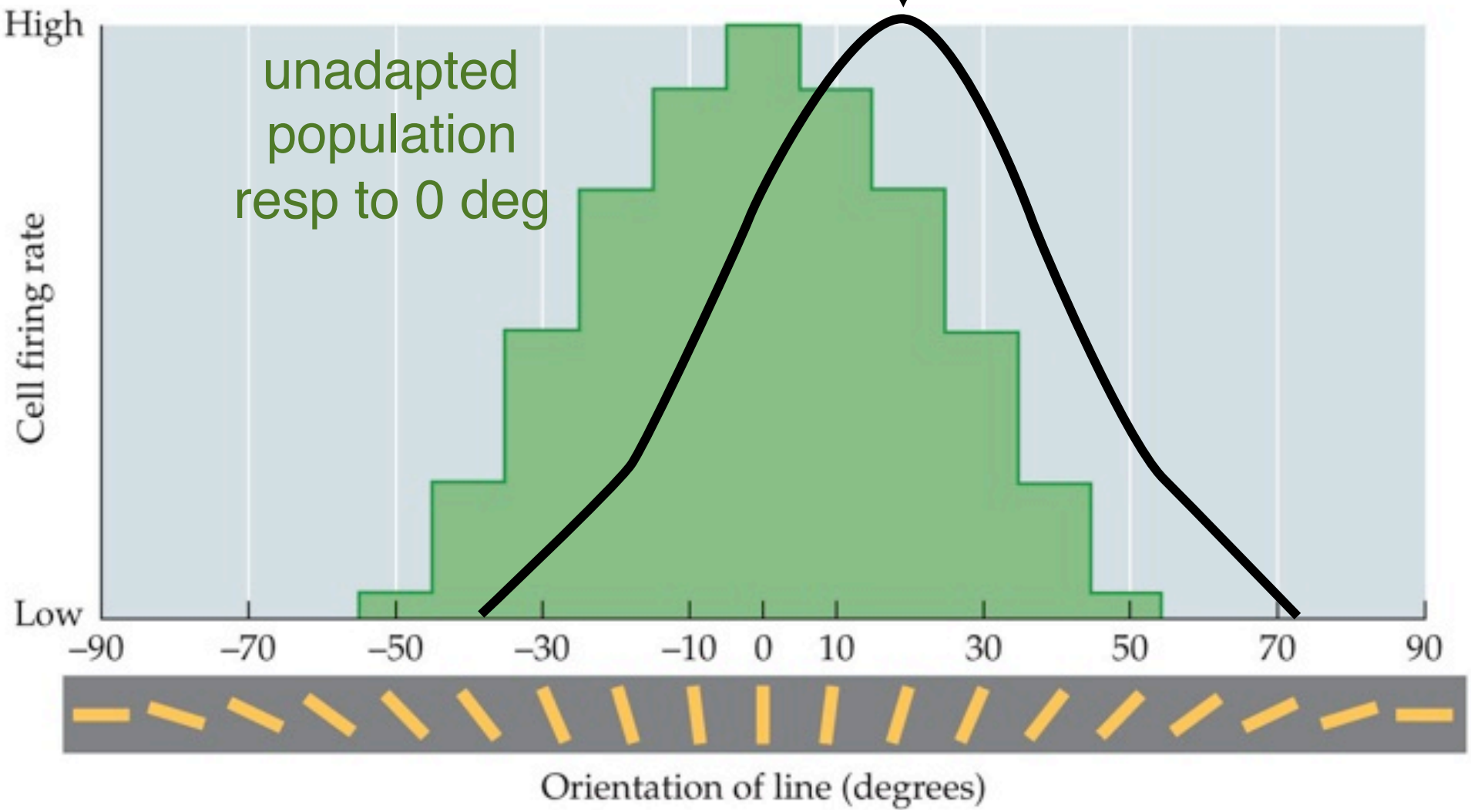


Stimulus presented =

Effects of adaptation on population response and perception

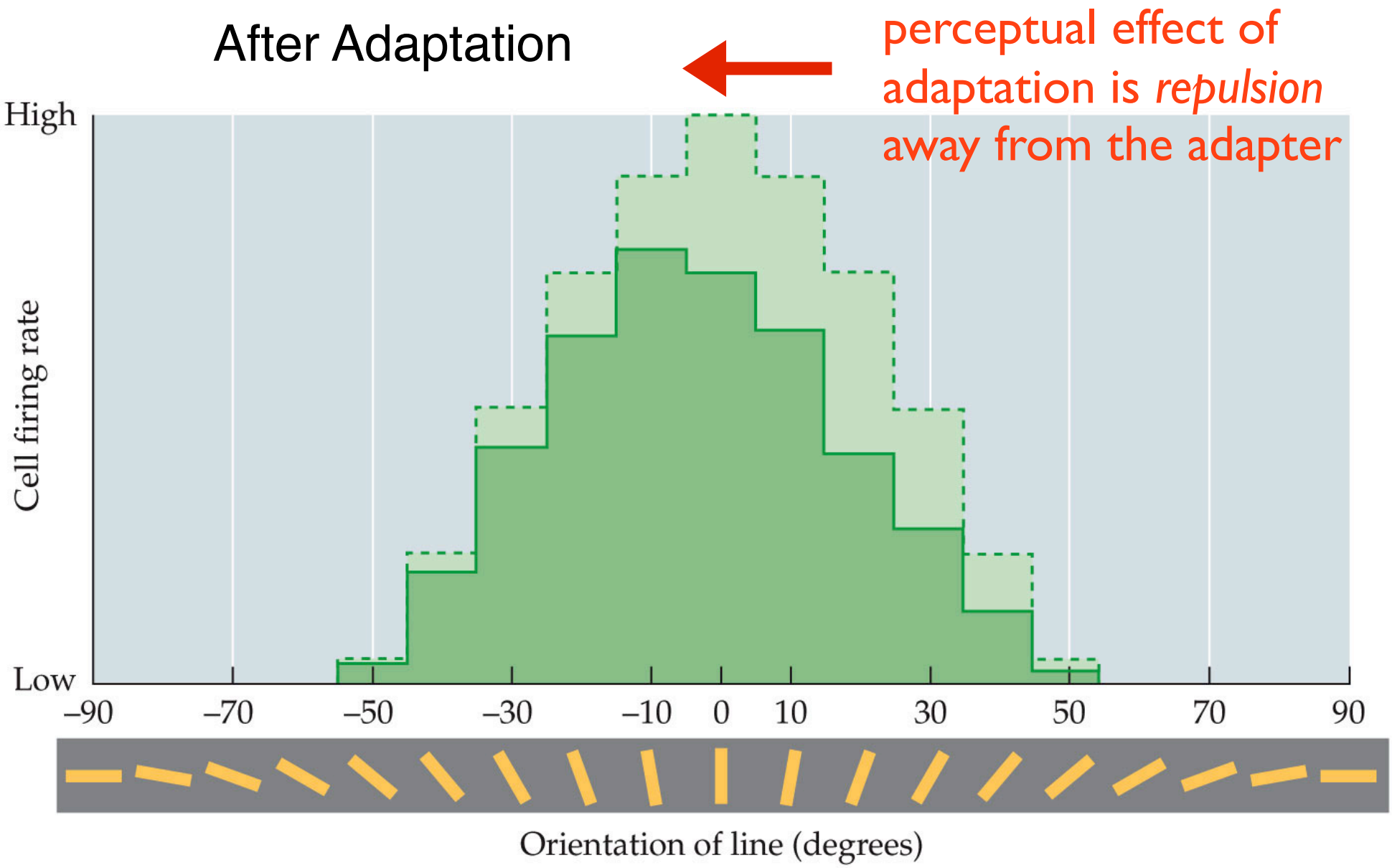
Before Adaptation

Then adapt to 20º



Stimulus presented = /

