The Midget and Parasol Channels

Retinal ganglion cells, cross section, Golgi label

Image removed due to copyright restrictions.

Please refer to lecture video or Figure 4 from Schiller, Peter H. "Parallel information processing channels created in the retina." *Proceedings of the National Academy of Sciences* 107, no. 40 (2010): 17087-17094.

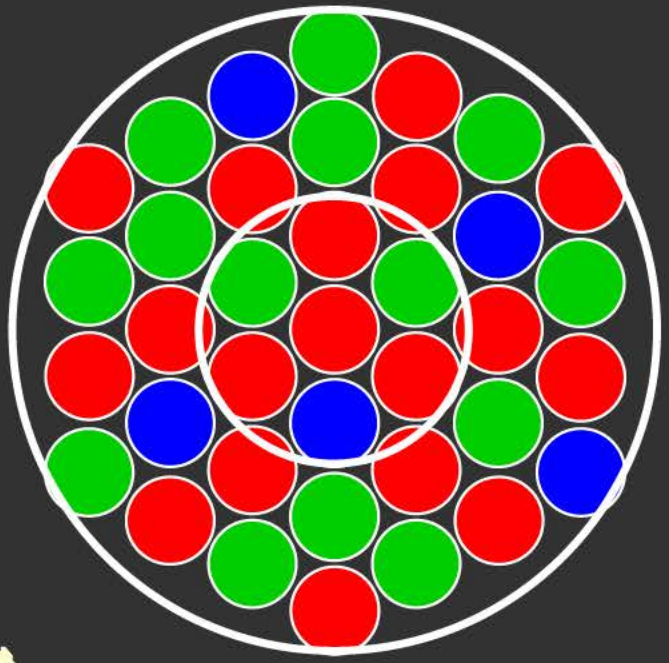
by Polyak

Images removed due to copyright restrictions.

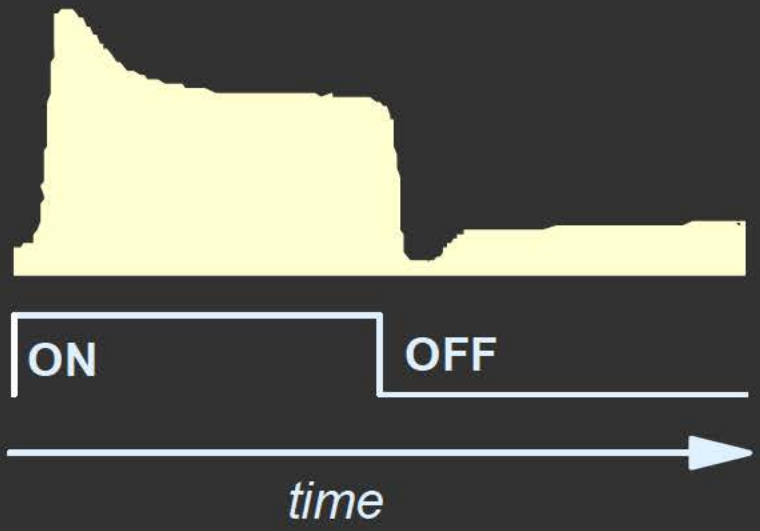
Please refer to lecture video or Figure 2c and 3c of Watanabe, M., and R. W. Rodieck. "Parasol and midget ganglion cells of the primate retina." *Journal of Comparative Neurology* 189, no. 3 (1989): 434-454.

