Construction of the Visual Image: Color, Motion, and Form

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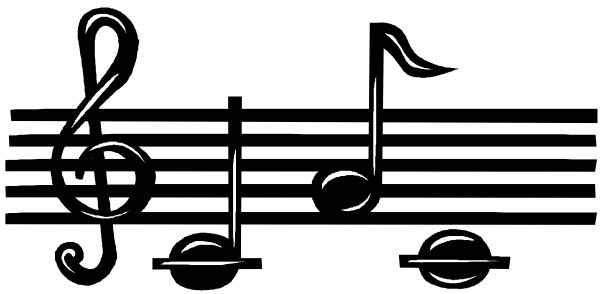
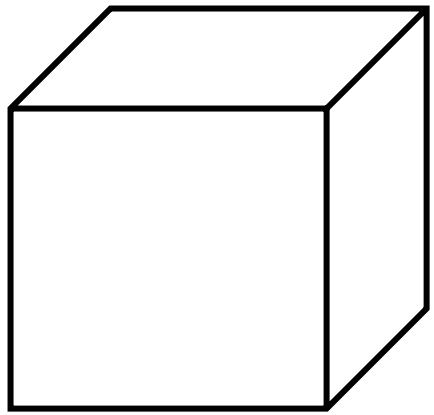
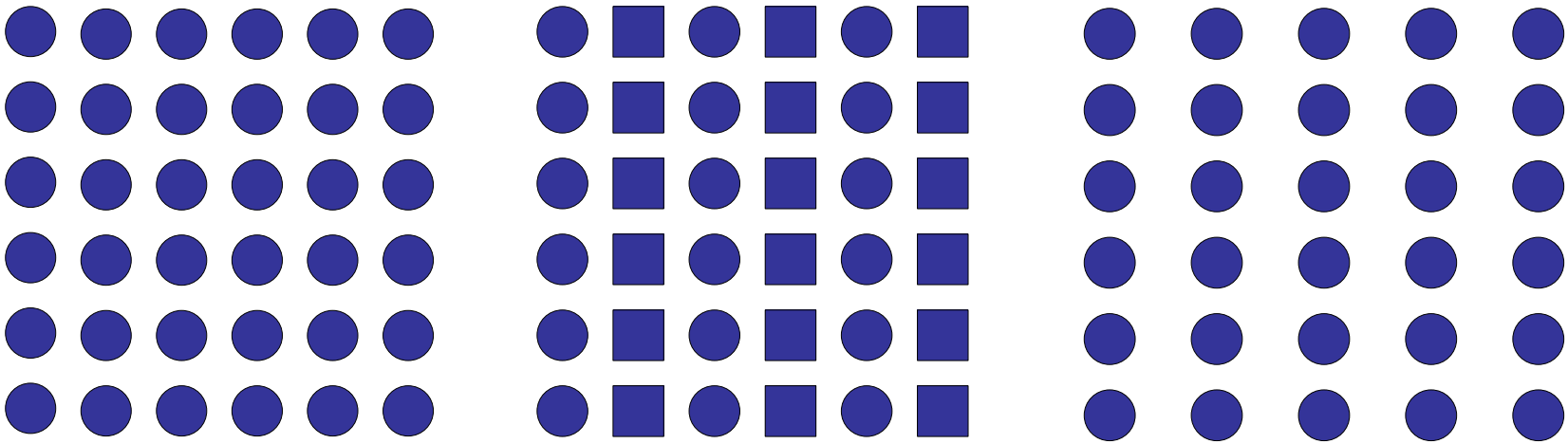
Gestalt Theory

Perception is a creative process, involving both experience and built-in neural wiring