Selective adaptation alters neural responses and perception

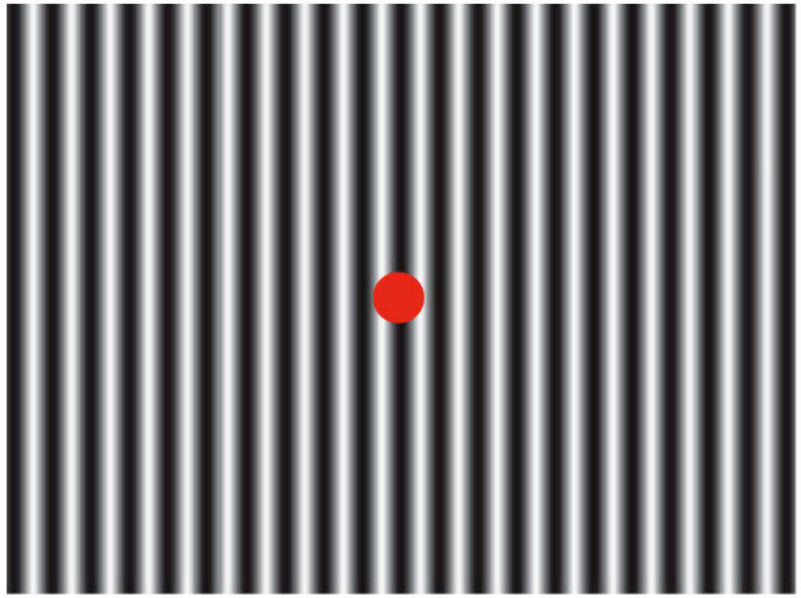


Stimulus presented =

Selective adaptation for spatial frequency:
= evidence that visual system contains neurons selective for spatial frequency

