Lecture 1 Eye and Human Vision

COMP3204 Computer Vision

Is human vision a good model for computer vision?

Book pp 1-28

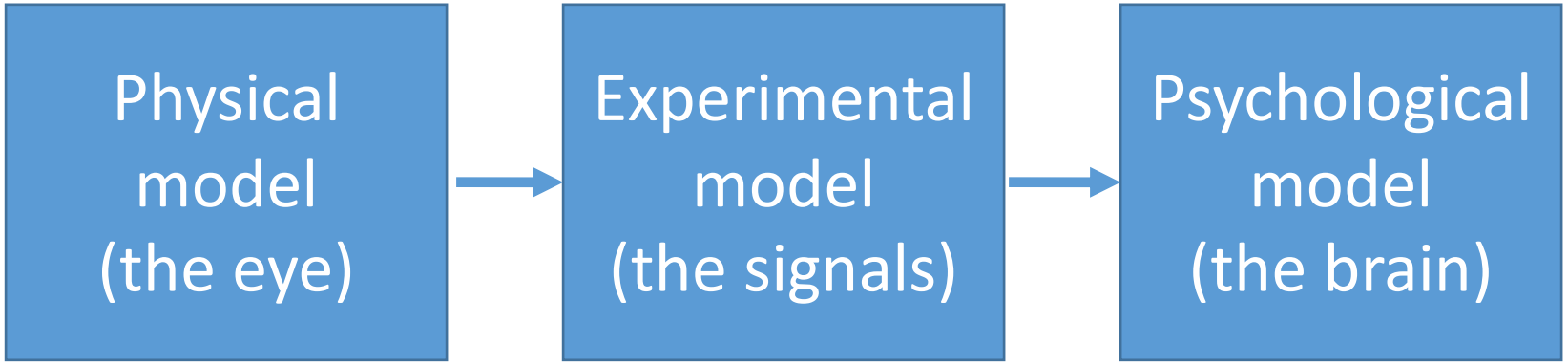
Department of Electronics and Computer Science

UNIVERSITY OF Southampton
School of Electronics and Computer Science

Content

1. Is human vision a good model for computer vision?
2. How does human vision work (and how does it fail)?
3. Software languages & associated literature