Gestalt Theory



Ambiguous pattern

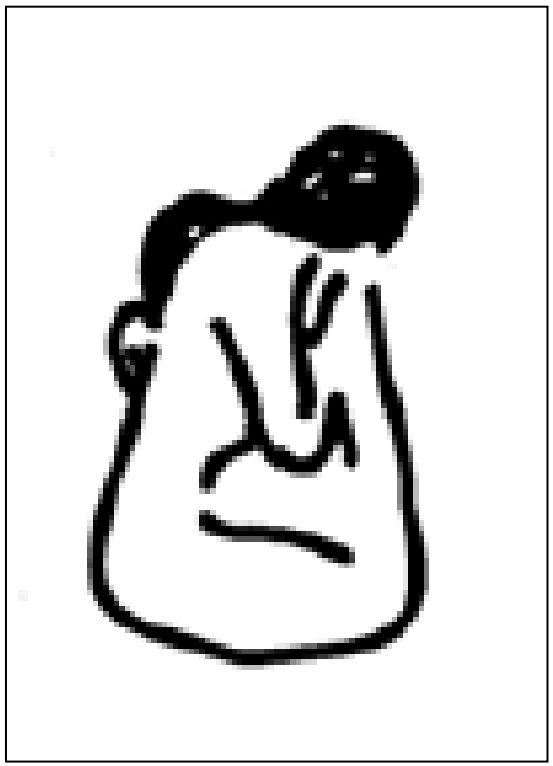
Law of similarity

Law of proximity

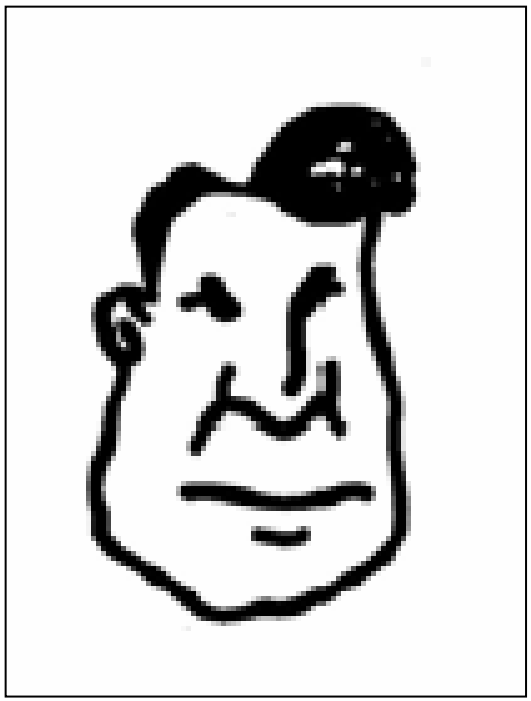
Object Recognition

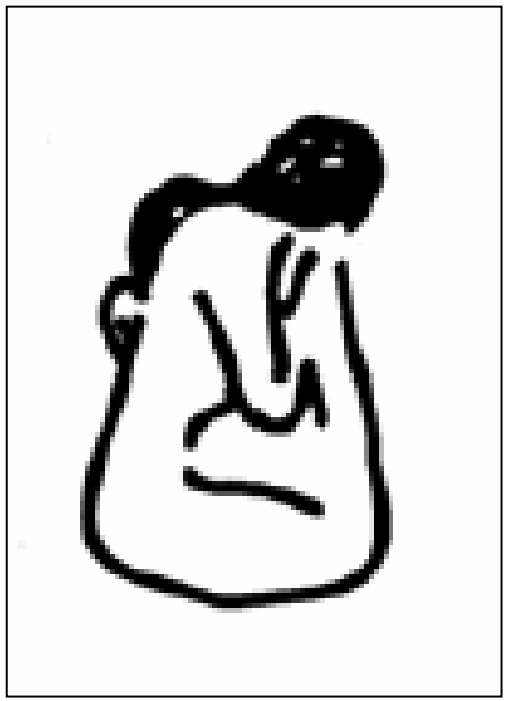
Object Recognition

Object Recognition



Object Recognition

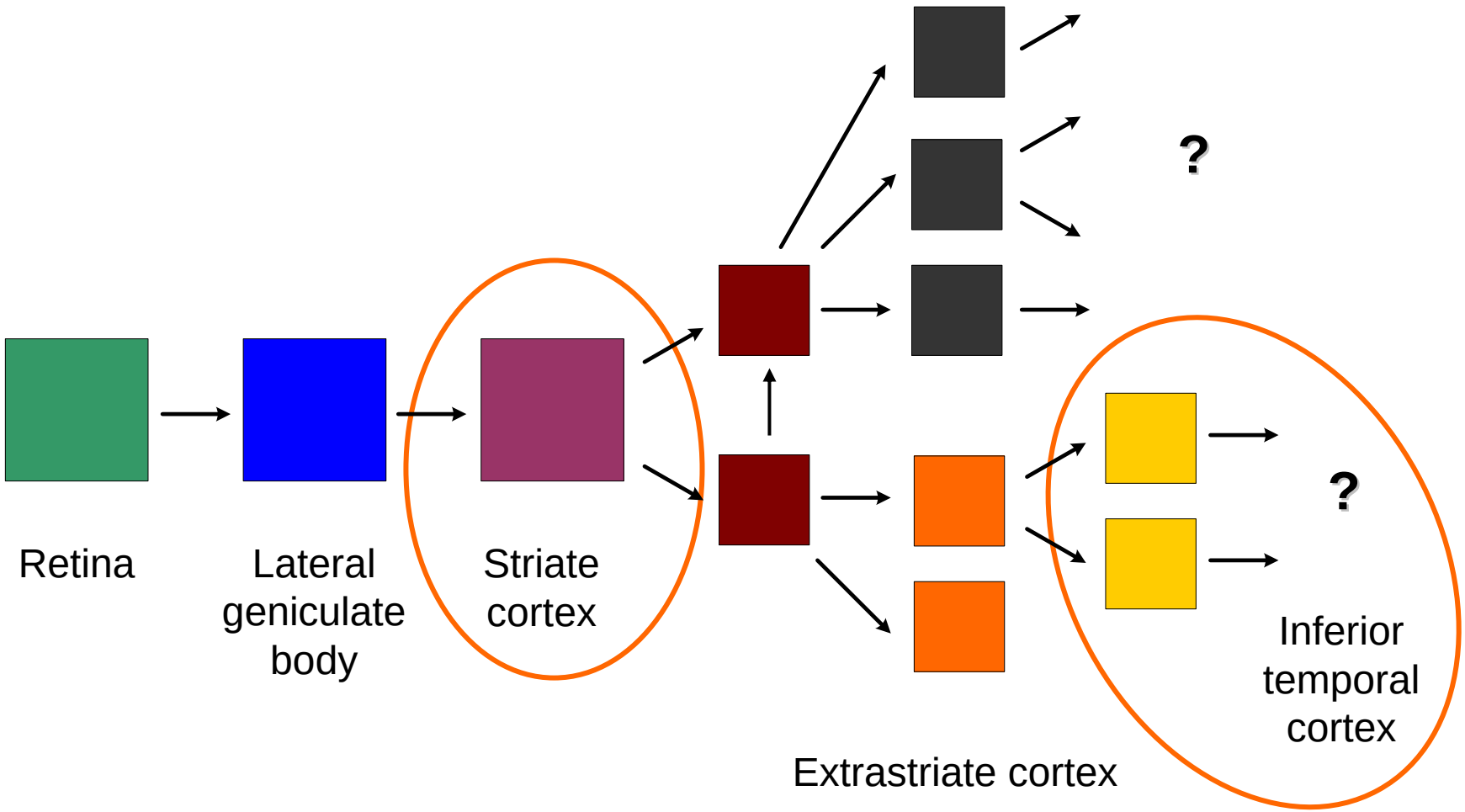




Visual Agnosias

Agnosia	*Types of Deficits*
Form & pattern	- Object recognition - Face recognition
Color	- Associating colors & objects - Distinguishing hues - Naming colors
Depth & mvt	- Stereovision - Movement of objects