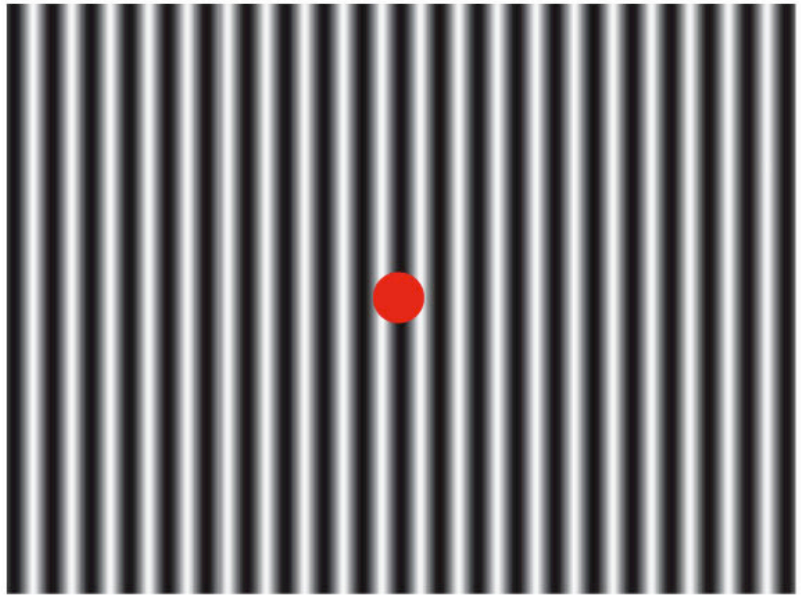
Adaptation that is specific to spatial frequency (SF)

1. adapt

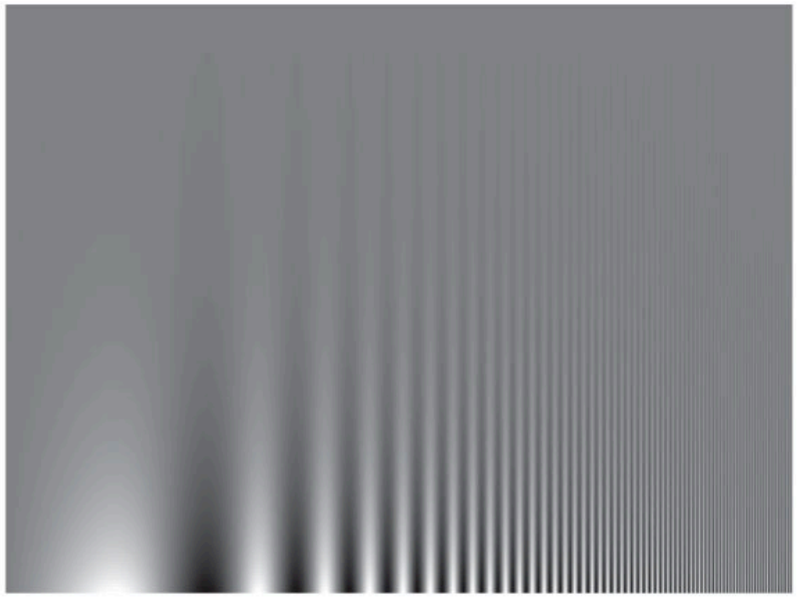


Adaptation that is specific to spatial frequency (SF)