Modelling the eye in three parts



Each is not fully understood, especially the brain ……

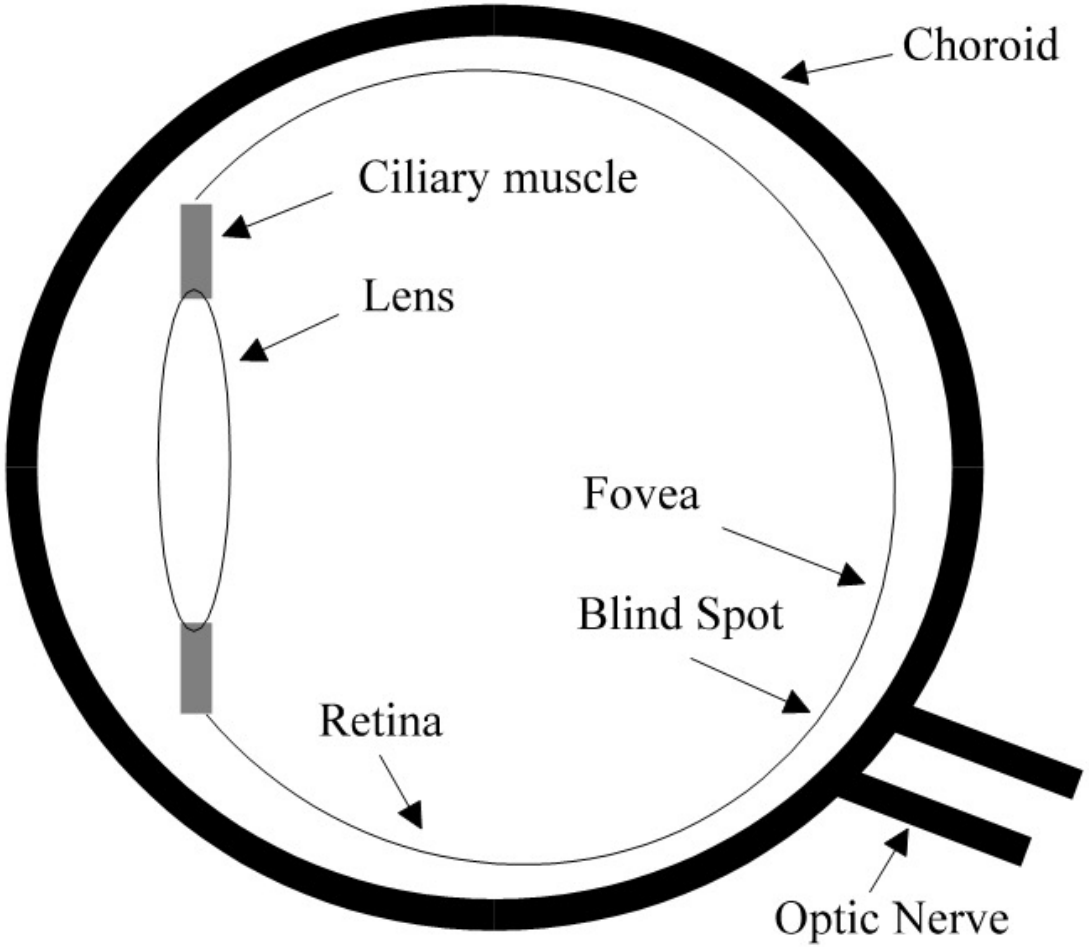
Human eye

Evolved for survival

Function of the eye is to form an image on the retina (on fovea)

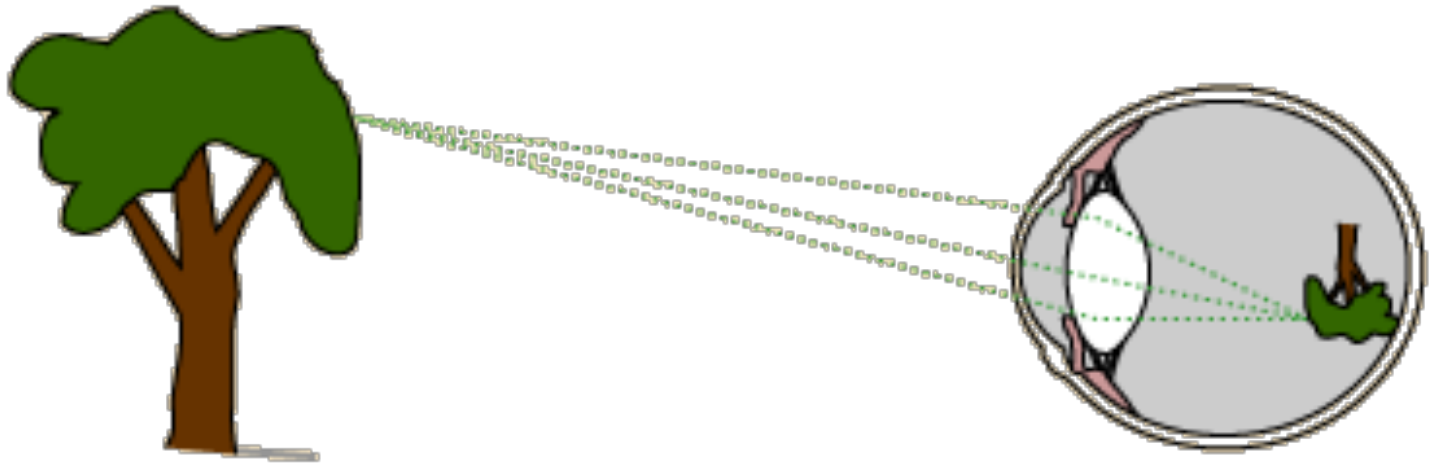
The lens is shaped, rather than moved

Image is transmitted via optic nerve



Optics

Your brain must invert the image



http://hyperphysics.phy-astr.gsu.edu/hbase/vision/rfreye.html

Sensors

There must be a lot!