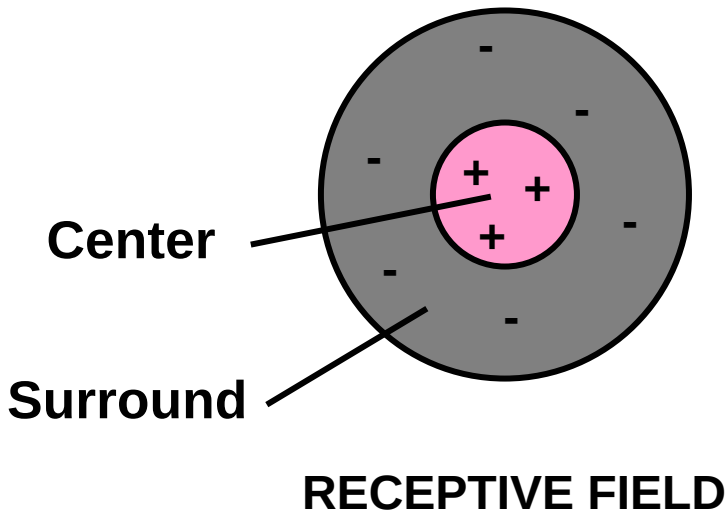
Visual Processing Pathway



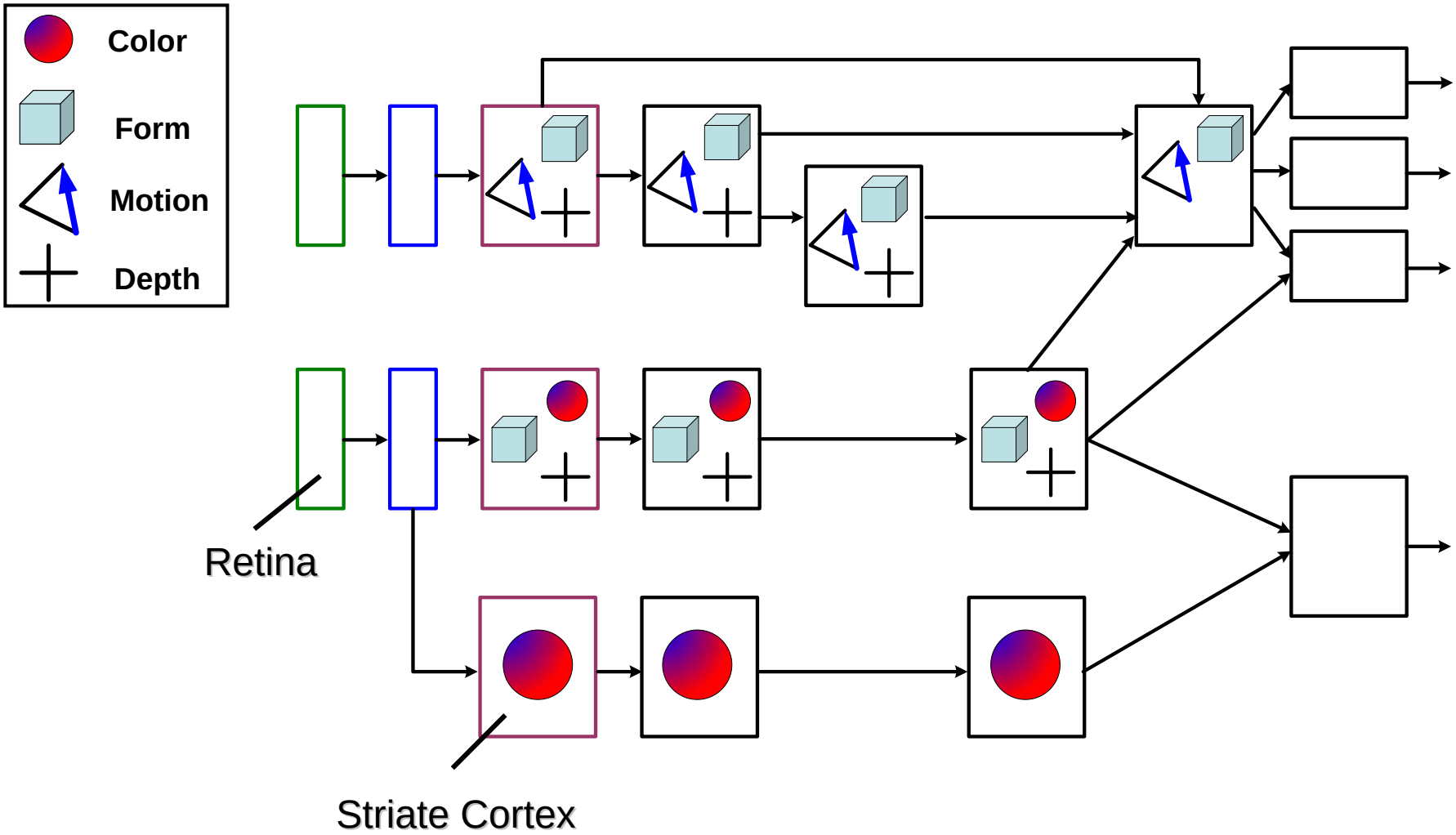
Visual processing occurs through selective collection, reorganization, and interpretation of retinal information.

Visual Processing in the Retina

- Multiple levels of signal filtering & amplification
- Signal propagation determined at the level of the ganglion neurons