1. adapt

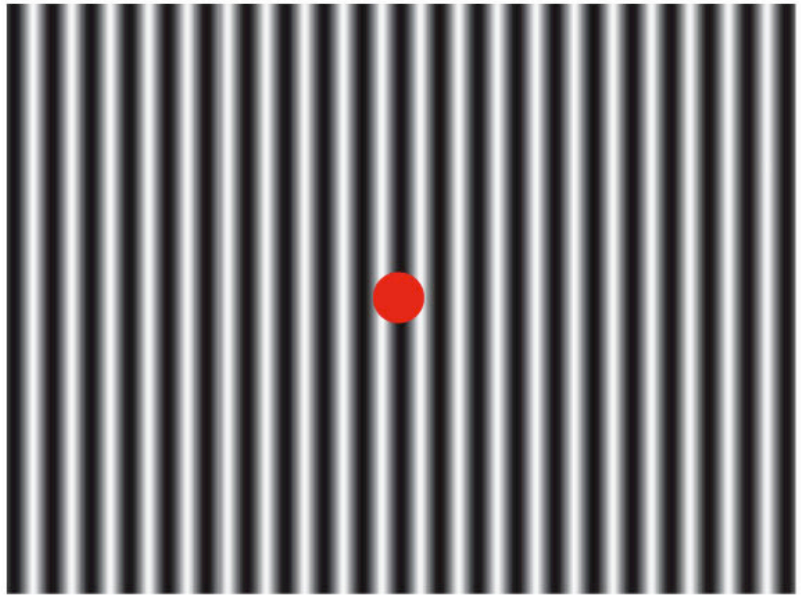


2. test



Adaptation that is specific to spatial frequency (SF)

1. adapt



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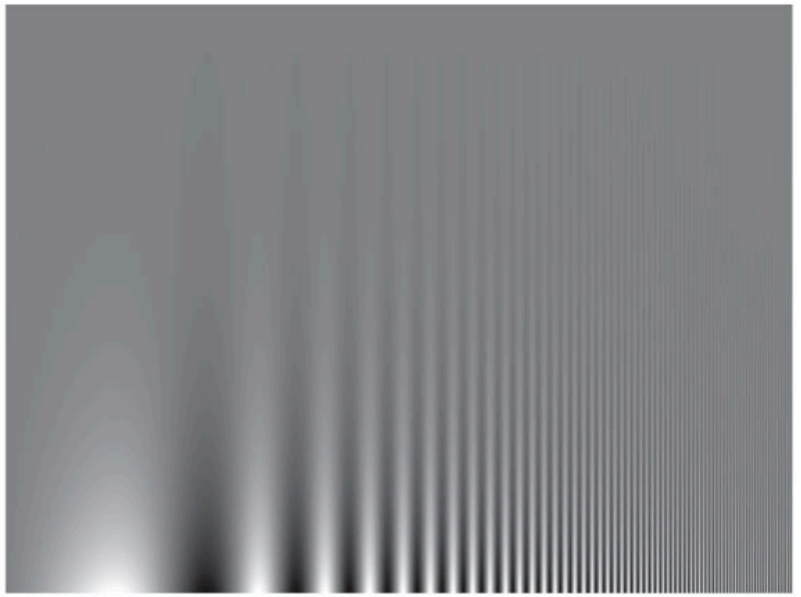
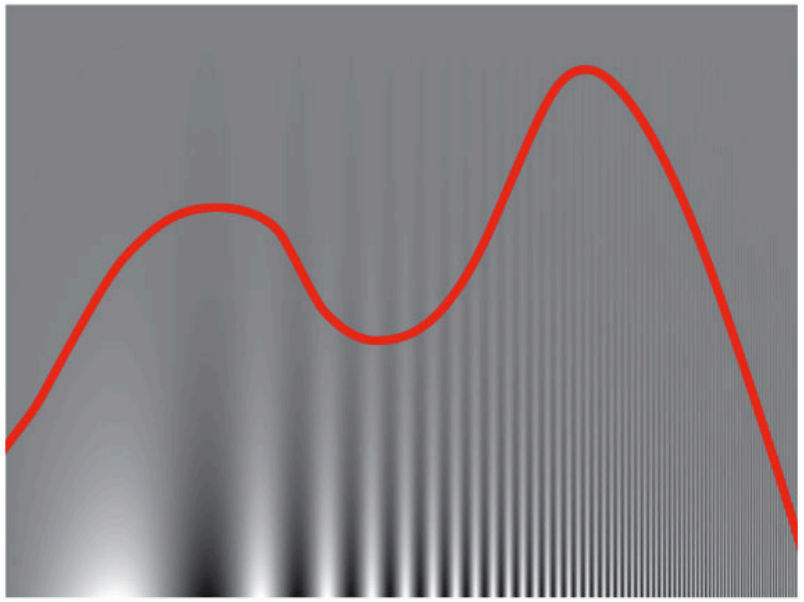
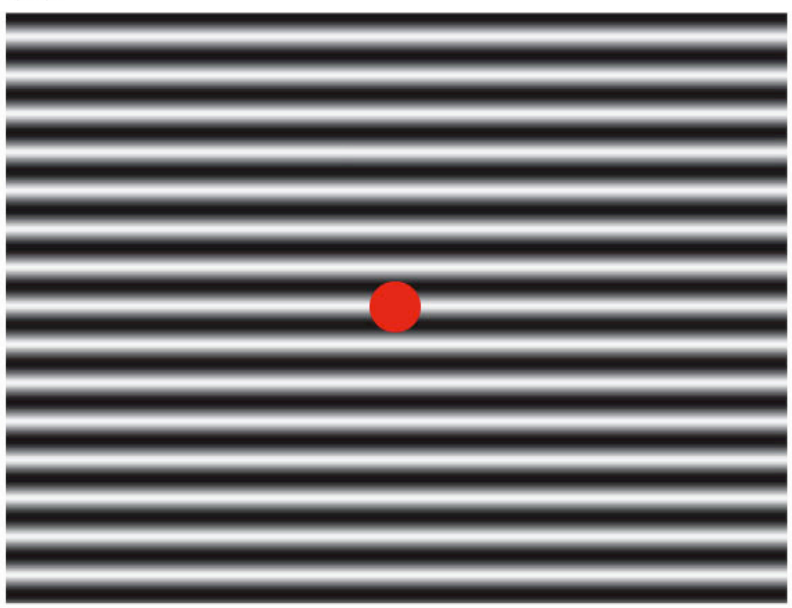