MIDGET SYSTEM

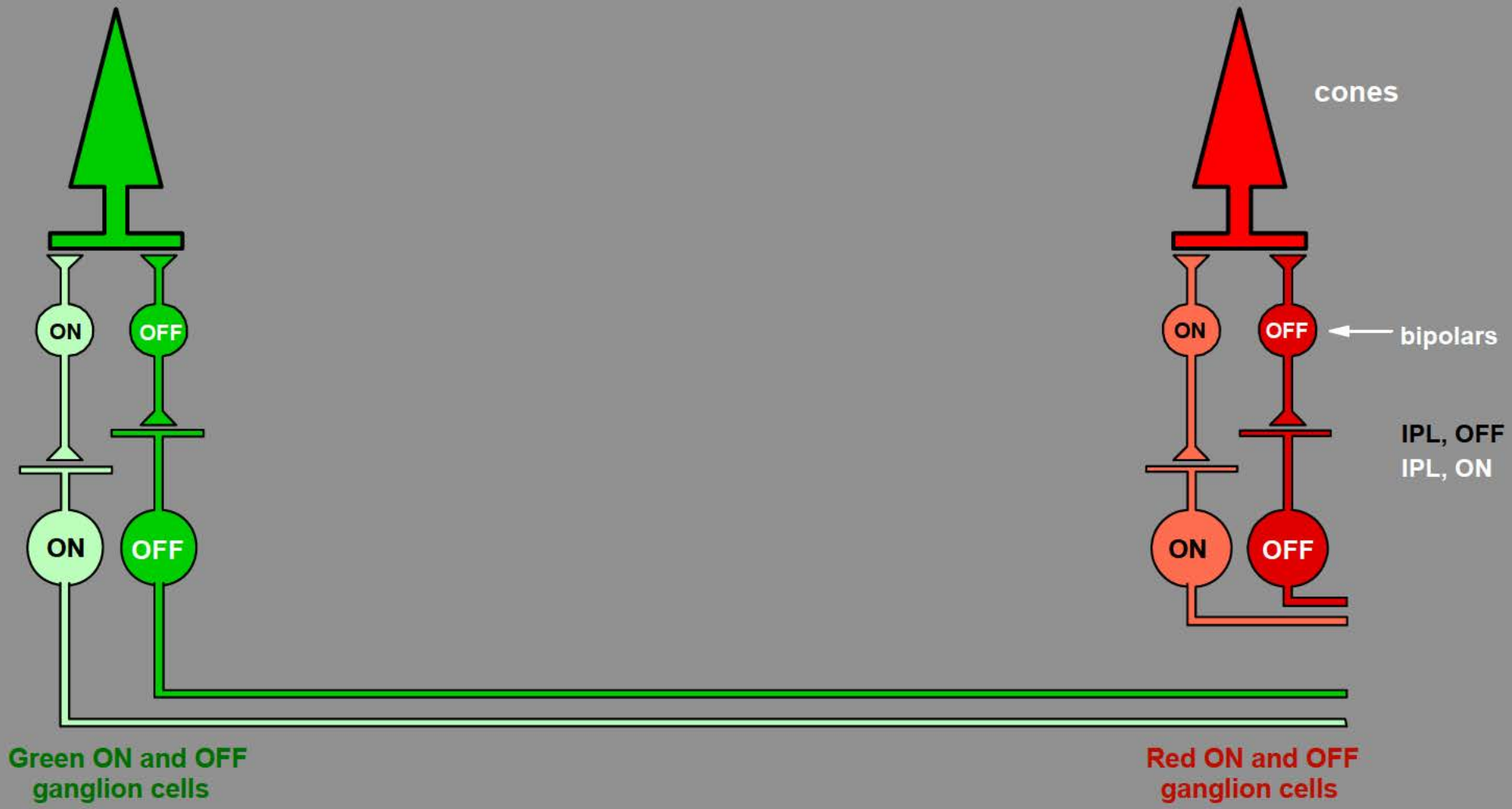
PARASOL SYSTEM



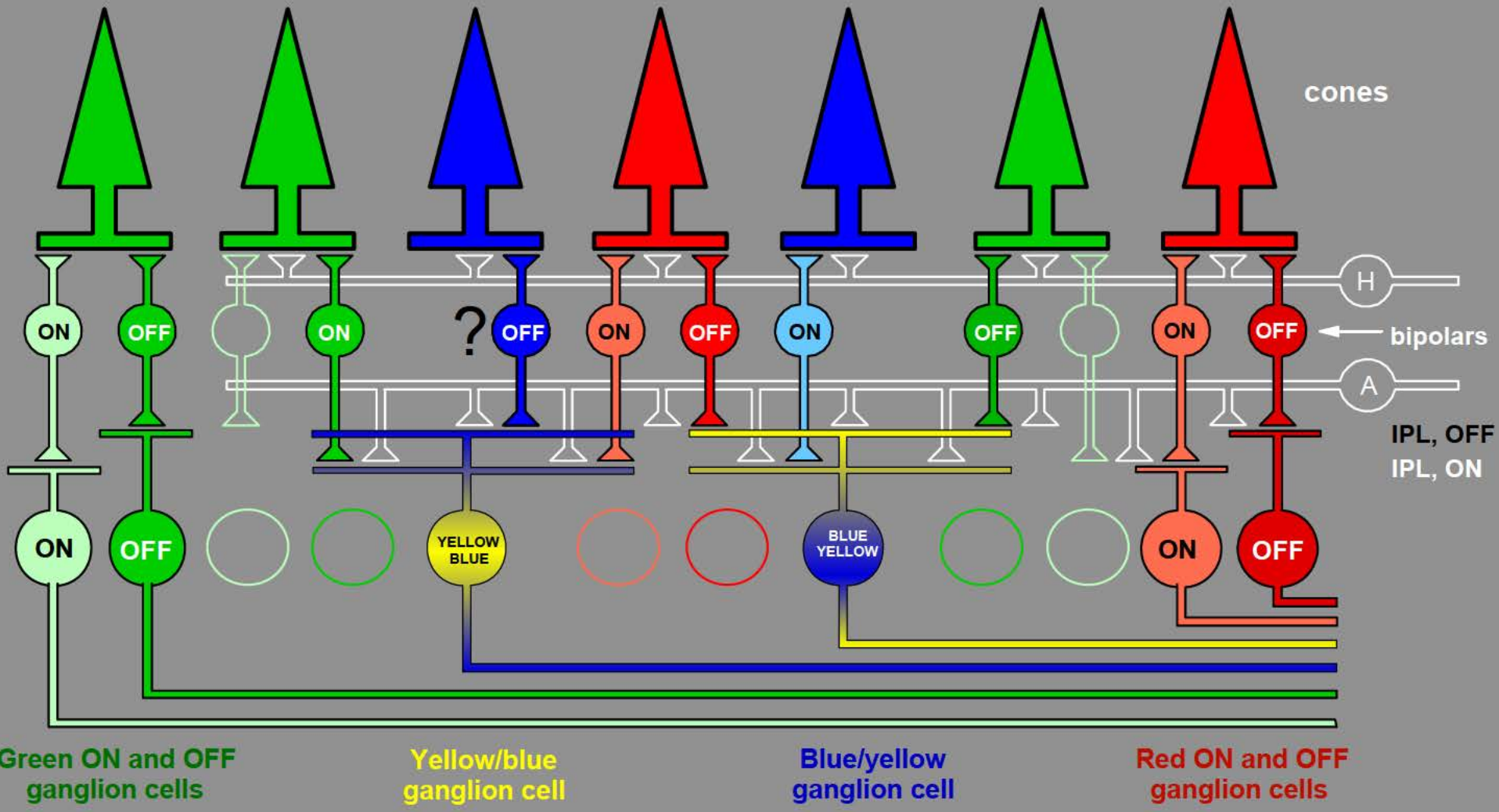
Neuronal response profile



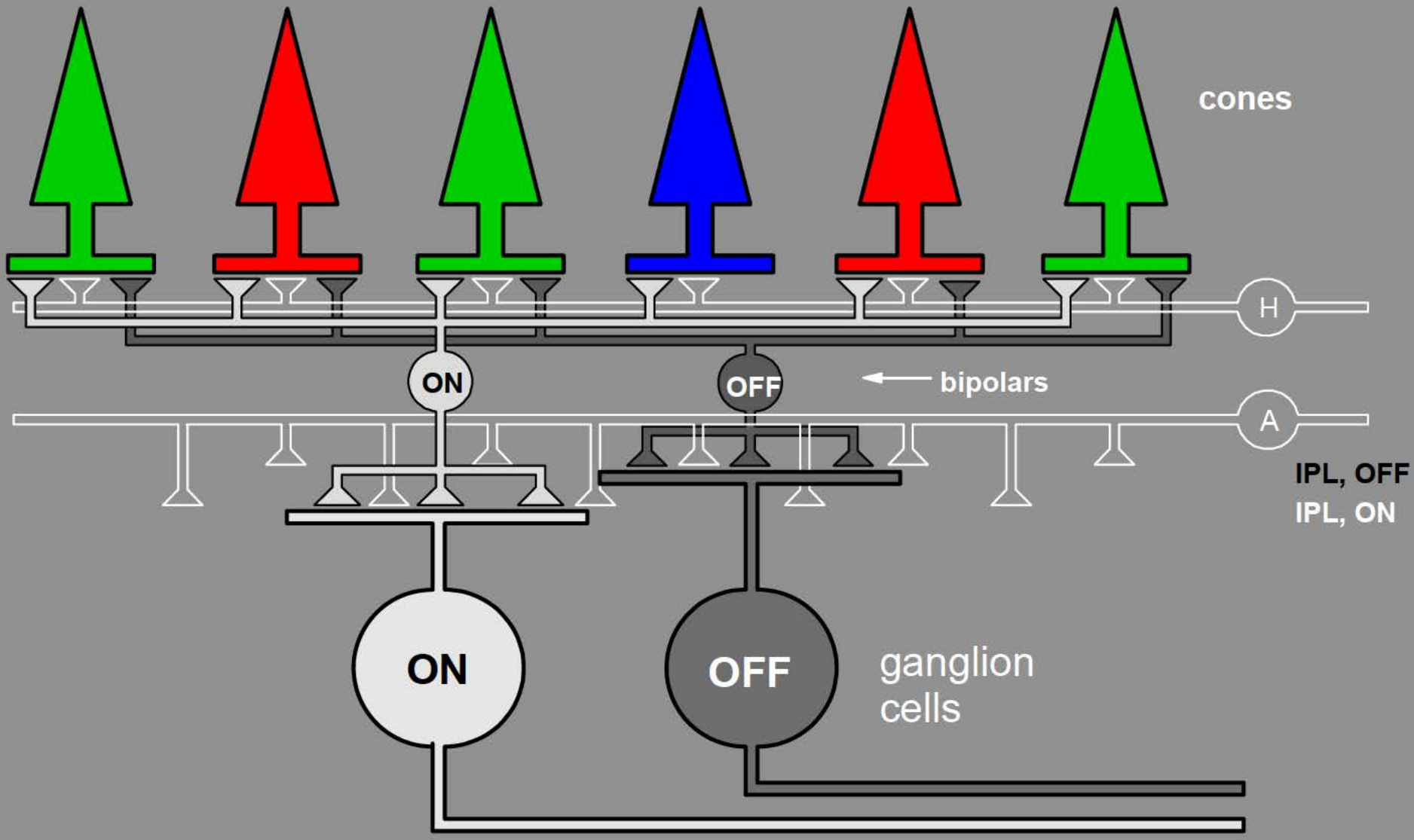
Midget system

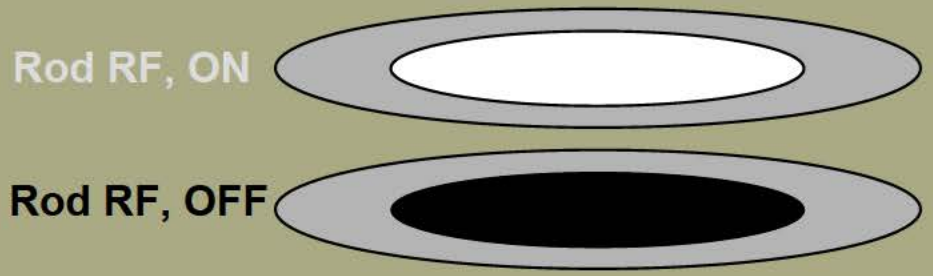


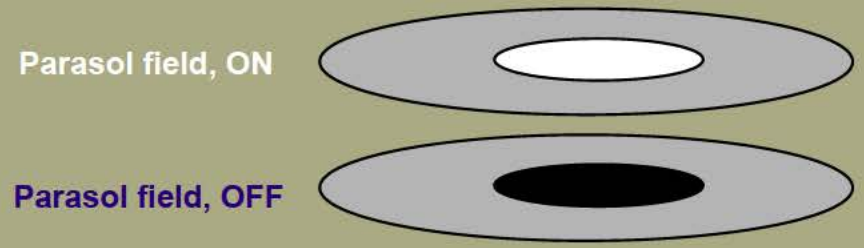
Midget and blue/yellow system

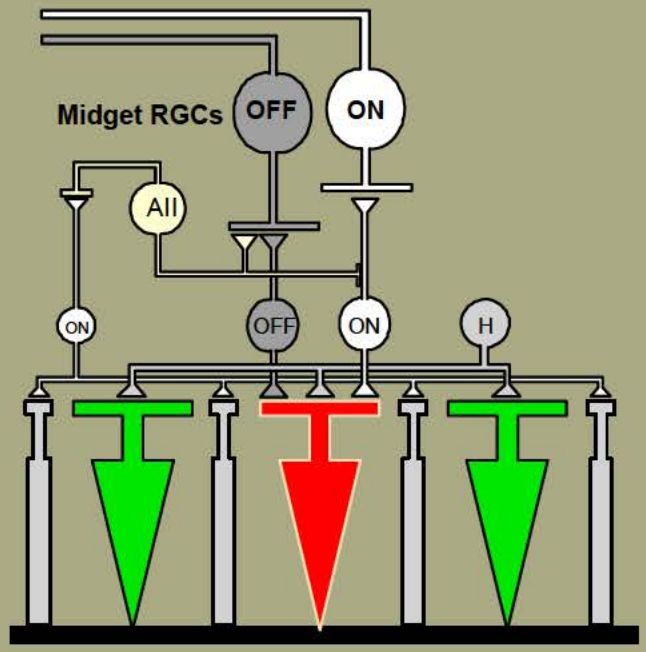


Parasol system





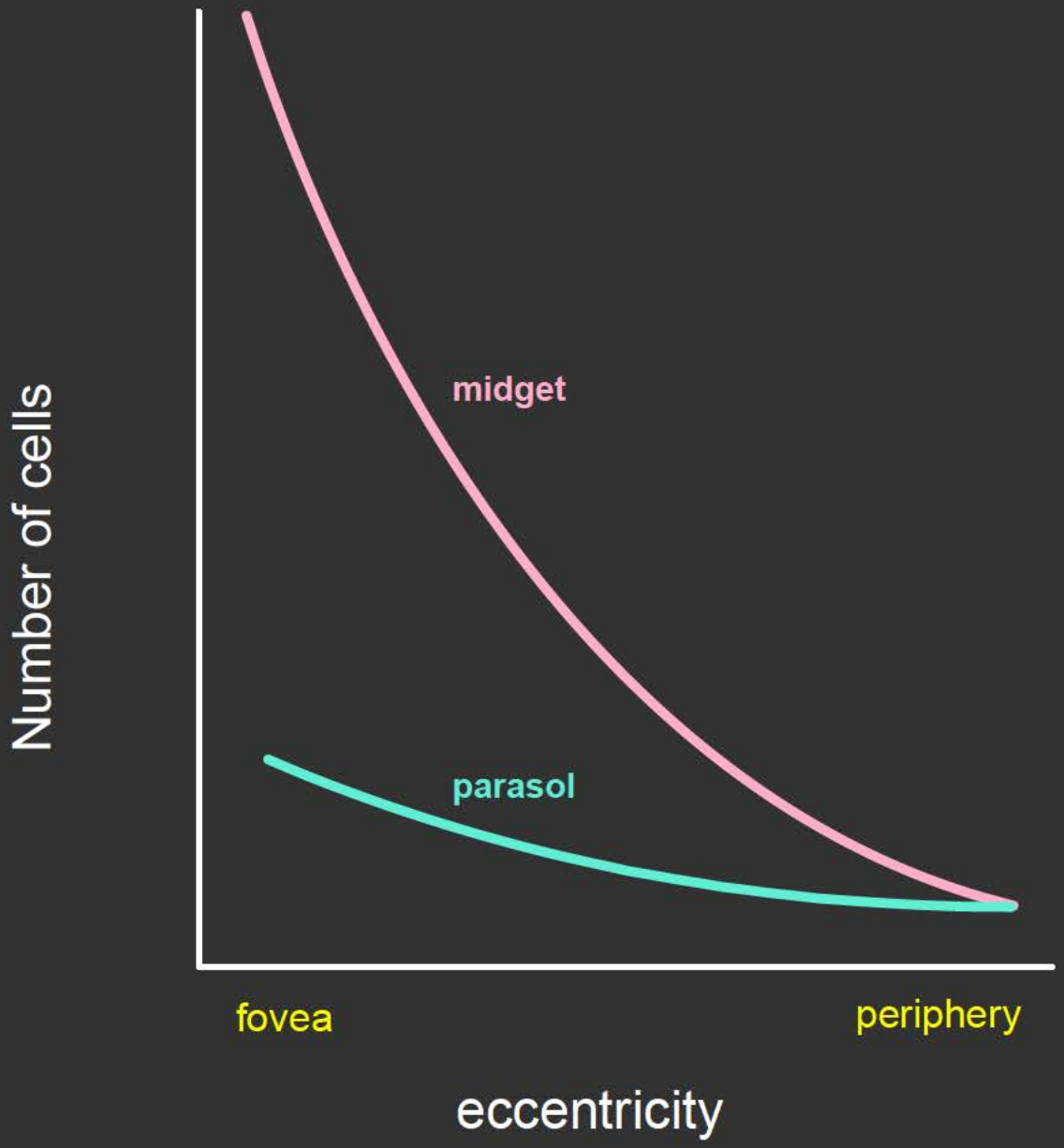


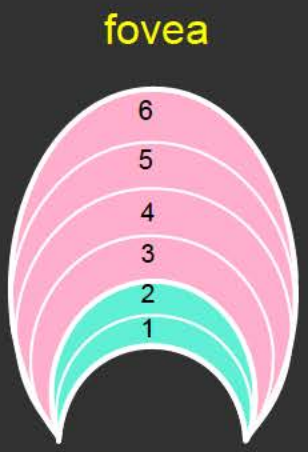


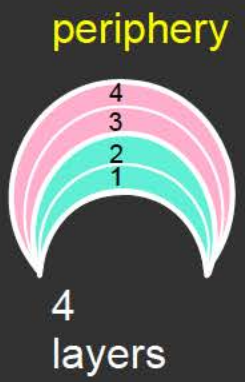
Overlapping RFs for:

- ✓ Midget ON, cones
- ✓ Midget OFF, cones
- ✓ Midget ON, rods
- ✓ Midget OFF, rods
- Parasol ON, cones
- Parasol OFF, cones
- Parasol ON, rods
- Parasol OFF, rods
- Plus others: W-cells, AOS cells

Number of midget and parasol cells per unit area as a function of eccentricity





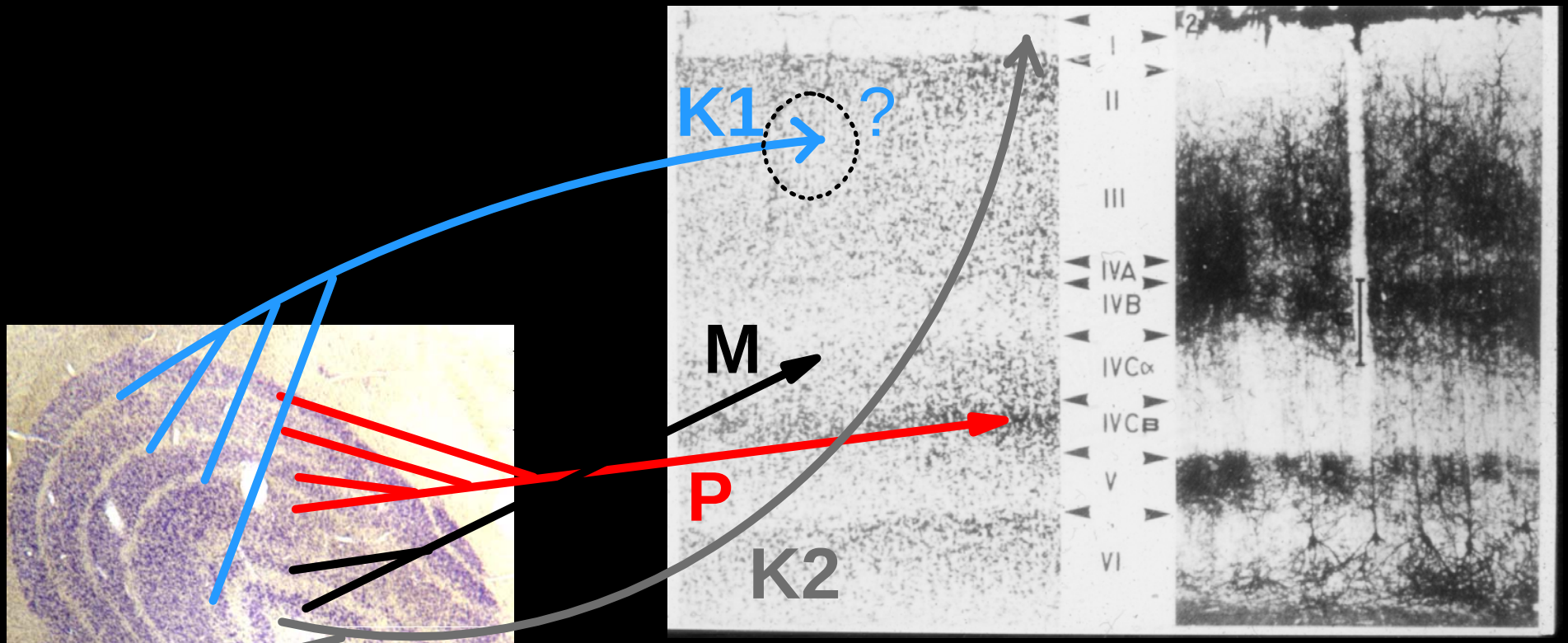


midget/parasol ratio:

fovea: 8 to 1 periphery: 1 to 1

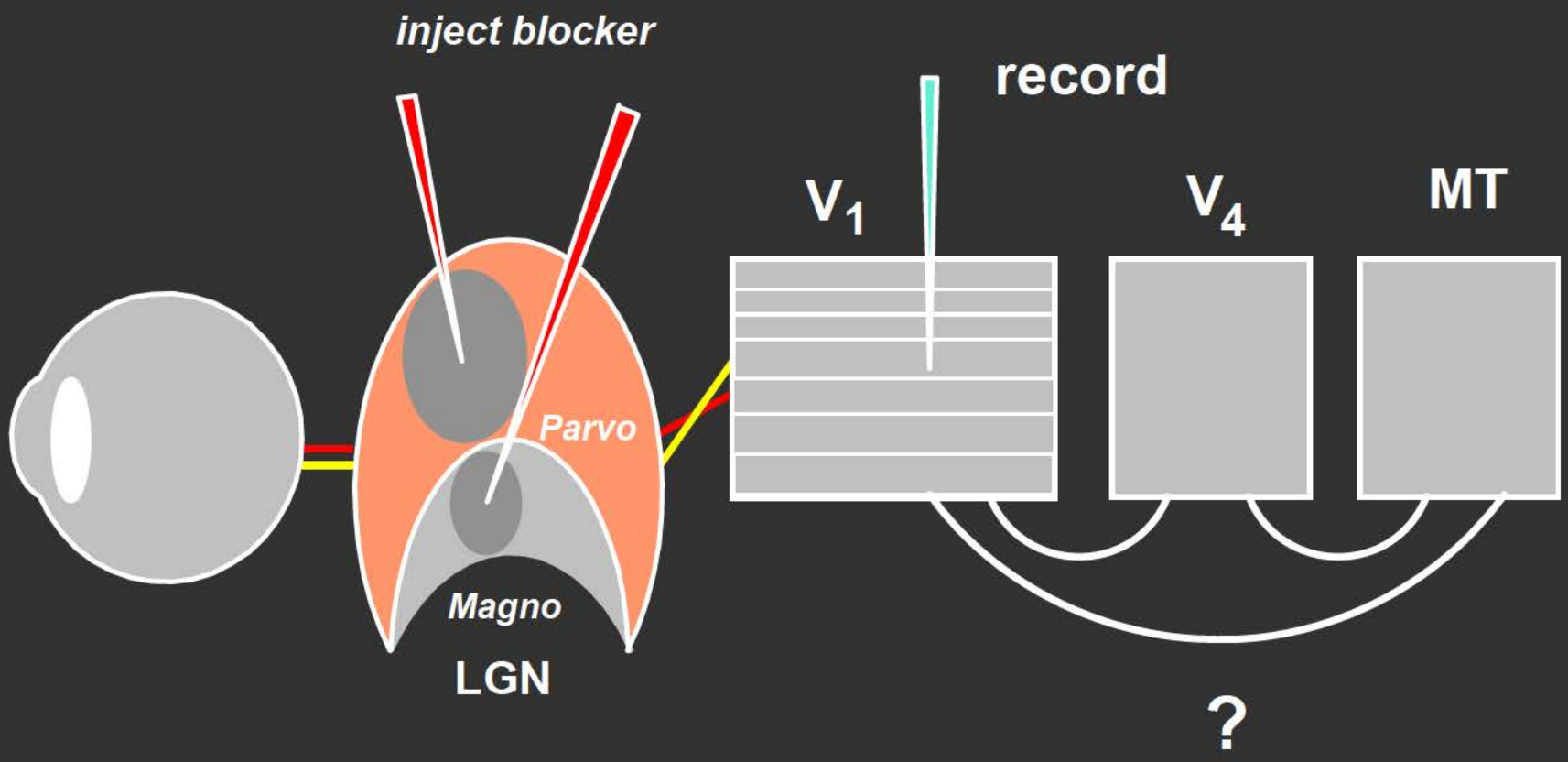
Projections of the retinal ganglion cells