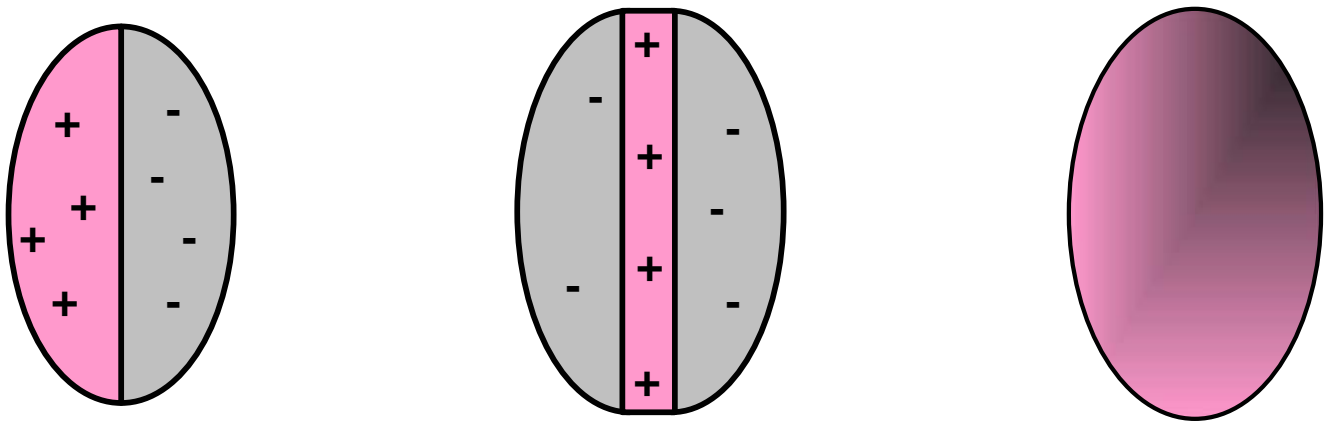


Visual Processing in the Brain



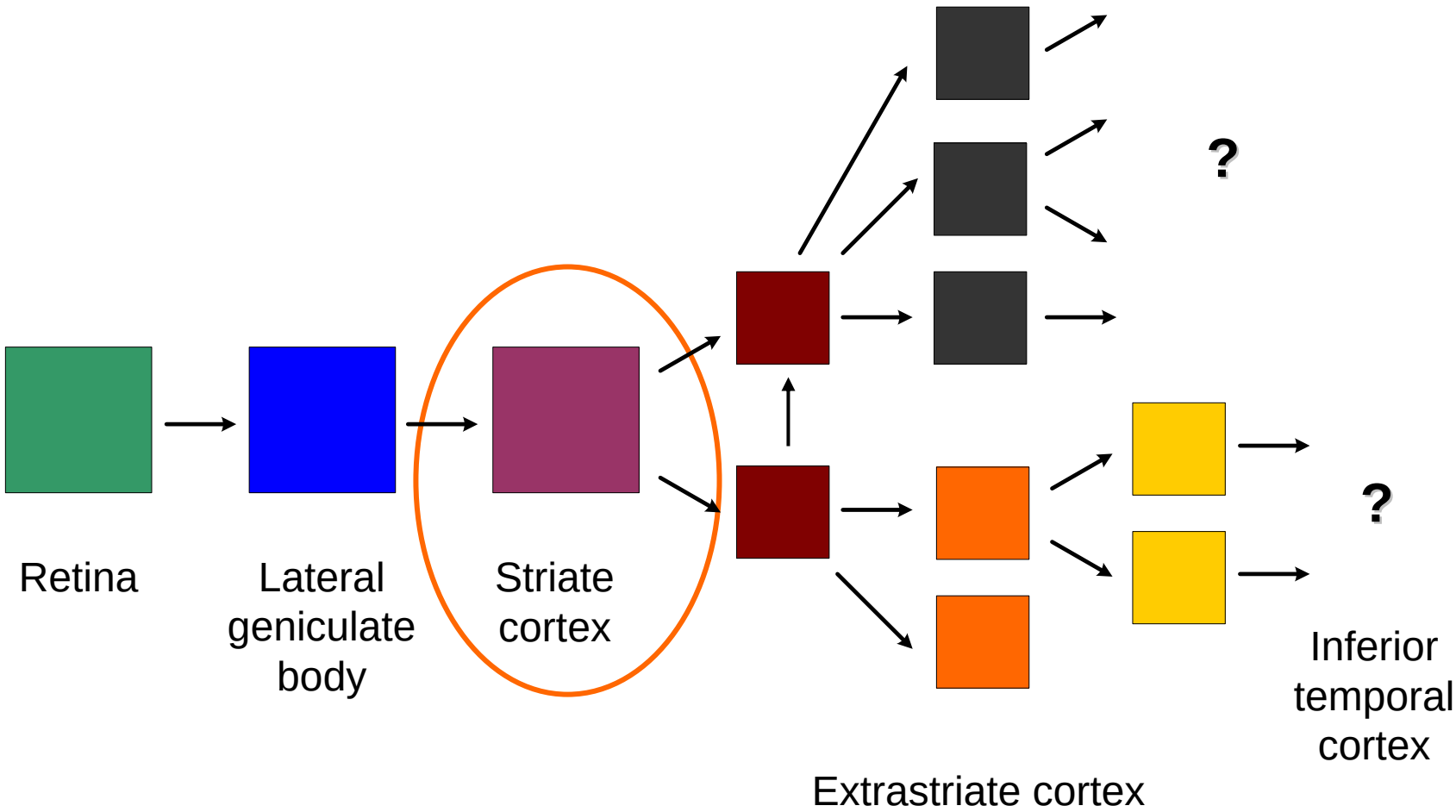
Visual Processing in the Brain

Modulated by neurons with unique receptive fields



Form

Visual Processing Pathway



Striate Cortex

Responds to linear stimuli…

Striate Cortex

6 weeks

Does not recognize horizontal objects

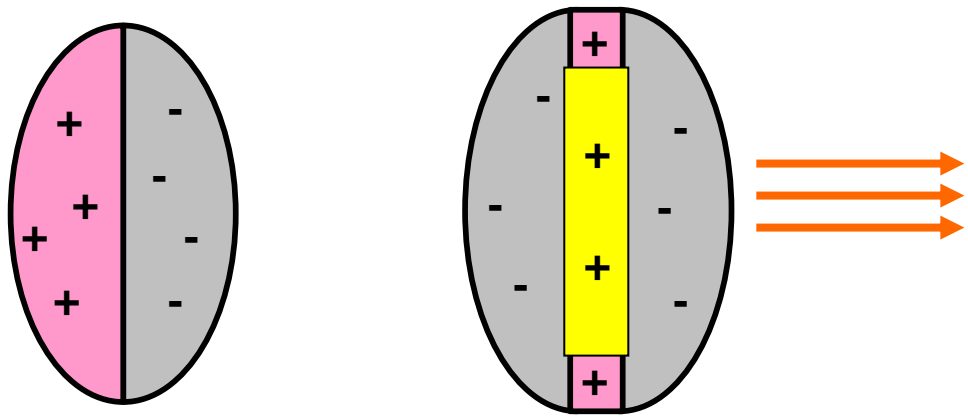
Recognizes horizontal component of complex objects

→ detects linear components

Striate Cortex

Simple Cells:

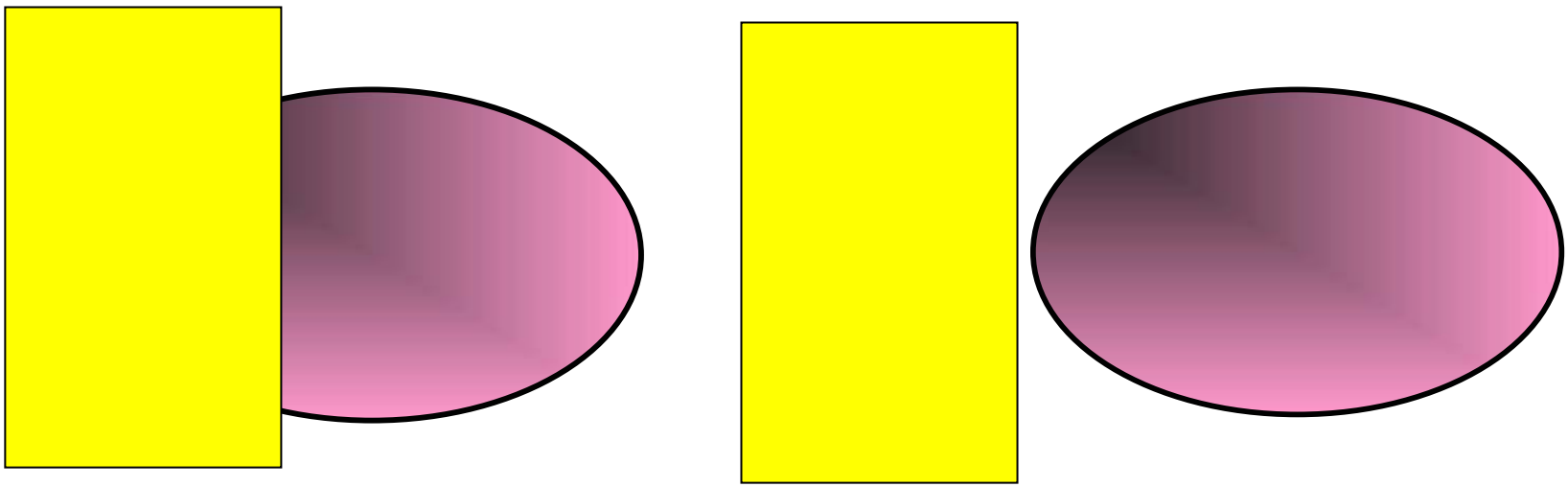
- Elliptical receptive fields
- 20 populations with a different axis of orientation
- 10° tuning



Striate Cortex

Complex Cells:

- Sensitive to both position and orientation



Striate Cortex

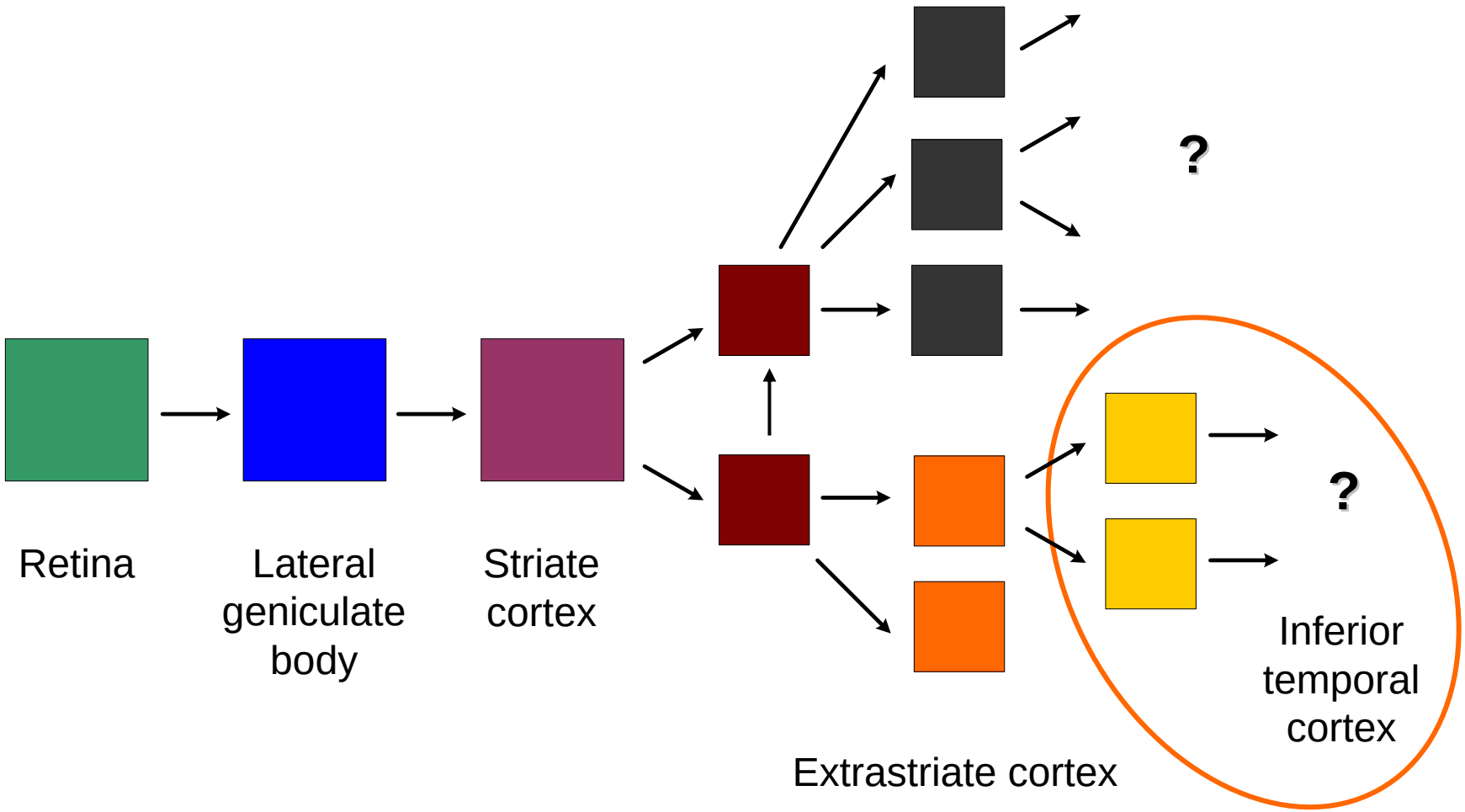
The combined action of simple and complex cells facilitates the recognition of edges

Complex Form Recognition

- Occurs downstream of striate cortex
- Neurons can be highly specialized
  - Face recognition
  - Hand recognition
- Lesion of these regions does not impair visual recognition of other shapes & patterns