3. percept



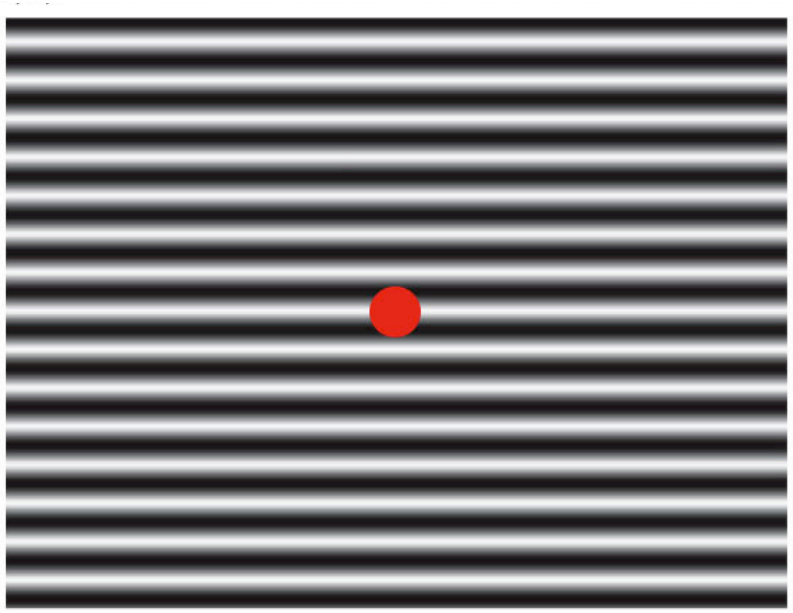
Adaptation that is specific to spatial frequency AND orientation