Cortical projections from LGN



The central connections of the midget and parasol channels

Tissue block with injections



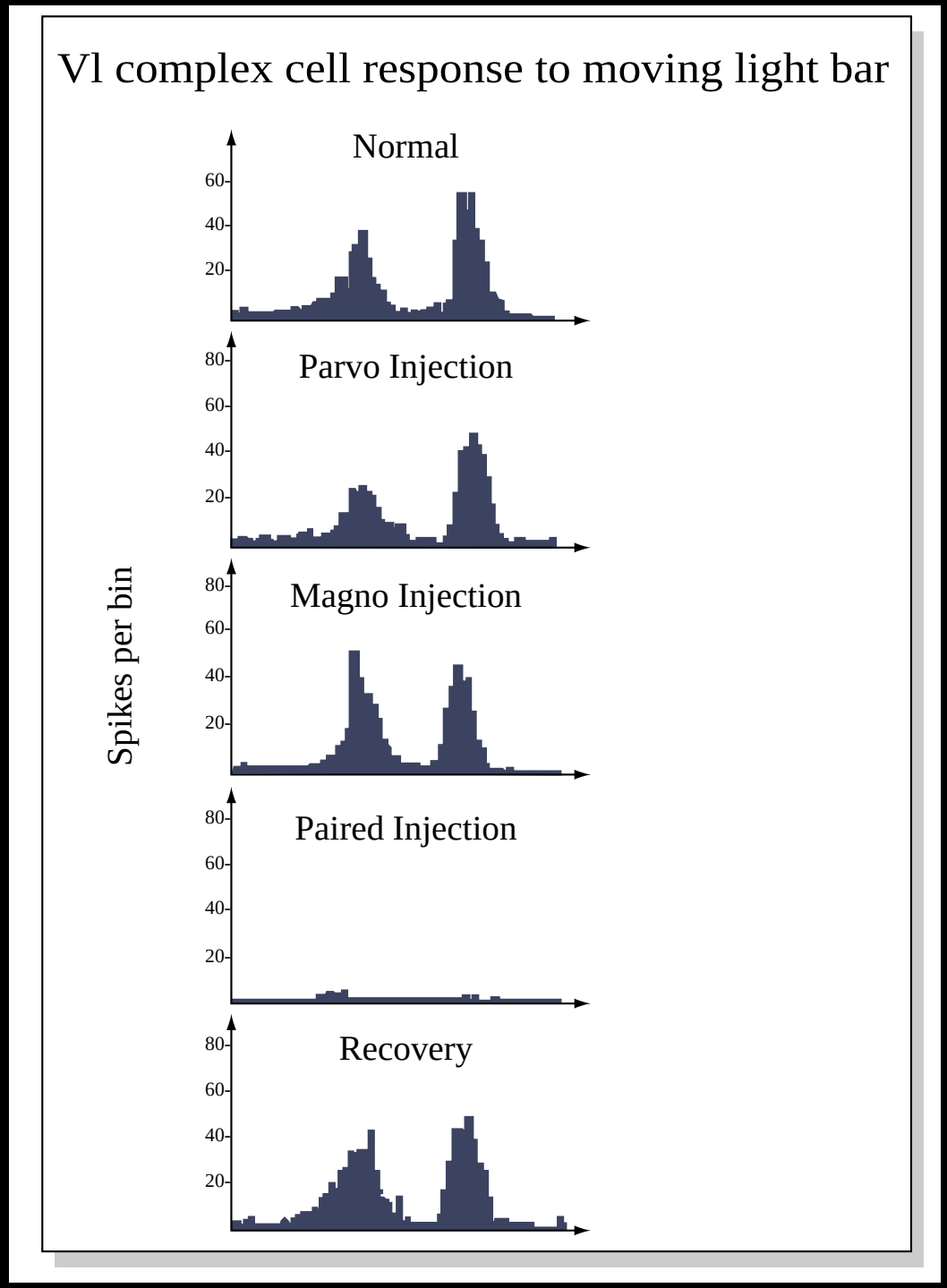
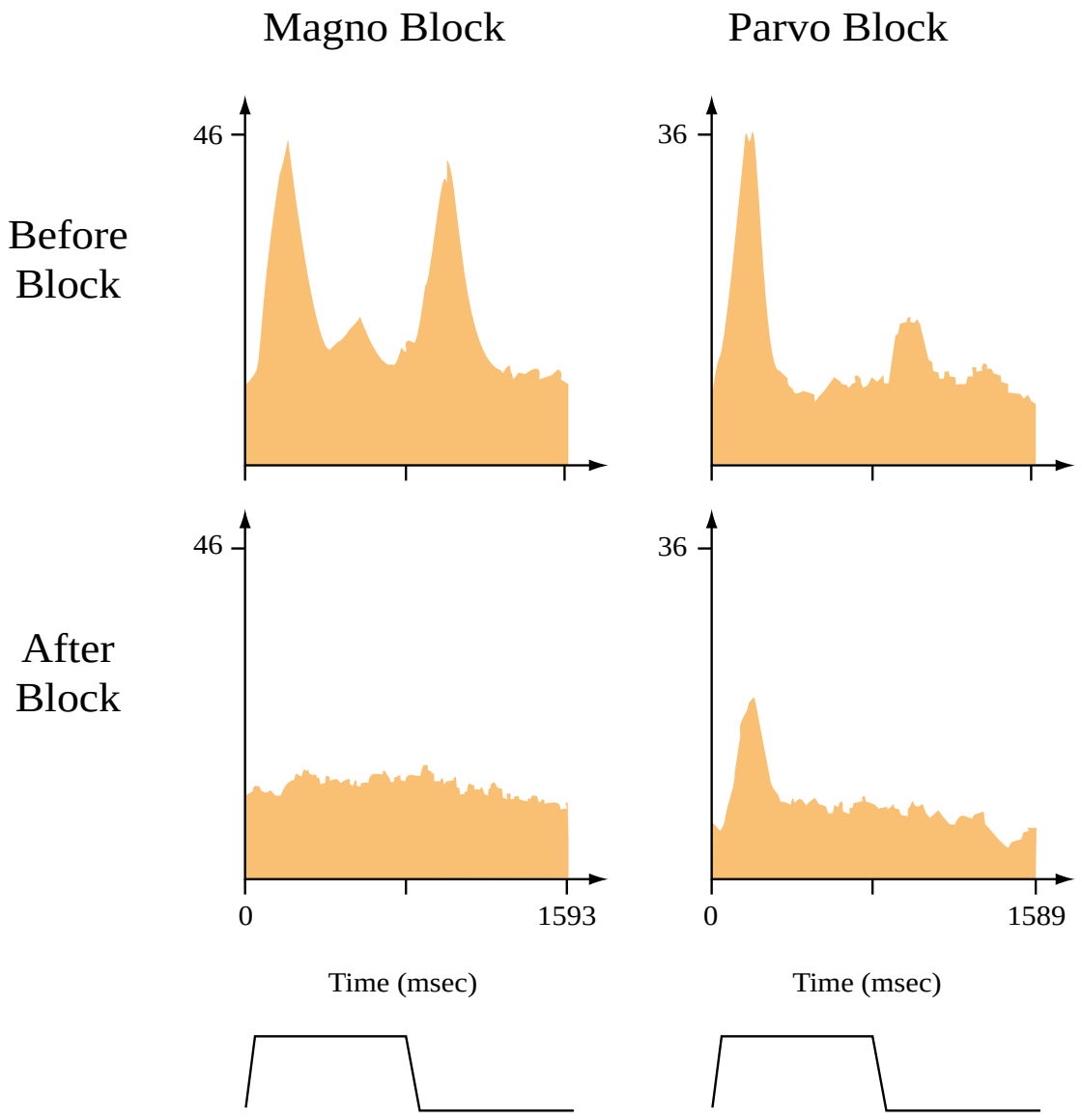


Image by MIT OpenCourseWare.

Recording in V4



Recording in MT

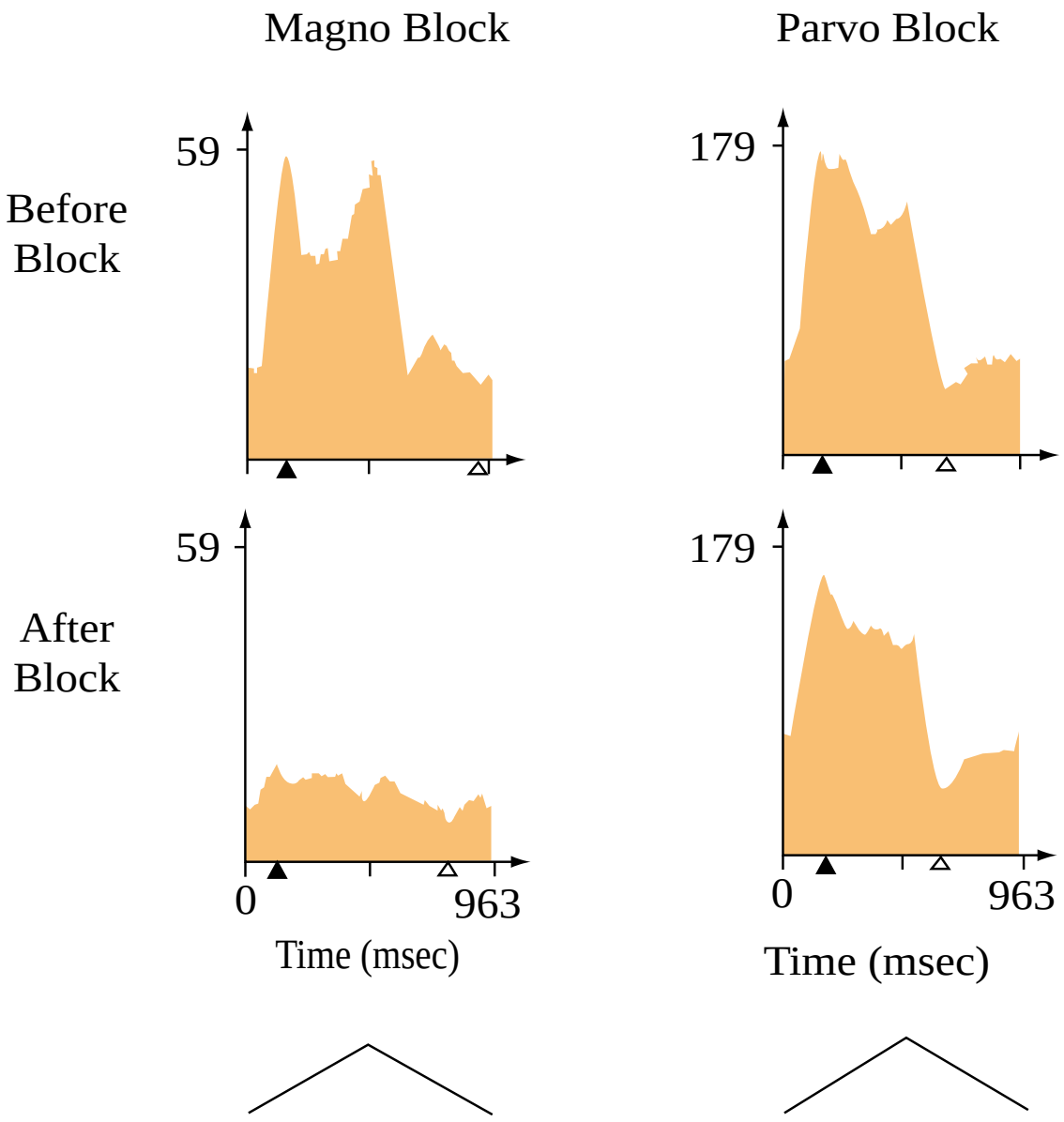
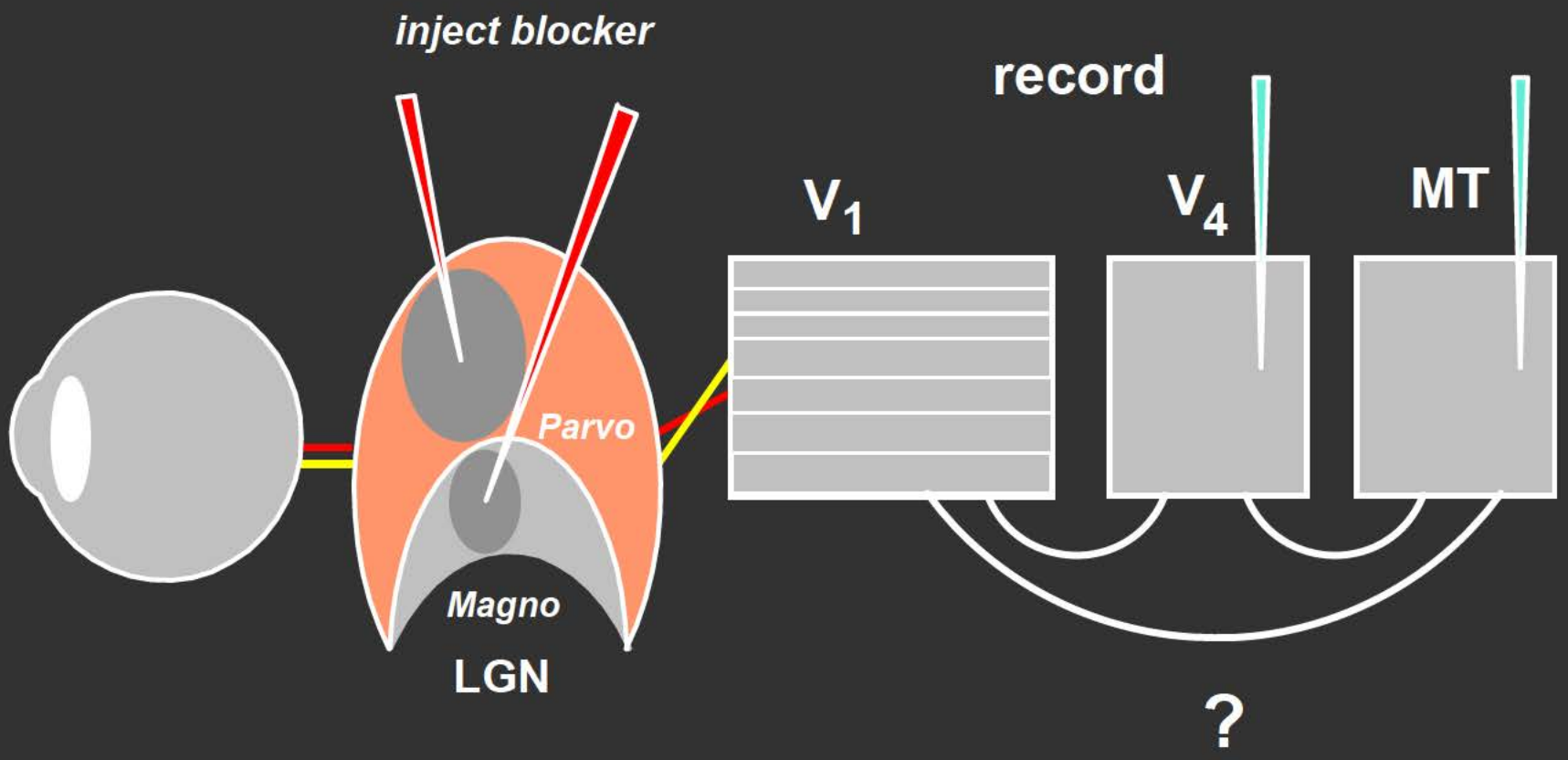


Image by MIT OpenCourseWare.

Tissue block with injections



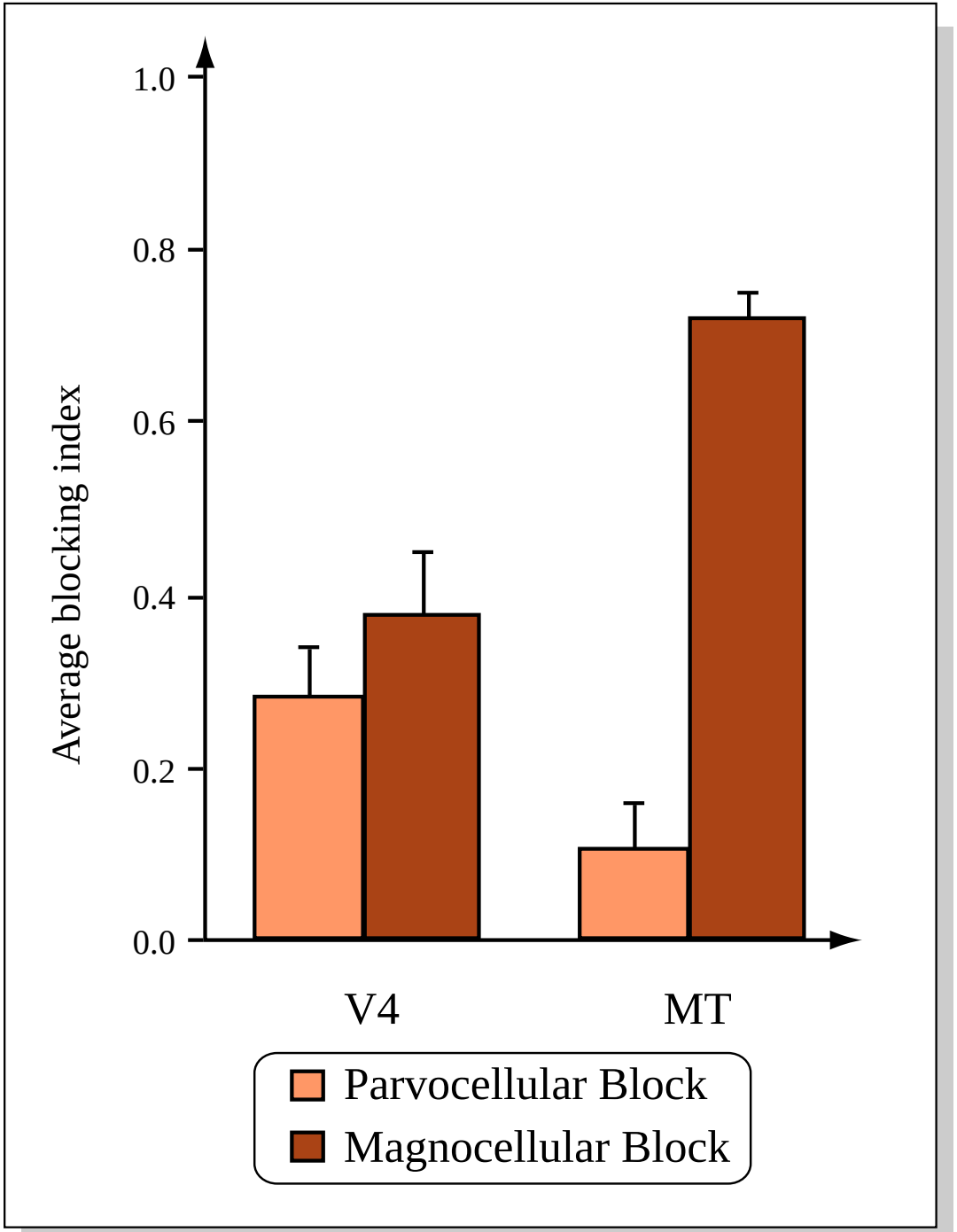
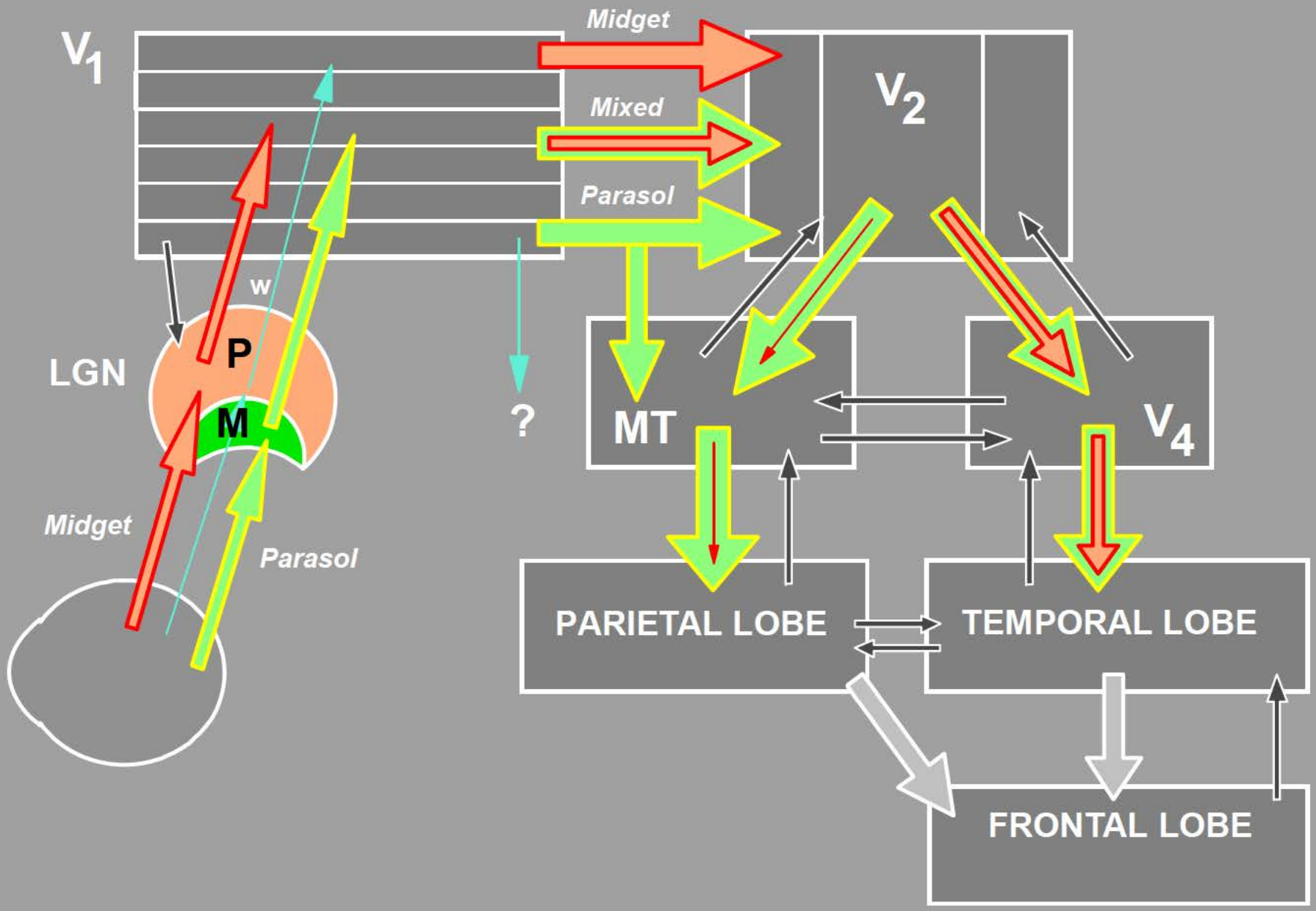