Motion

Visual Processing Pathway



Inferior Temporal Cortex

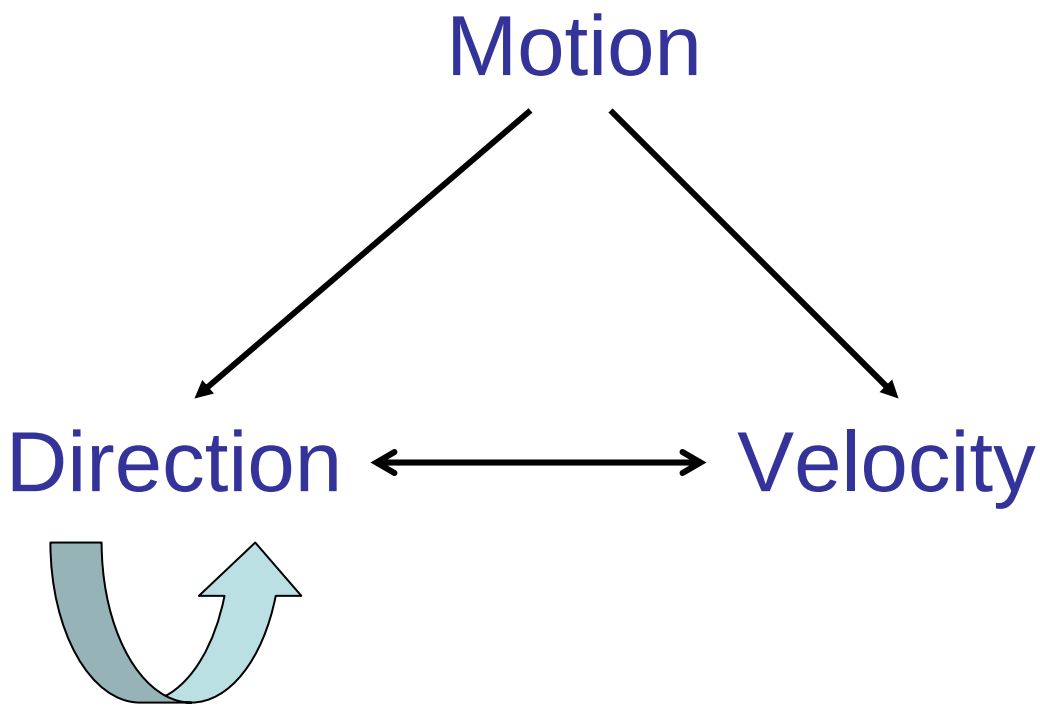
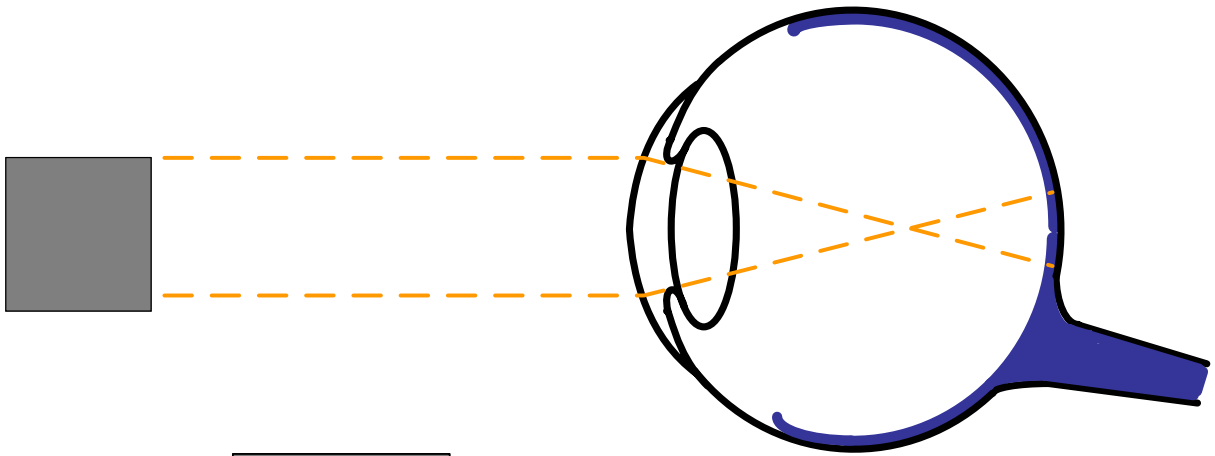
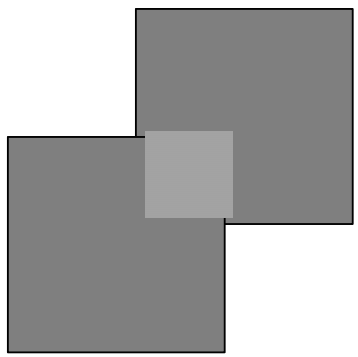


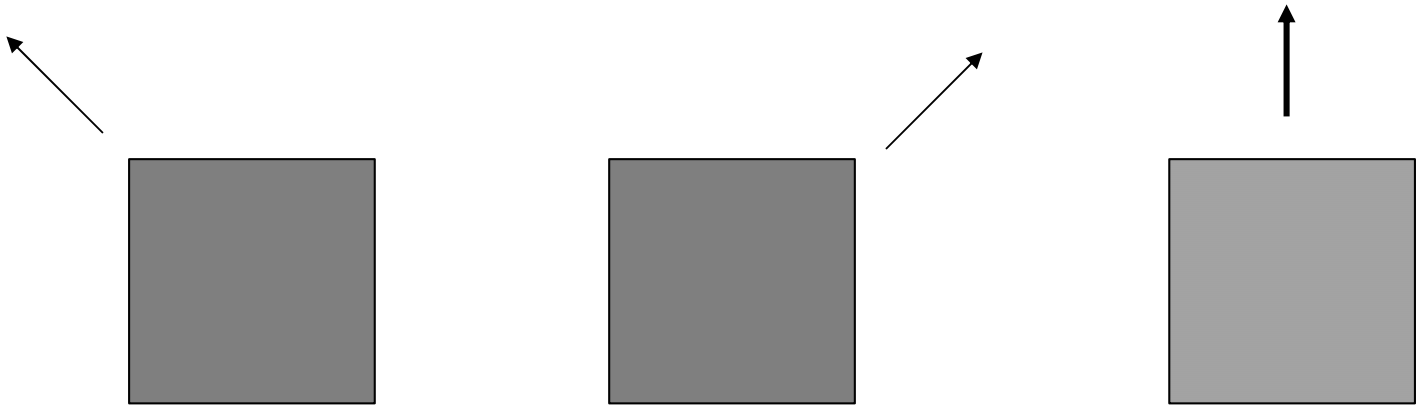
Image location is compared with previous location on retina