1. adapt

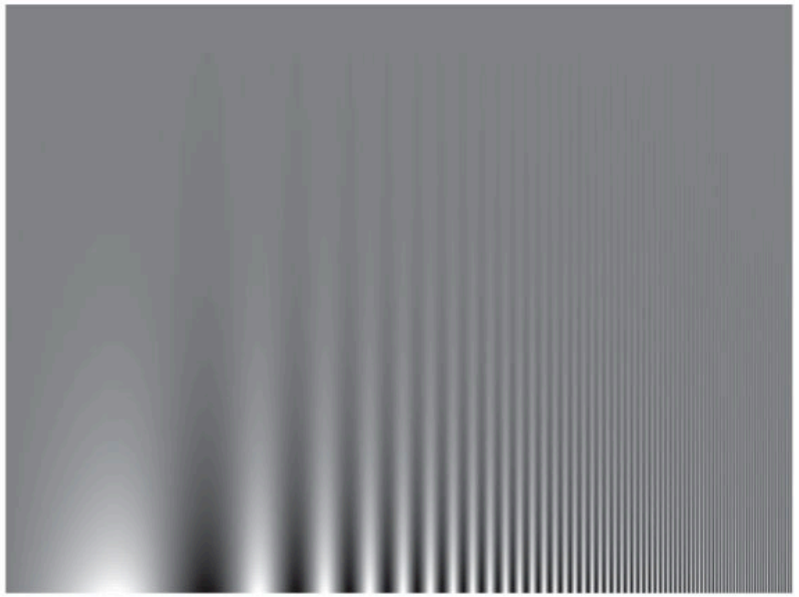


Adaptation that is specific to spatial frequency AND orientation

1. adapt

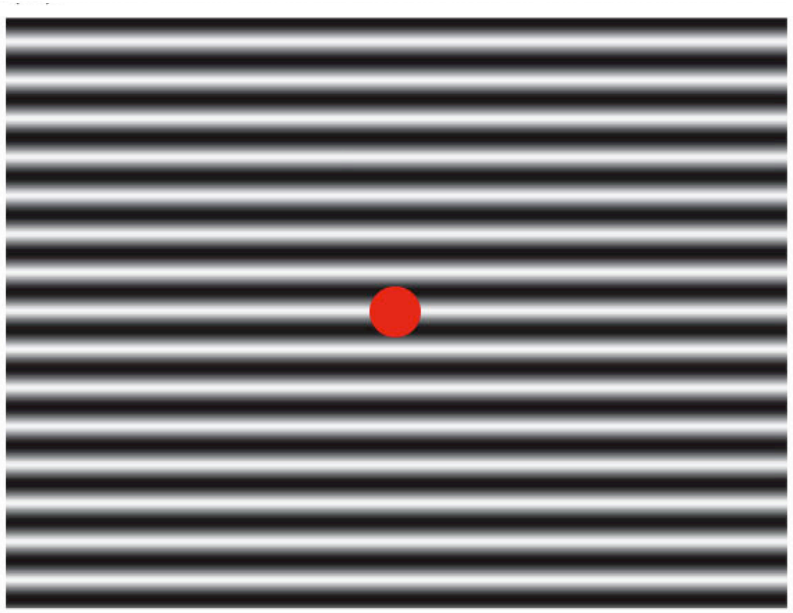


2. test

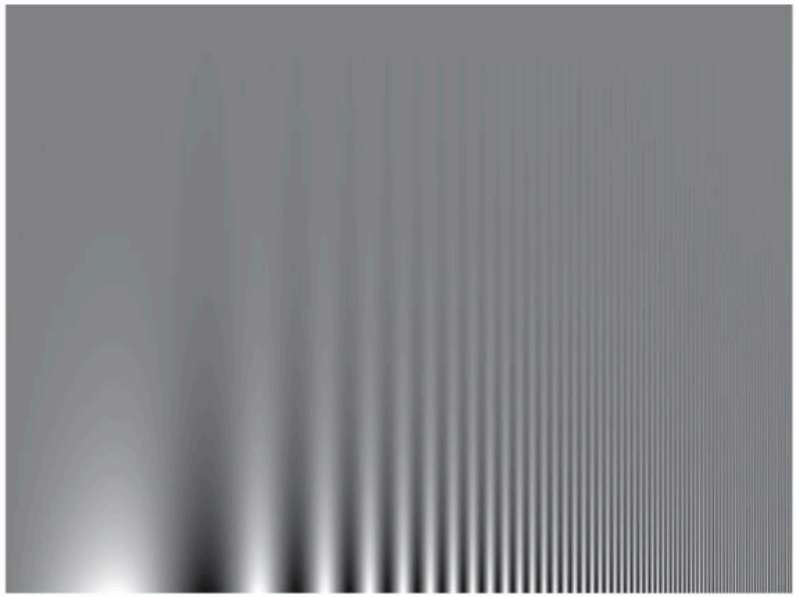


Adaptation that is specific to spatial frequency AND orientation

1. adapt

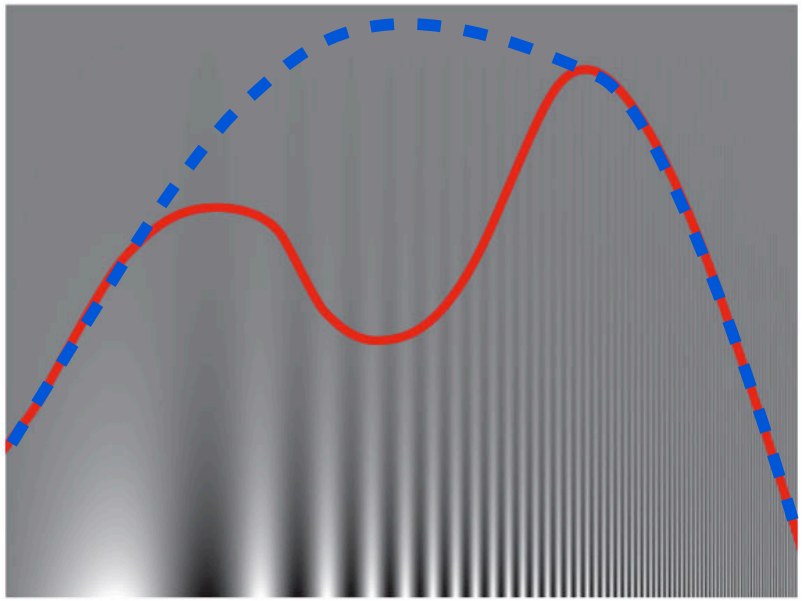


2. test



(c)

3. No adaptive percept



Selective Adaptation: The Psychologist's Electrode

Orthodox viewpoint:

- If you can observe a particular type of adaptive after-effect, there is a certain neuron in the brain that is selective (or tuned) for that property