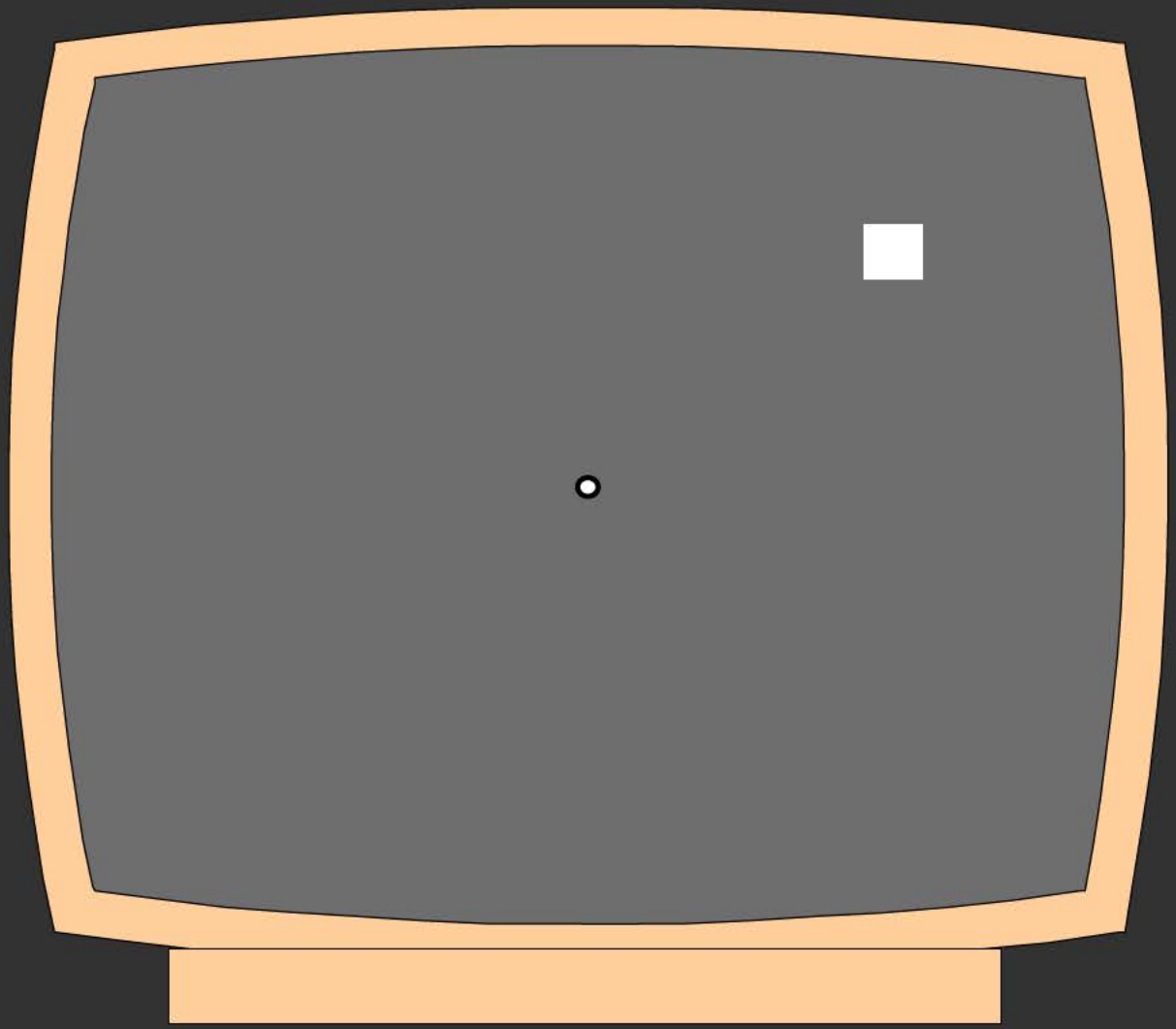
Image by MIT OpenCourseWare.


V1
Midget
Mixed
Parasol
V2
W
P
M
LGN
?
MT
V4
Midget
Parasol
PARIETAL LOBE
TEMPORAL LOBE
FRONTAL LOBE

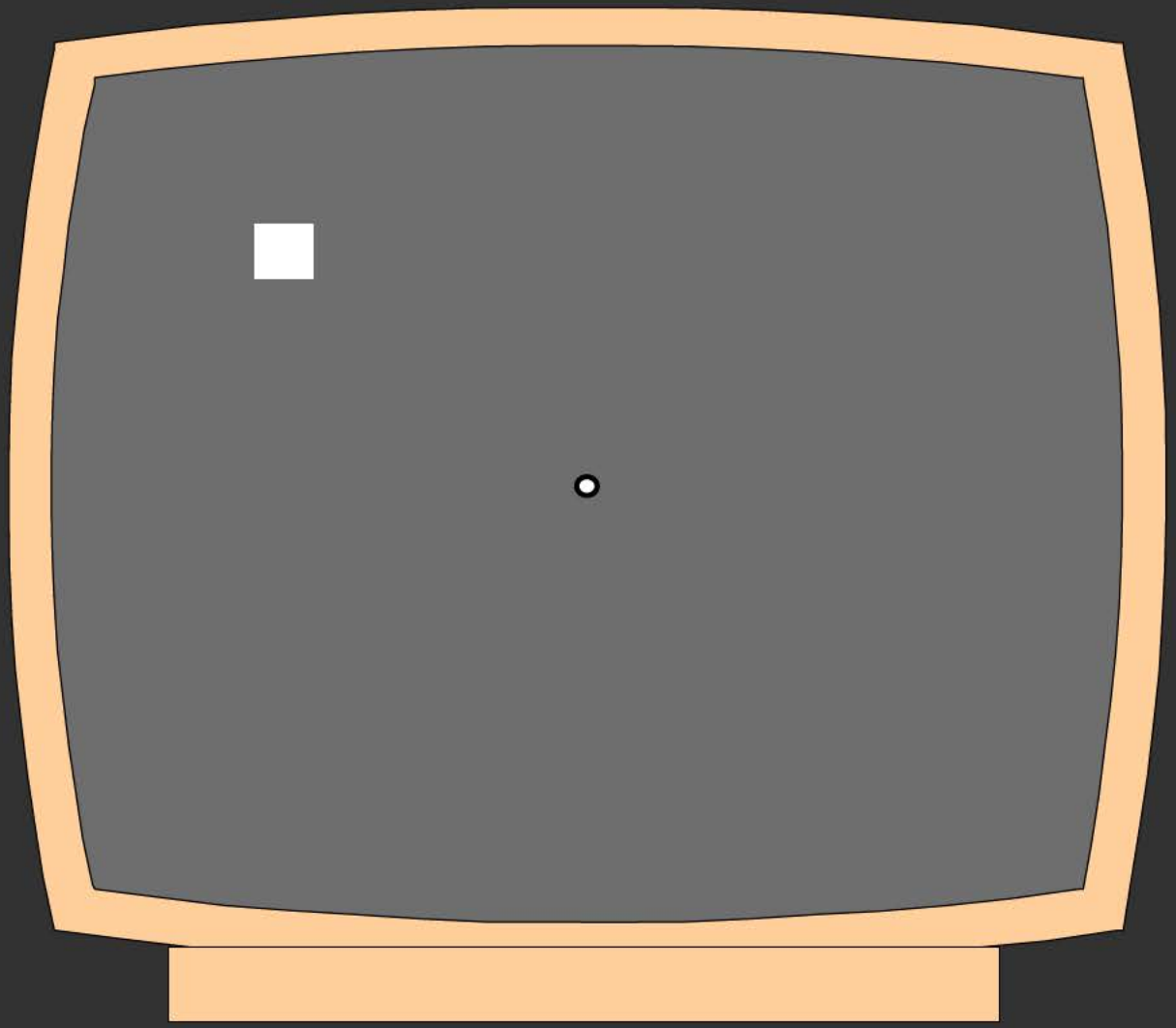
Lesion studies

Behavioral procedures

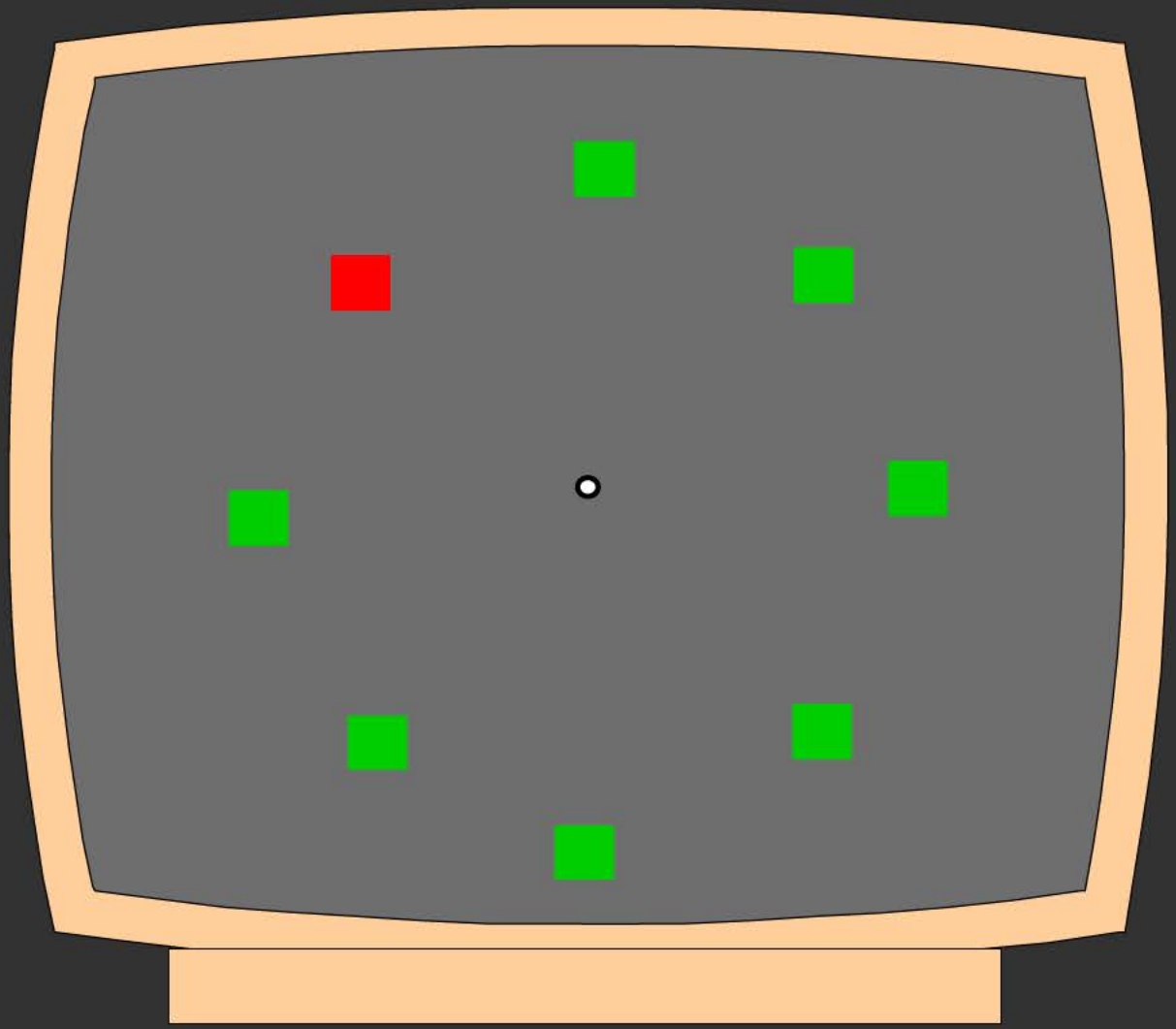
Detection



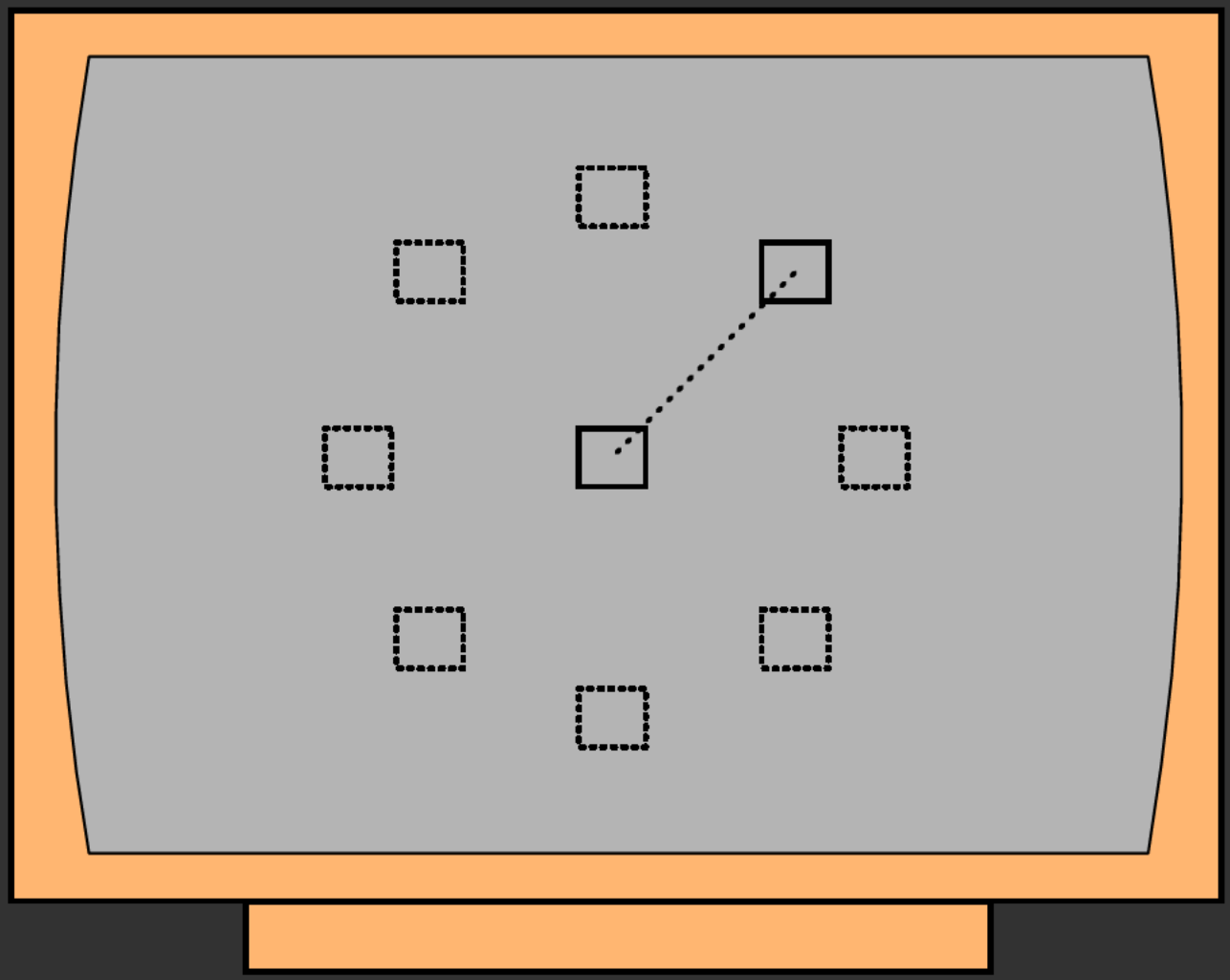
Detection



Discrimination



Performance Monitor



The lesions

Example of LGN lesions with ibotenic acid

Images removed due to copyright restrictions.