Movement Detection





Movement Detection

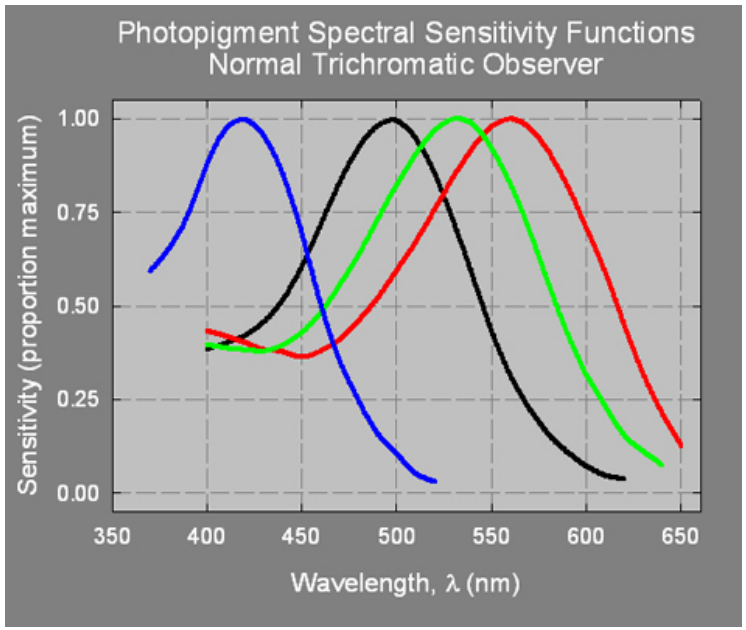


2-step hypothesis:

- most neurons respond to only to 1 vector component of plaid
- other neurons sum these vectors

Color Vision

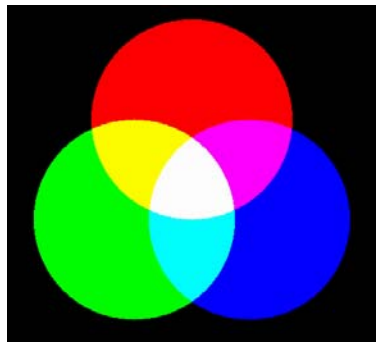
Color Vision

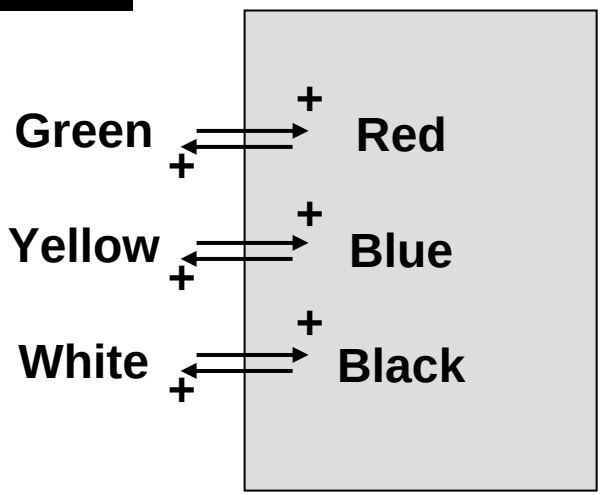


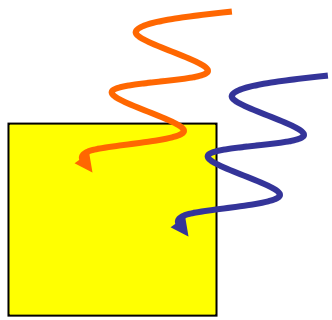
- Tri-Chromatic
- Cone sensitivity is dependent on intensity & wavelength

Unique Features of Human Vision

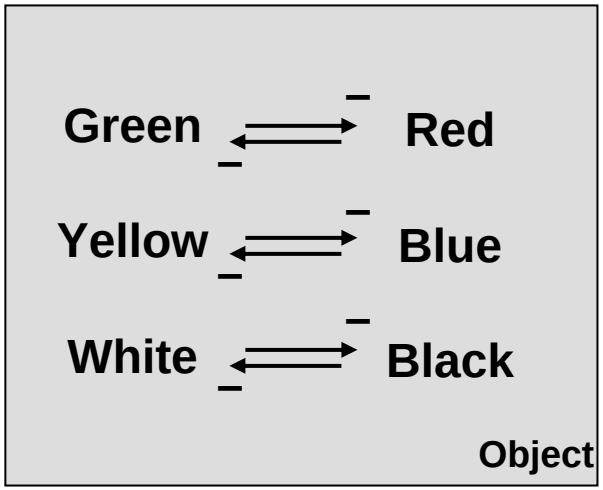
- Color opponency
- Color contrast
- Color constancy