THUS (for example):

There are no neurons tuned for spatial frequency across all orientations, because adaptation is orientation specific.

Selective Adaptation to Faces

Selective Adaptation to Faces

The Development of Spatial Vision

- how can you study the vision of infants who can't yet speak?

Read in book!

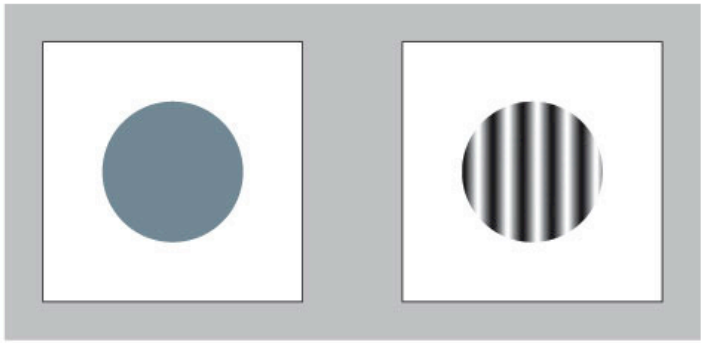
The Development of Spatial Vision

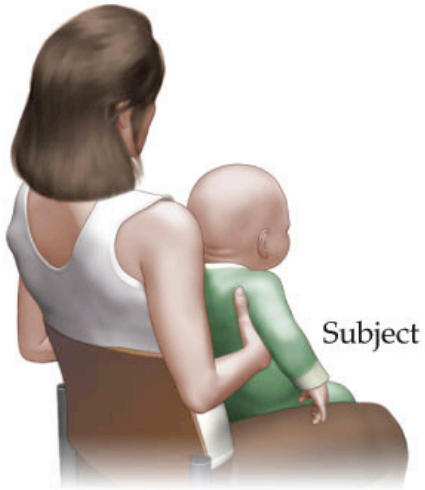
- how can you study the vision of infants who can't yet speak?