Please refer to lecture video or Figure 4 of Schiller, Peter H., Nikos K. Logothetis, and Eliot R. Charles. "Role of color-opponent and broad-band channels in vision." *Visual Neuroscience* 5, no. 4 (1990): 312-346.

PERCEPTUAL FUNCTIONS TESTED

Contrast Sensitivity

Color

Pattern

Texture

Shape

Stereopsis

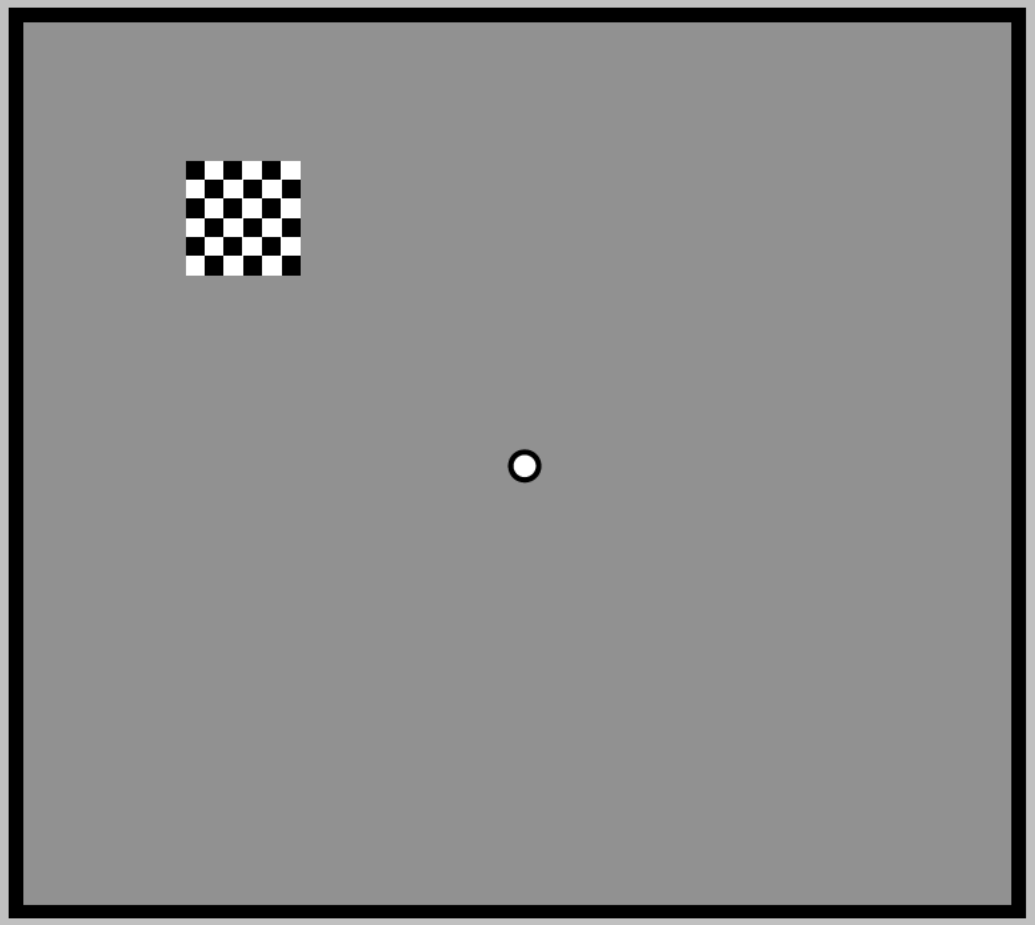
Flicker

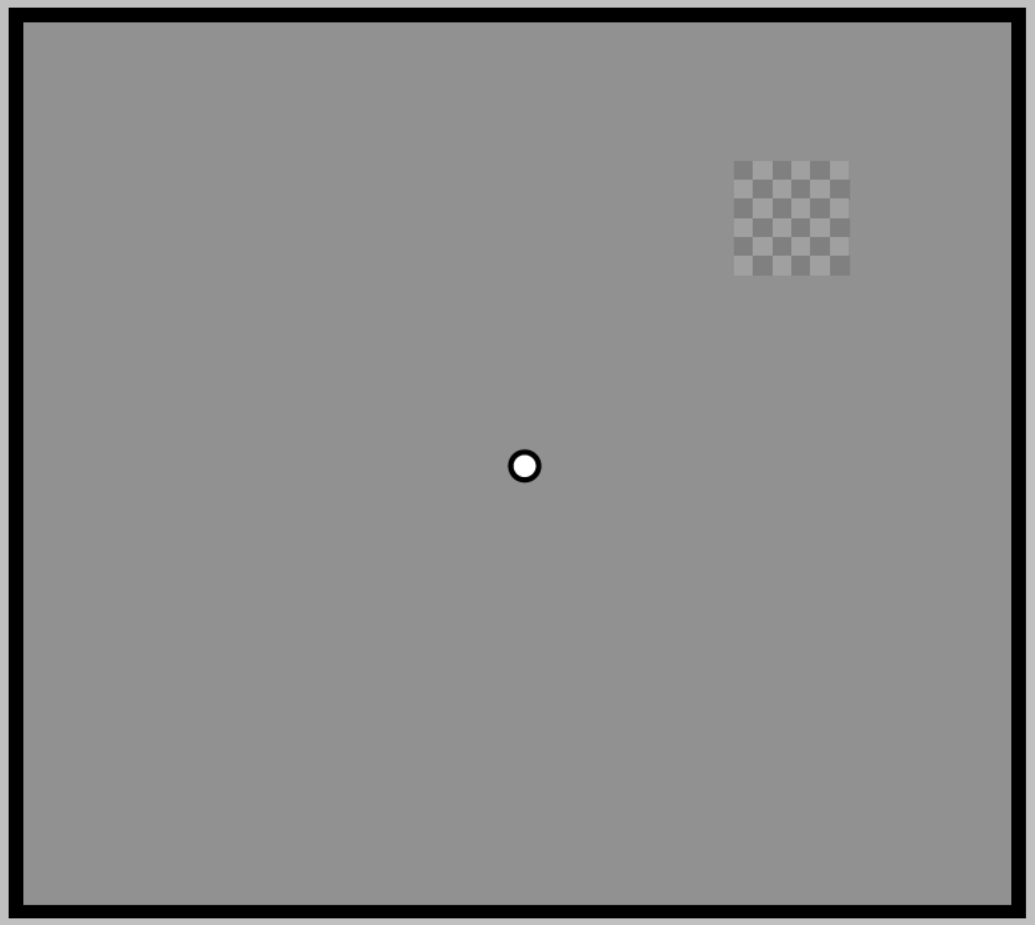
Motion

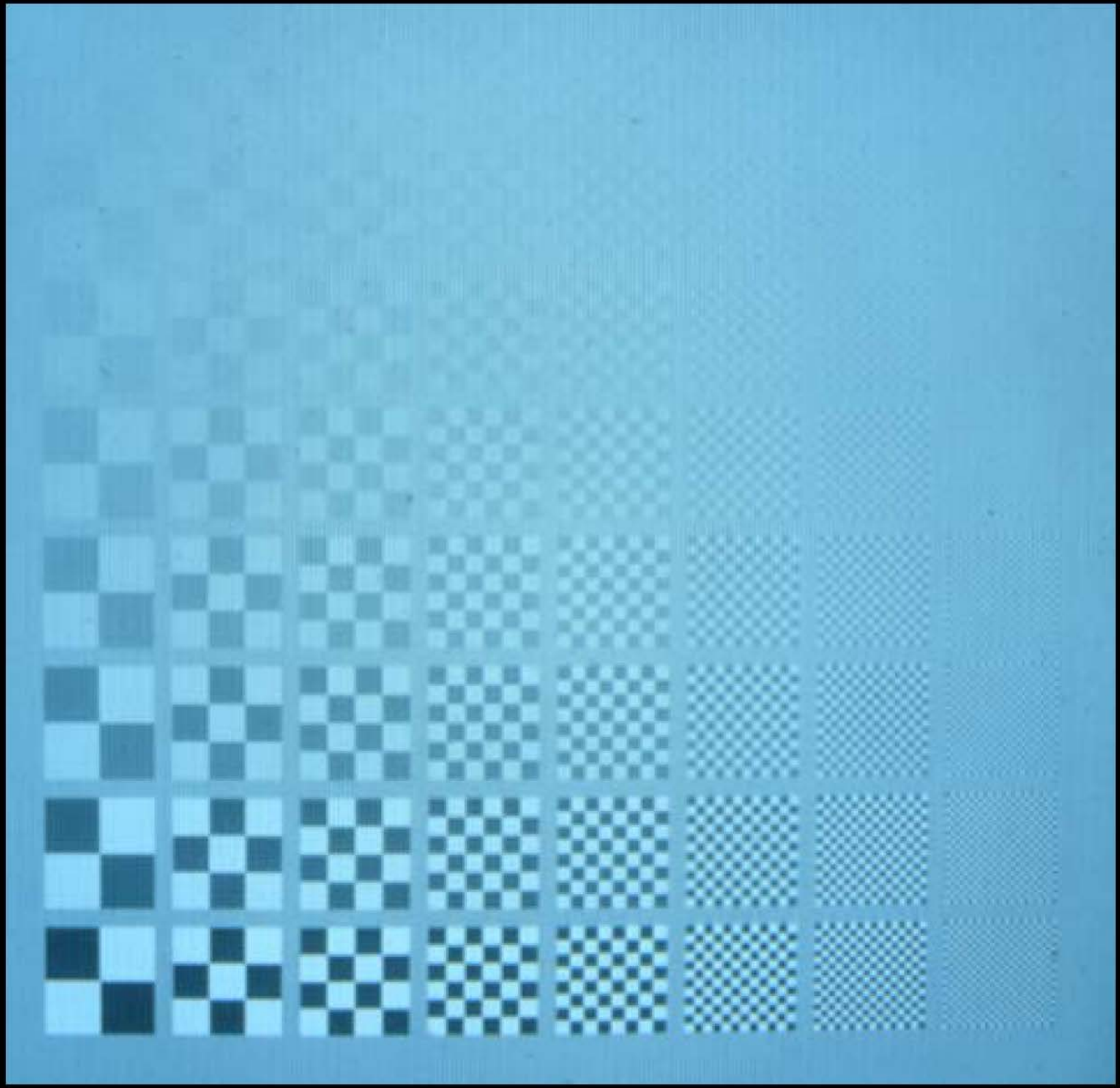
Brightness

Scotopic Vision

Contrast sensitivity







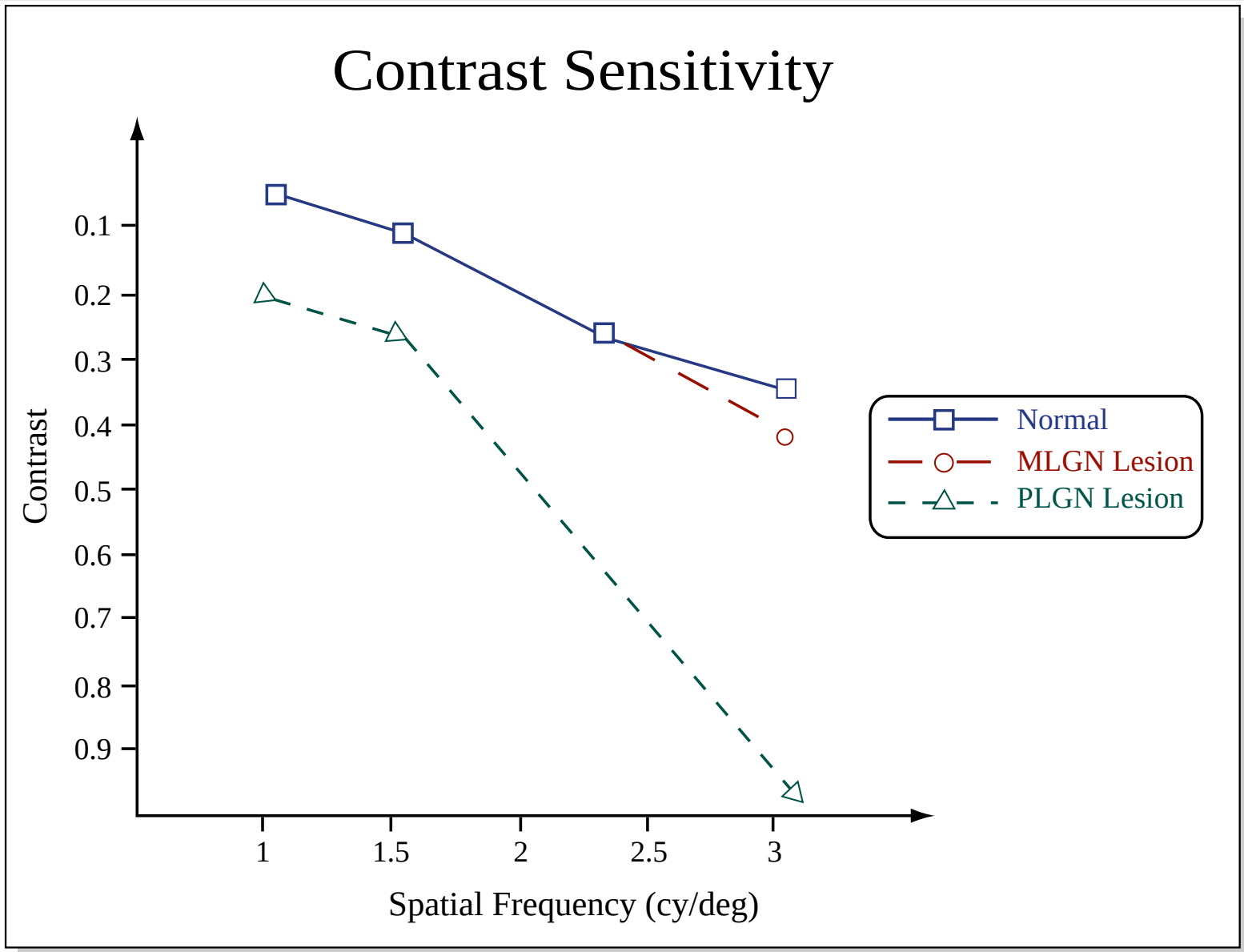
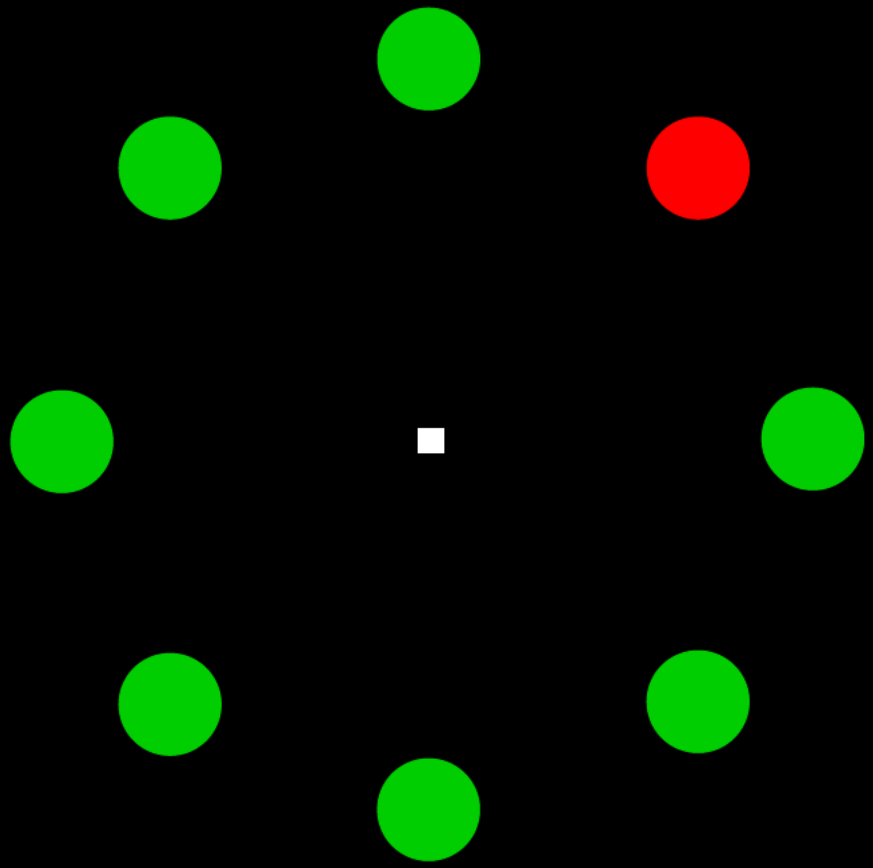
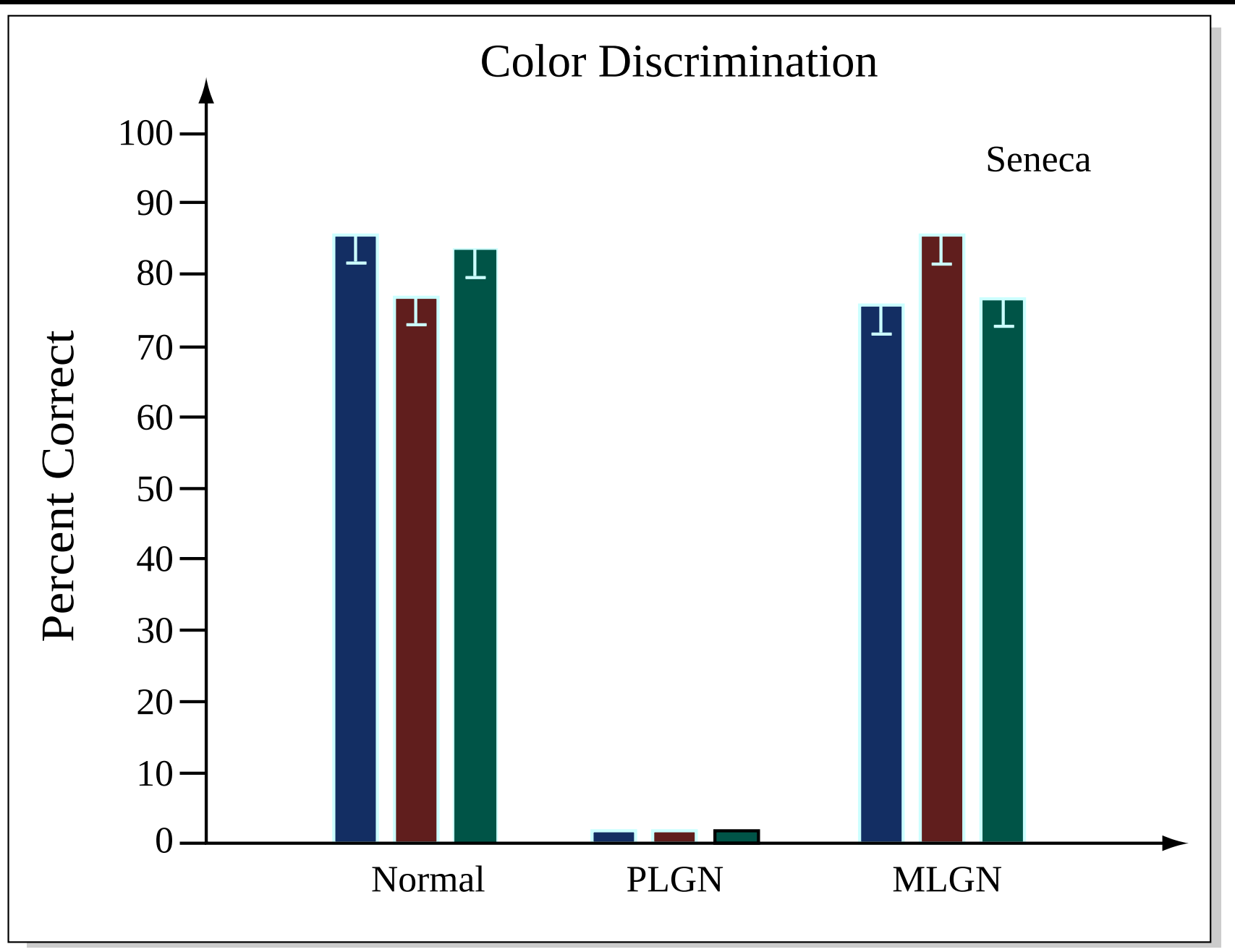