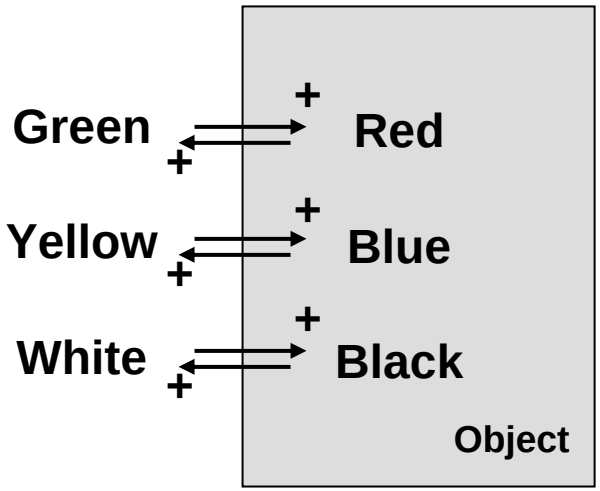






Color Opponency & Contrast





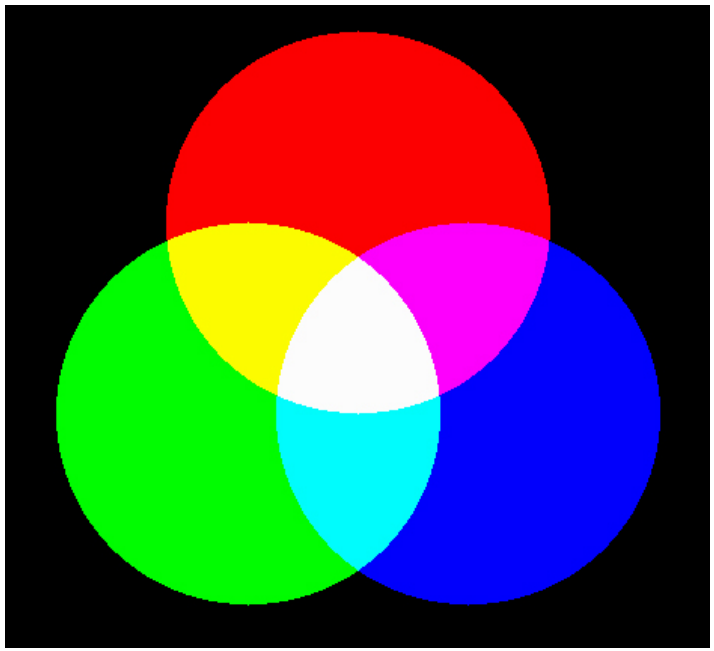
OPPONENCY

Certain colors cannot be combined when they emanate from the same point in space

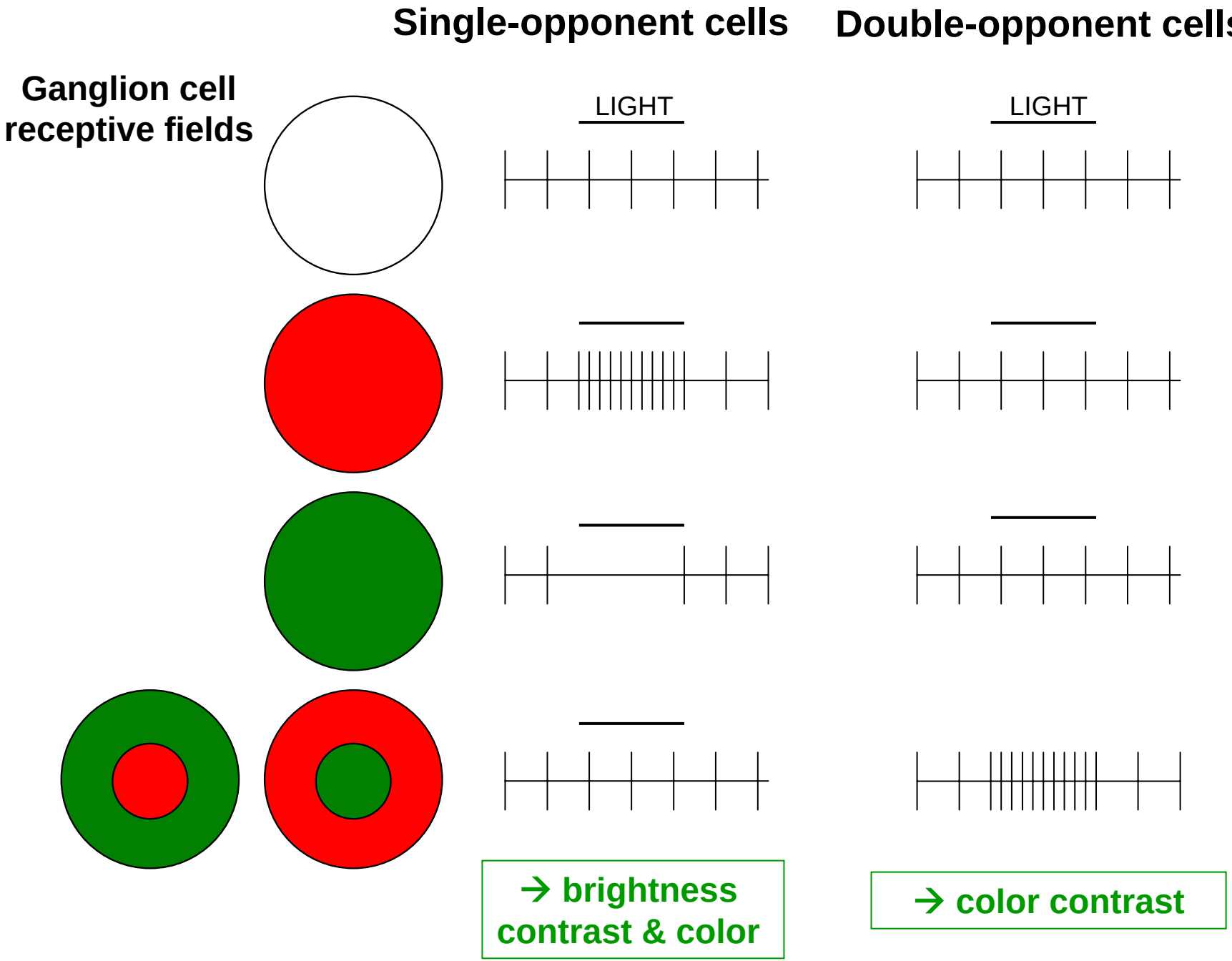
CONTRAST

Opponent colors enhance each other when they emanate from different points in space

Color Opponency & Contrast



- 3 mutually antagonistic color pairs
- Mediated by 3-channel ganglion cells


Single-opponent cells
Double-opponent cells
Ganglion cell receptive fields
LIGHT
LIGHT
→ brightness contrast & color
→ color contrast

Color Constancy

Global color contrast is analyzed in the cortex

→ Compensation for color changes in ambient light

Color Blindness

- Red, Green pigment genes are highly similar and closely linked
- Recombination → gene mutation or loss
- X-linked

  1% Red-blind

  2% Green-blind

  **% R/G-blind

Summary

- Recognition of form, motion, and color is dictated by neural wiring
- The pathways are complex…
  - Info is processed at multiple levels
  - Neurons in each cortical region are specialized

References

- Essentials of Neuroscience and Behavior. Kandall ER, Schwartz JH, Jessel TM. Prentice Hall 1995: 367-488.
- Sensation and Perception, 6th ED. Goldstein BE. Wadsworth 2003: 109-225.
- http://www.webvision.med.utah.edu/
- http://www.psychology.psych.ndsu.nodak.edu/mccourt/website/htdocs/HomePage/Psy460/Color%20Vision/Color%20Vision.html