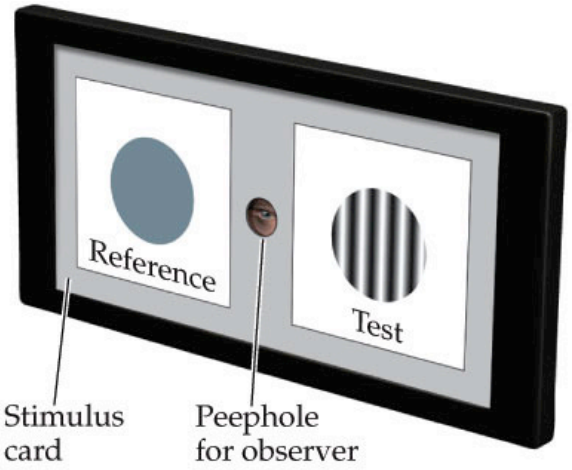
1. preferential-looking paradigm

- infants prefer to look at more complex stimuli

(a) Stimulus card





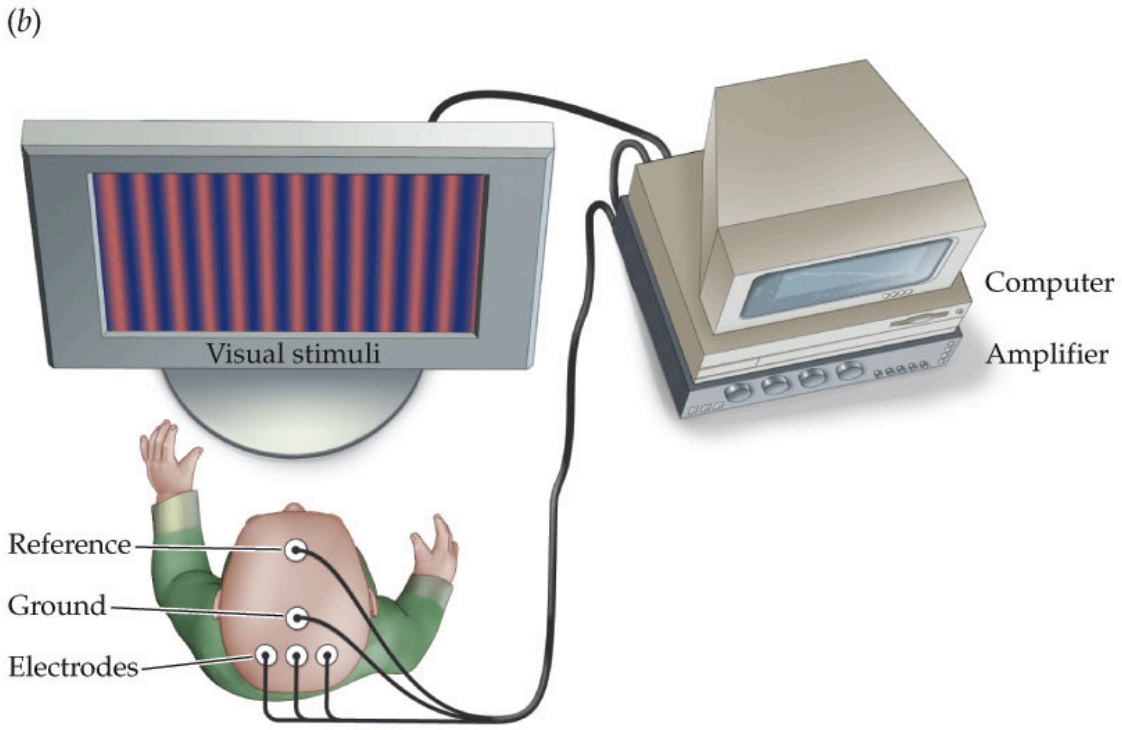


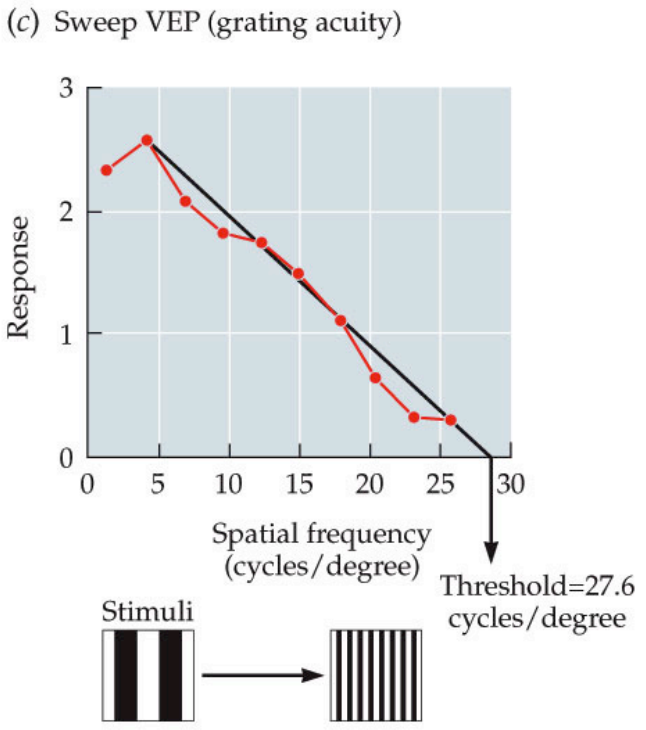
The Development of Spatial Vision

- how can you study the vision of infants who can't yet speak?

2. visually evoked potentials (VEP)

- measure brain's electrical activity directly





SENSATION & PERCEPTION 2e, Figure 3.32

The Development of Spatial Vision

young children: not very sensitive to high spatial frequencies

Visual system is still developing:

- Cones and rods are still developing
- Retinal ganglion cells still migrating and growing connections with the fovea
- fovea: not fully developed until 4 years of age

Summary (Chapter 3B)

- spatial frequency sensitivity & tuning
- V1 receptive fields, orientation tuning
- Hubel & Weisel experiments
- simple vs. complex cells
- cortical magnification
- cortical columns
- adaptation