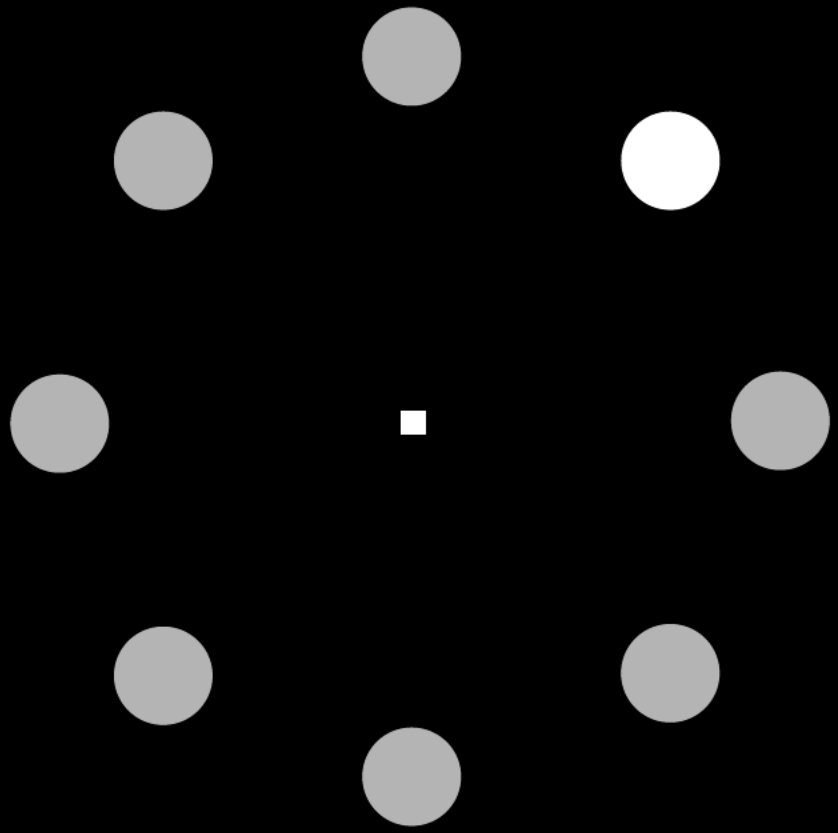
Image by MIT OpenCourseWare.

Color vision





Brightness perception



The perception of brightness in photopic vision

Images removed due to copyright restrictions.

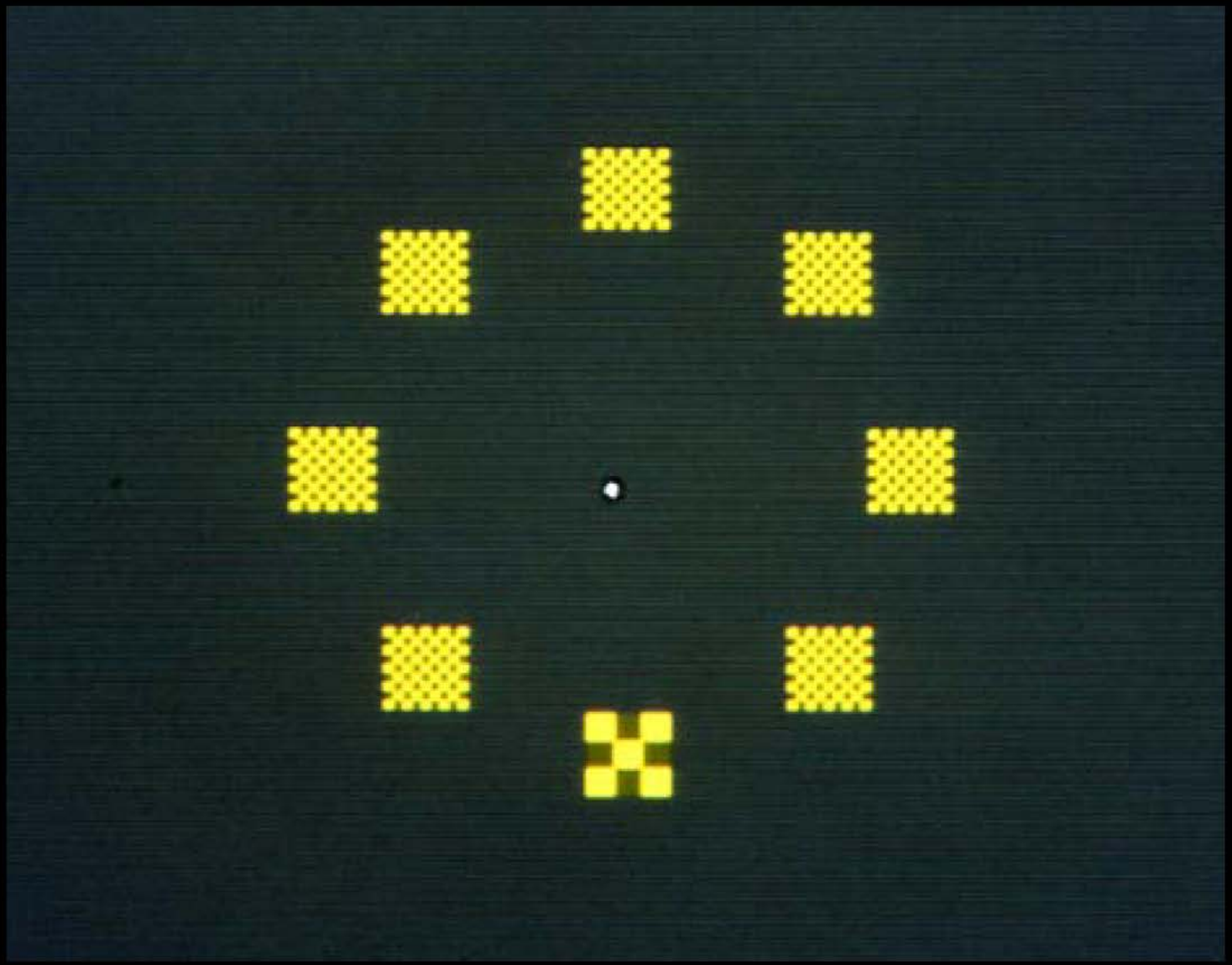
Please refer to lecture video or Figure 16b,d of Schiller, Peter H., Nikos K. Logothetis, and Eliot R. Charles. "Role of color-opponent and broad-band channels in vision." *Visual Neuroscience* 5, no. 4 (1990): 312-346.

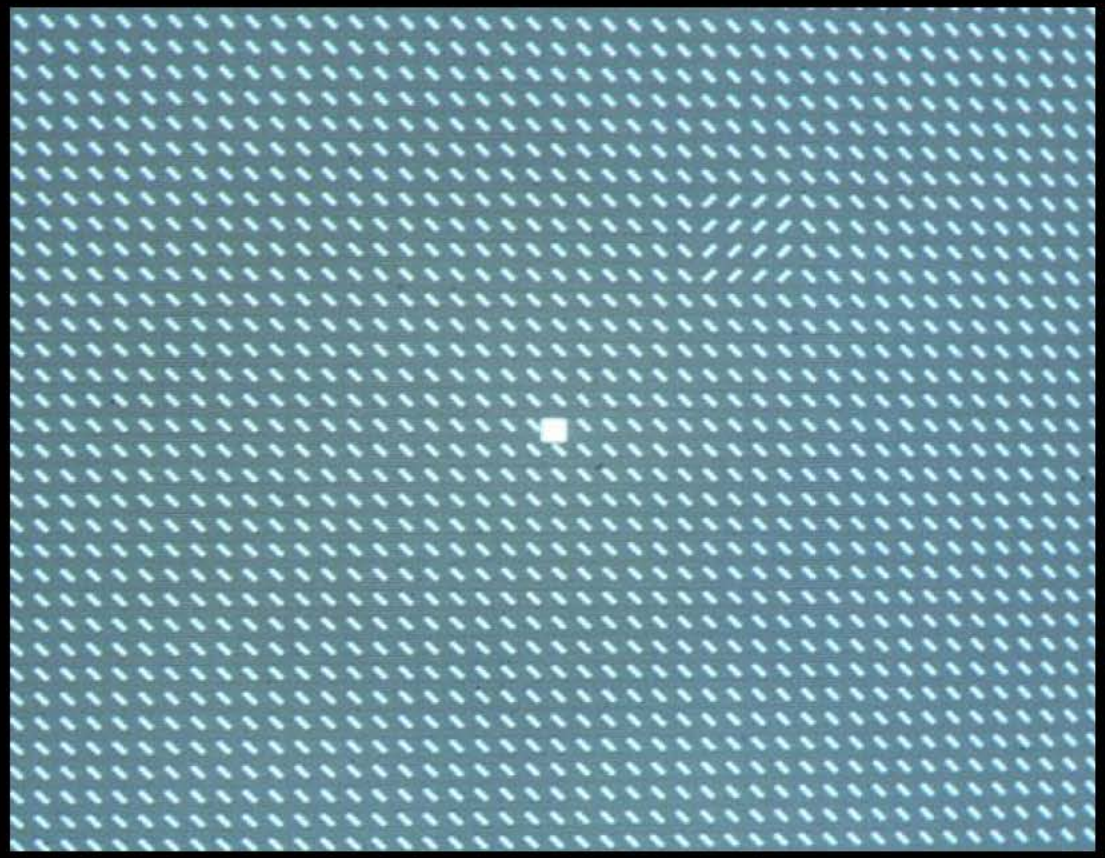
The perception of brightness in scotopic vision

Images removed due to copyright restrictions.

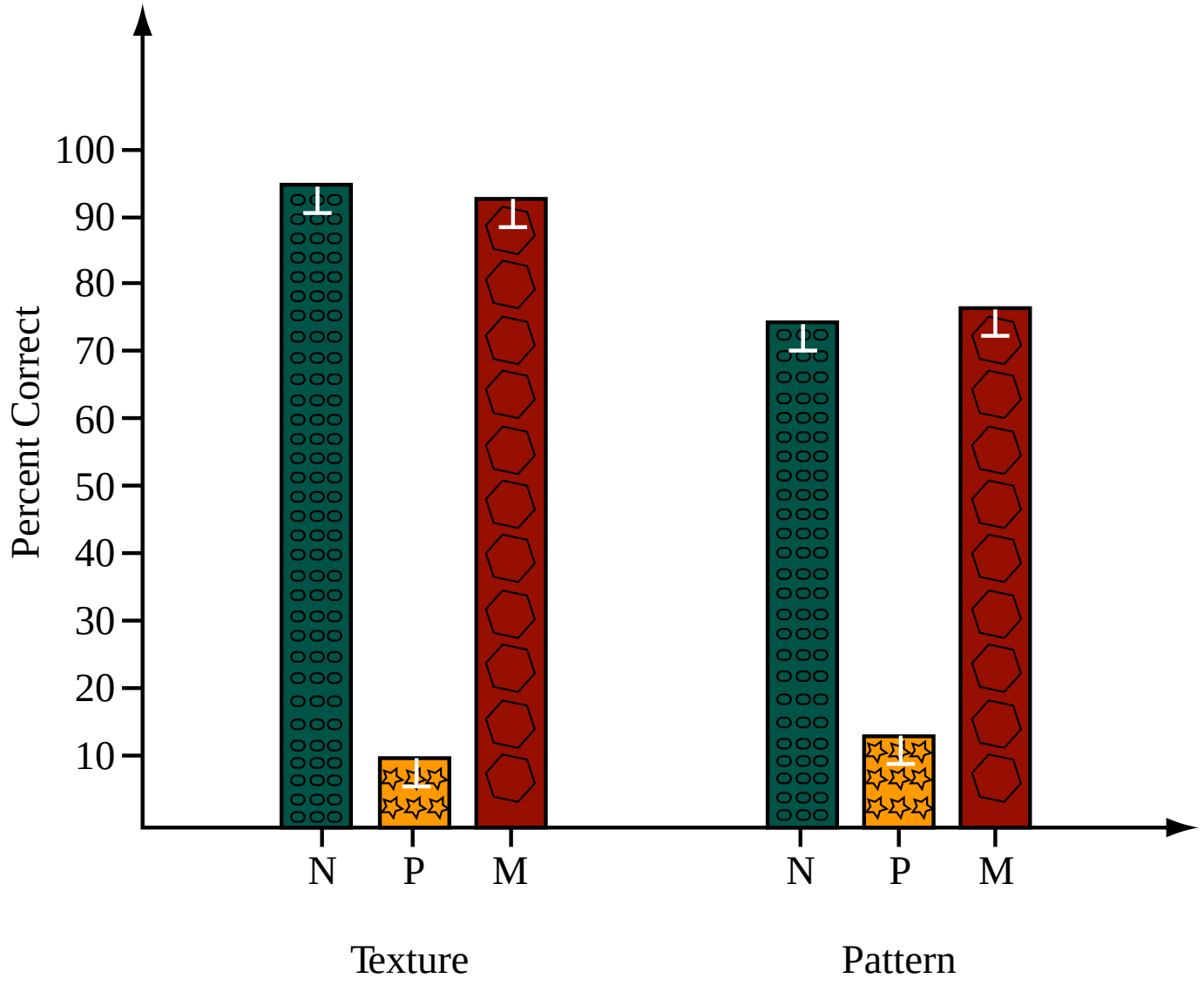
Please refer to lecture video or Figure 13 of Schiller, Peter H., Nikos K. Logothetis, and Eliot R. Charles. "Role of color-opponent and broad-band channels in vision." *Visual Neuroscience* 5, no. 4 (1990): 312-346.

Pattern and texture perception

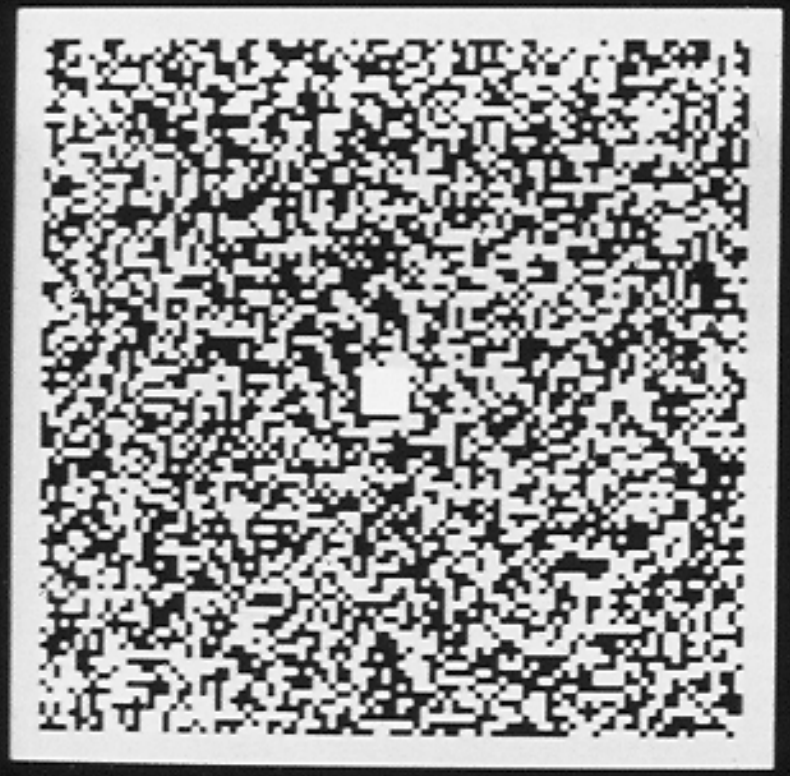


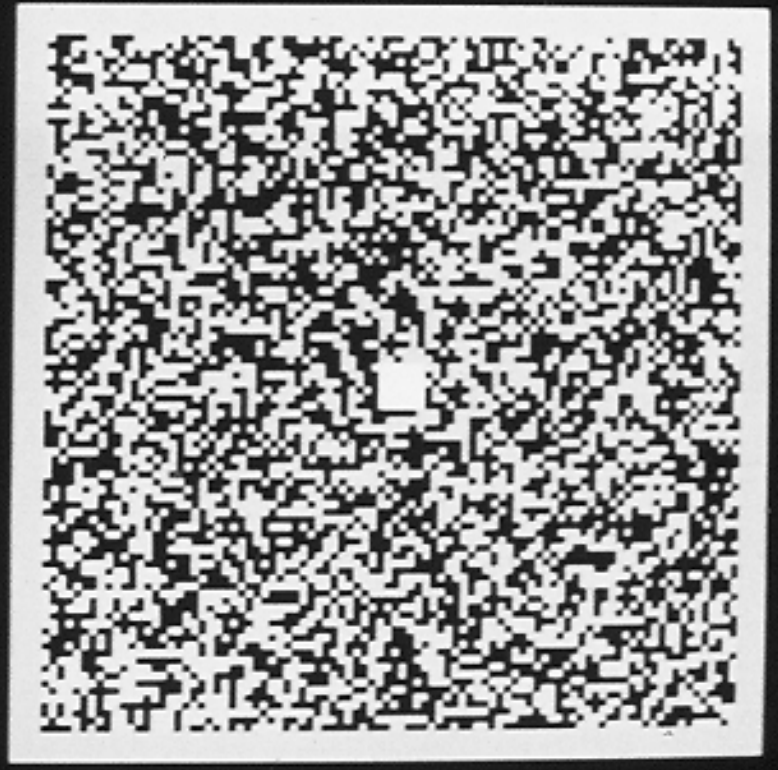


Texture and Pattern Discrimination



Stereoscopic depth perception





Images removed due to copyright restrictions.

Please refer to lecture video or Figure 1 of Schiller, Peter H., Geoffrey L. Kendall, Michelle C. Kwak, and Warren M. Slocum. "Depth perception, Binocular Integration and Hand-Eye Coordination in Intact and Stereo Impaired Human Subjects." *Journal of Clinical and Experimental Ophthamology* 3:210.

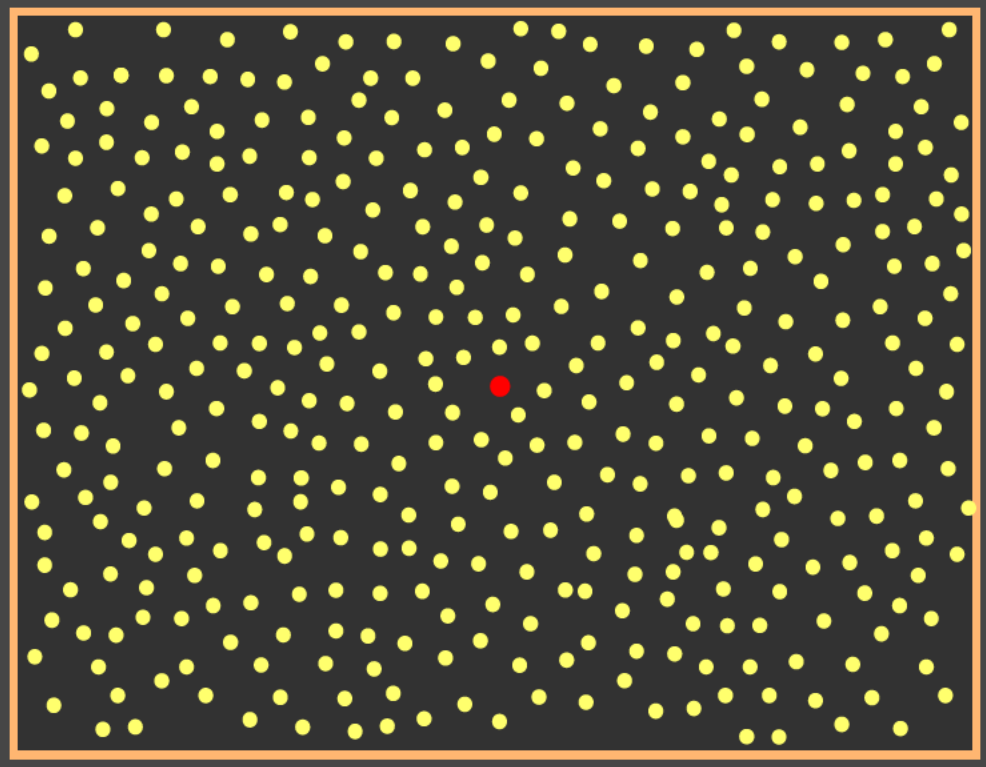
Stereoscopic depth perception

Images removed due to copyright restrictions.

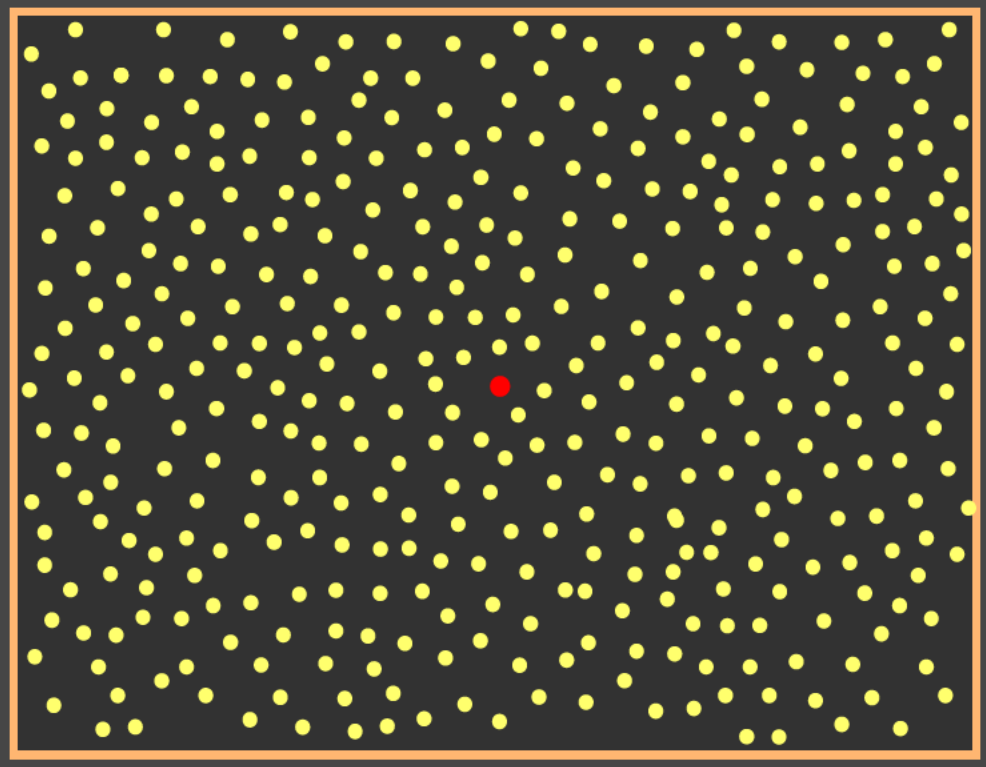
Please refer to lecture video or Figure 22a,b of Schiller, Peter H., Nikos K. Logothetis, and Eliot R. Charles. "Role of color-opponent and broad-band channels in vision." *Visual Neuroscience* 5, no. 4 (1990): 312-346.

Motion perception

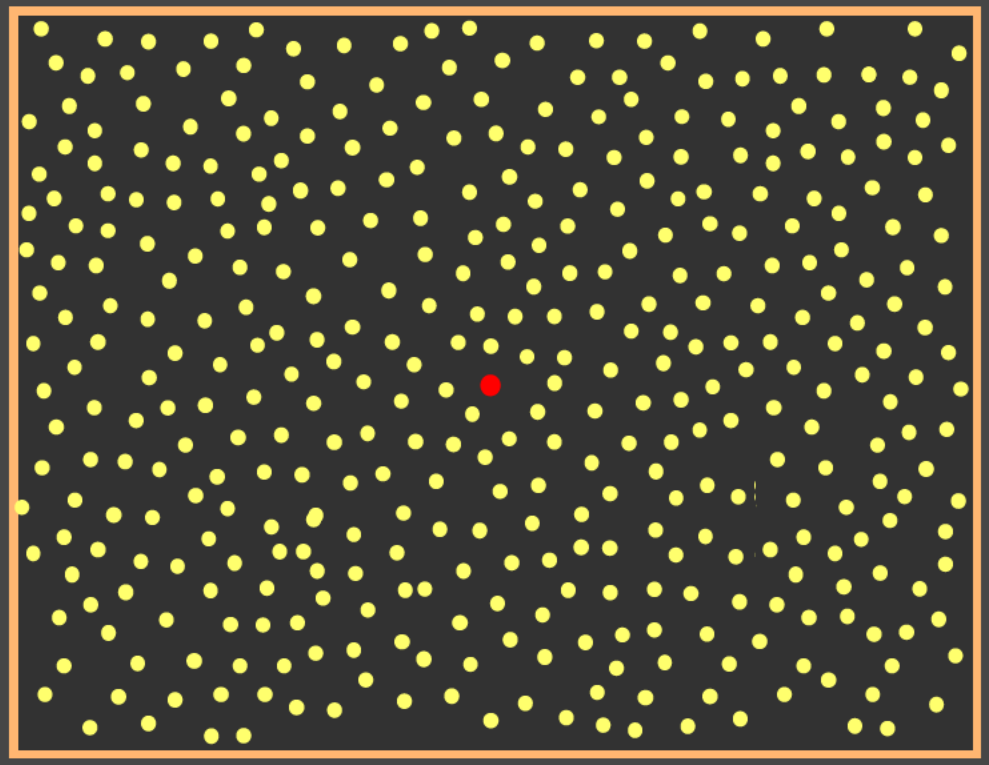
Motion detection



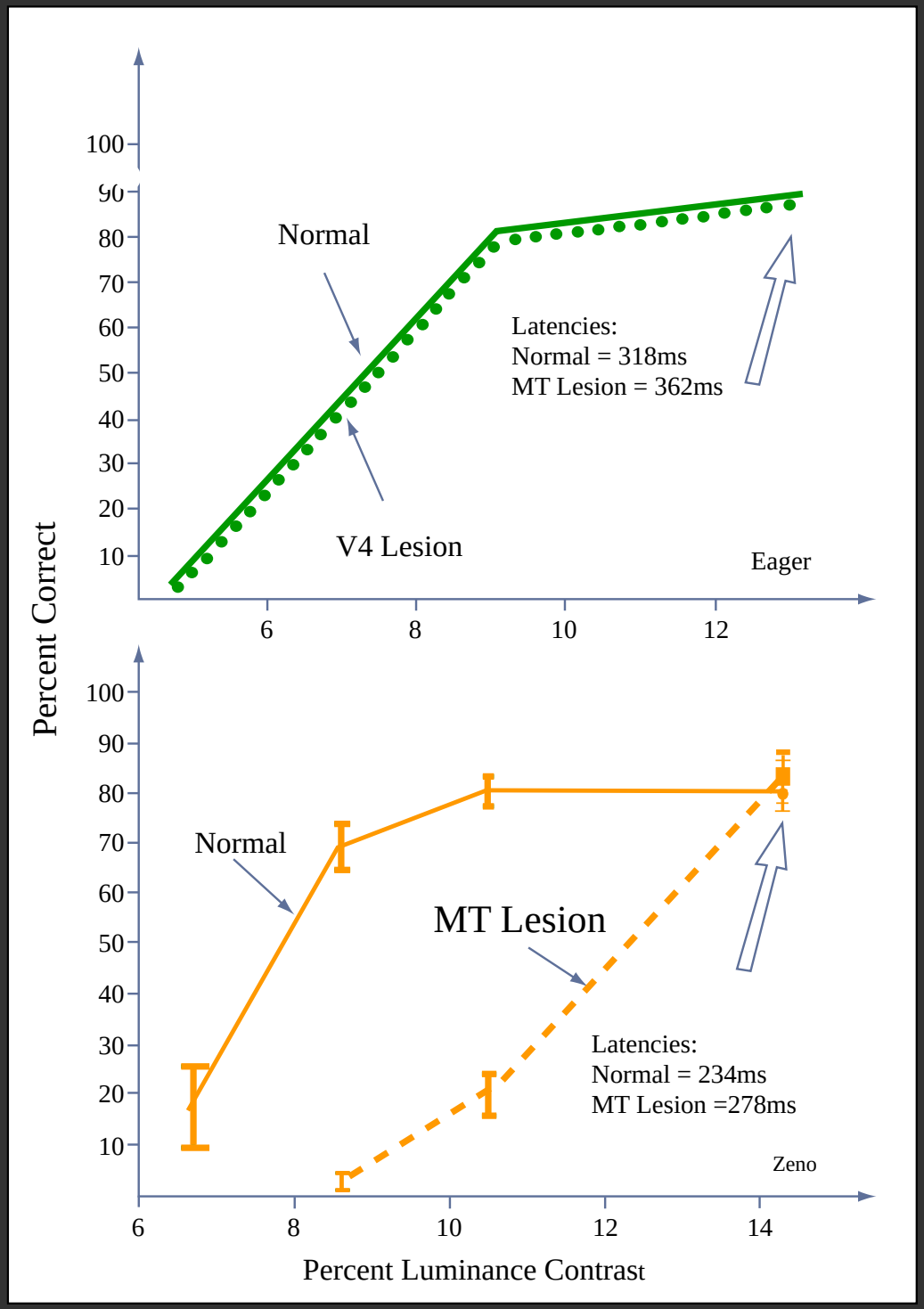
Motion detection



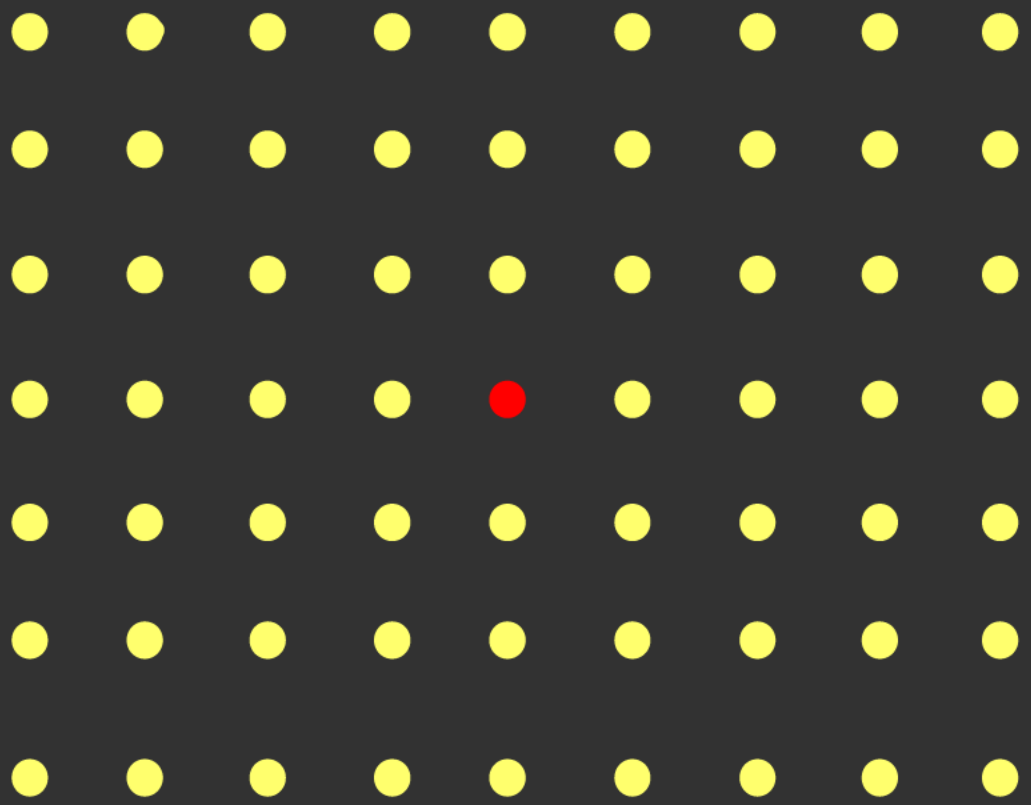
Motion detection

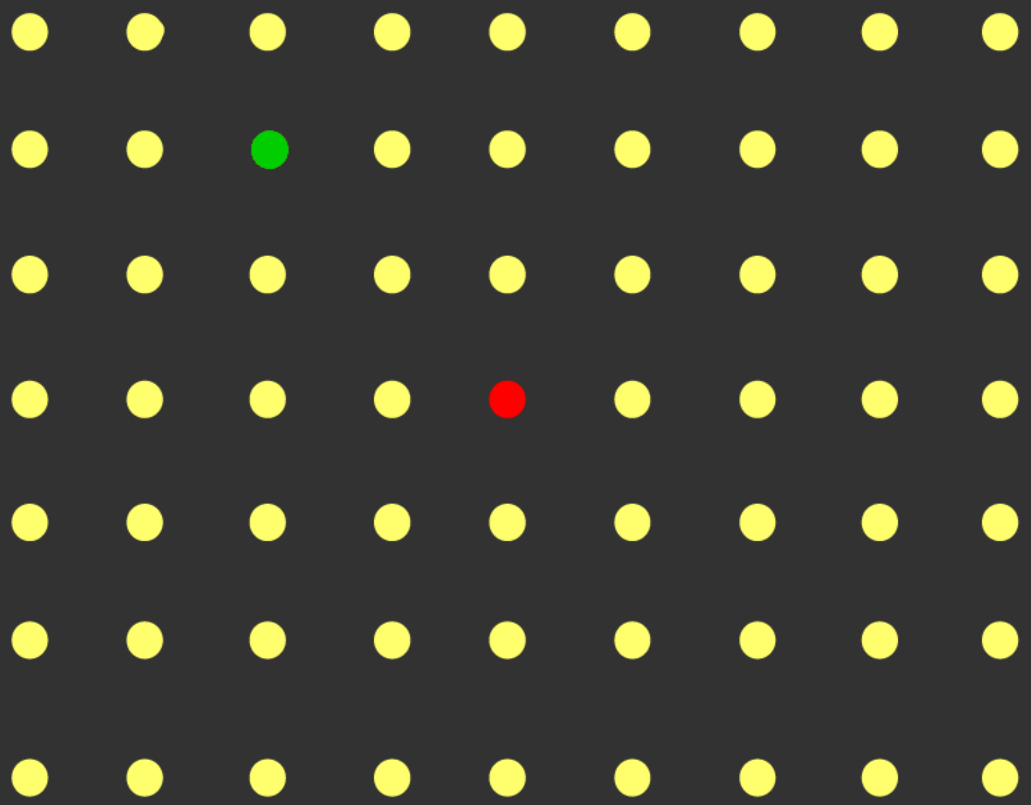


Motion detection

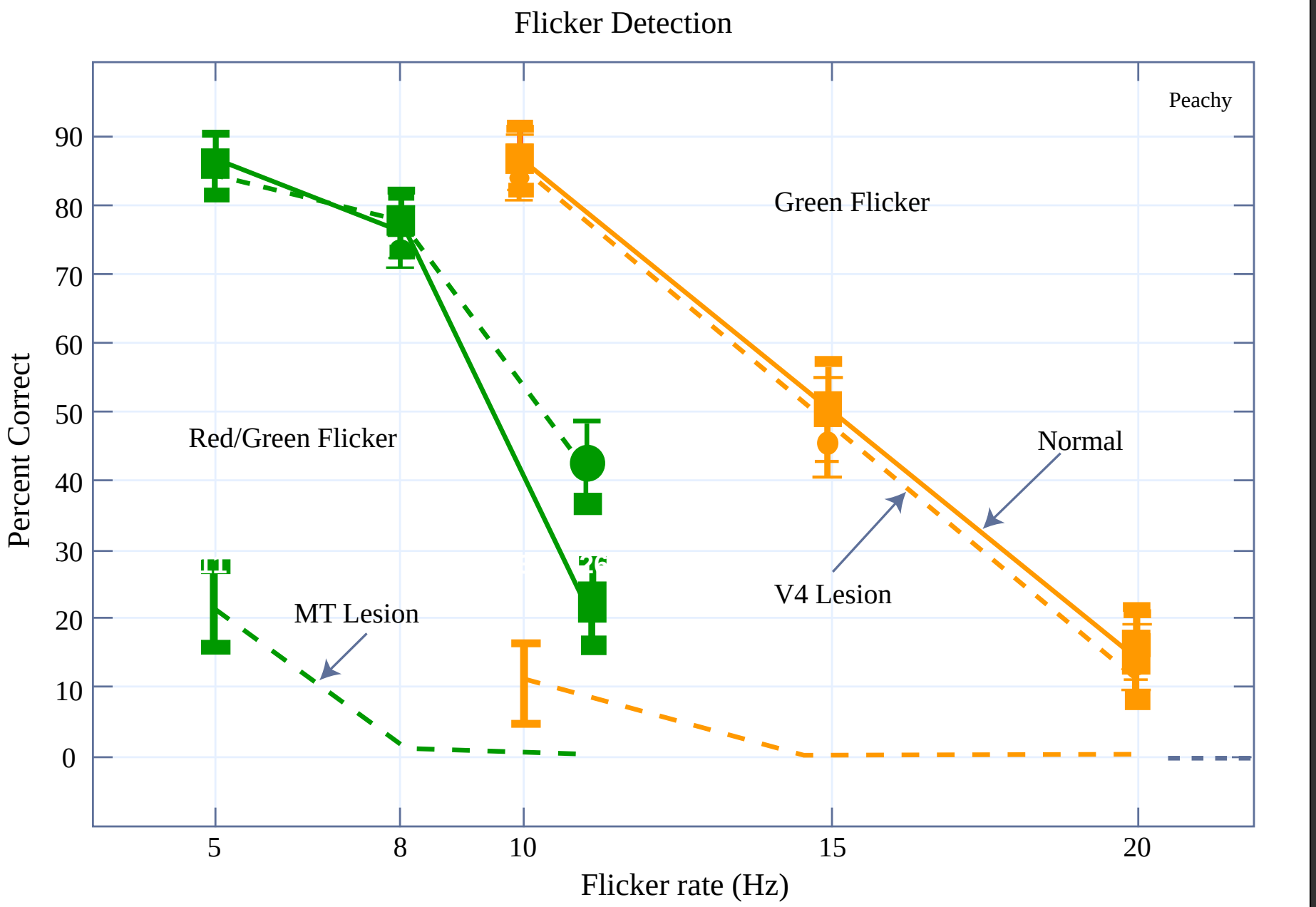


The perception of flicker





Flicker perception



Deficit magnitude following PLGN, MLGN, V4 and MT lesions

BASIC VISUAL FUNCTIONS

VISUAL CAPACITY		PLGN	MLGN
color vision		severe	none
texture perception		severe	none
pattern perception	fine	severe	none
shape perception	fine	severe	none
	coarse	mild	none
brightness perception		none	none
coarse scotopic vision		none	none
contrast sensitivity	fine	severe	none
	coarse	mild	none
stereopsis	fine	severe	none
	coarse	pronounced	none
motion perception		none	moderate
flicker perception		none	severe

Functions of the midget and parasol systems:

The midget system :

- color
- texture
- fine form
- fine stereo

The parasol system:

- fast flicker
- fast, low contrast motion

Both Systems:

- brightness
- coarse form
- coarse stereo
- slow flicker
- slow, high contrast motion
- scotopic vision

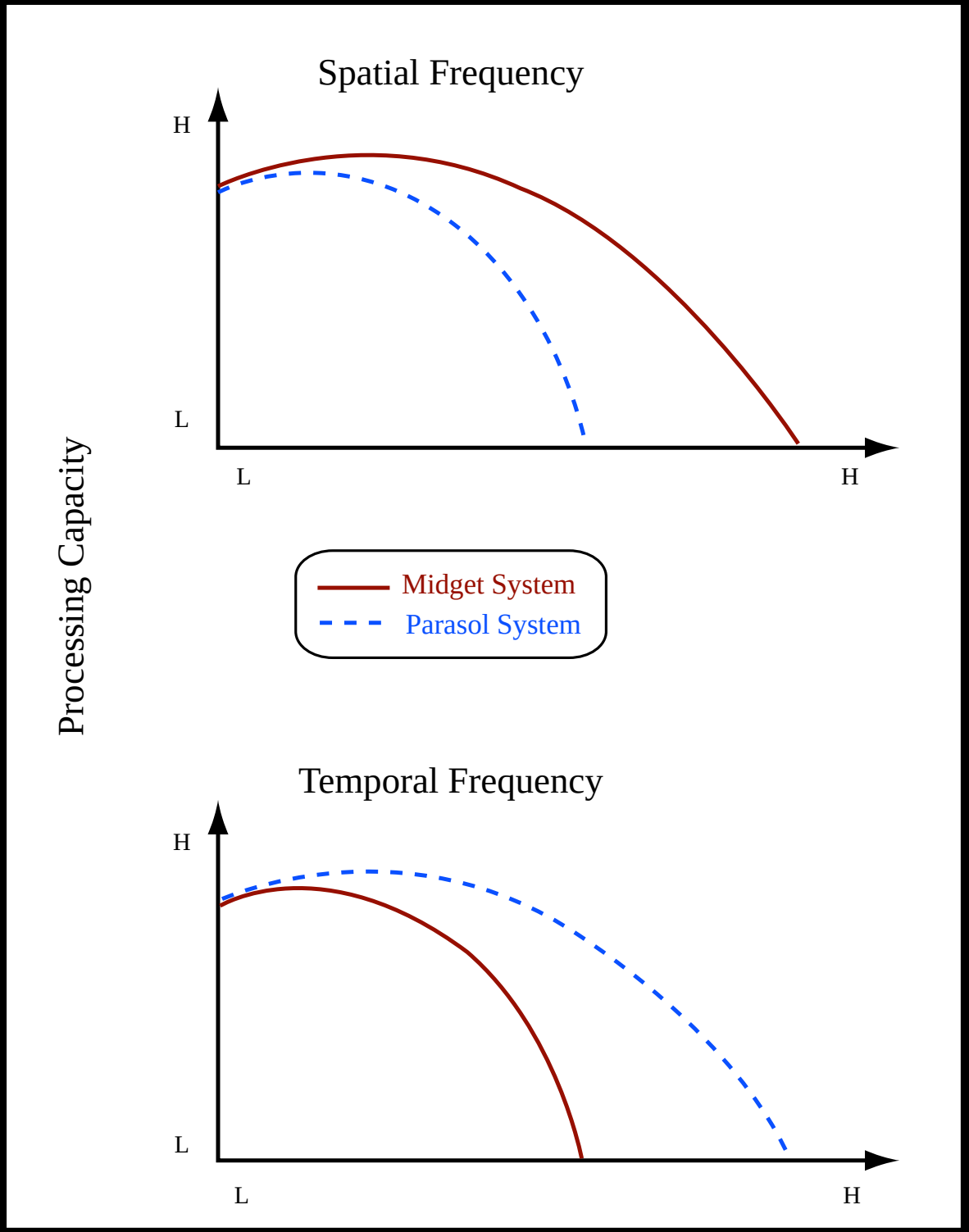


Image by MIT OpenCourseWare.

Summary:

1. Two major channels originating in the retina are the midget and the parasol.
2. In central retina the receptive field center of midget RGC and parvocellular LGN cells is compised of a single cone.
3. Parasol cells have much larger receptive fields; the cone input is mixed in both the center and the surround.
4. The midget and parasol cell ratio from center to periphery changes from 8 to 1 to 1 to 1.
5. The midget and parasol systems converge on some of the cells in V1.
6. V4 receives input from both the midget and parasol cells.
7. The major input to MT is from the parasol cells.
8. The midget system extends the range of vision in the wavelength and high spatial frequency domains
9. The parasol system extends the range of vision in the high temporal frequency domain.

9.04 Sensory Systems

Fall 2013