Cones (10^7) and rods (10^8)

Cones – colour; rods – greylevel

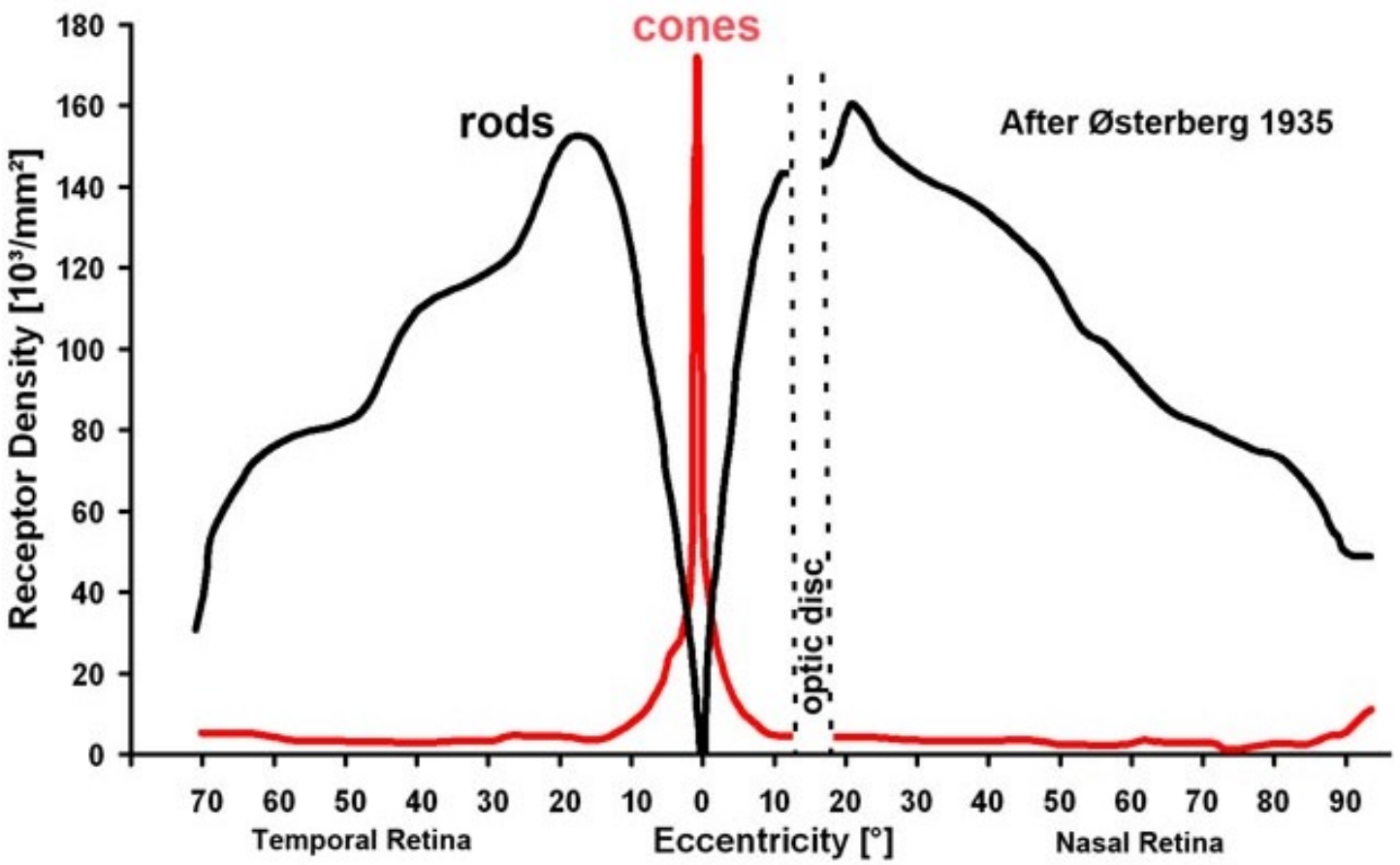
photopic scotopic

Cones come in three types

1. S – short wavelength (blue)
2. M – medium wavelength (green)
3. L – long wavelength (red)

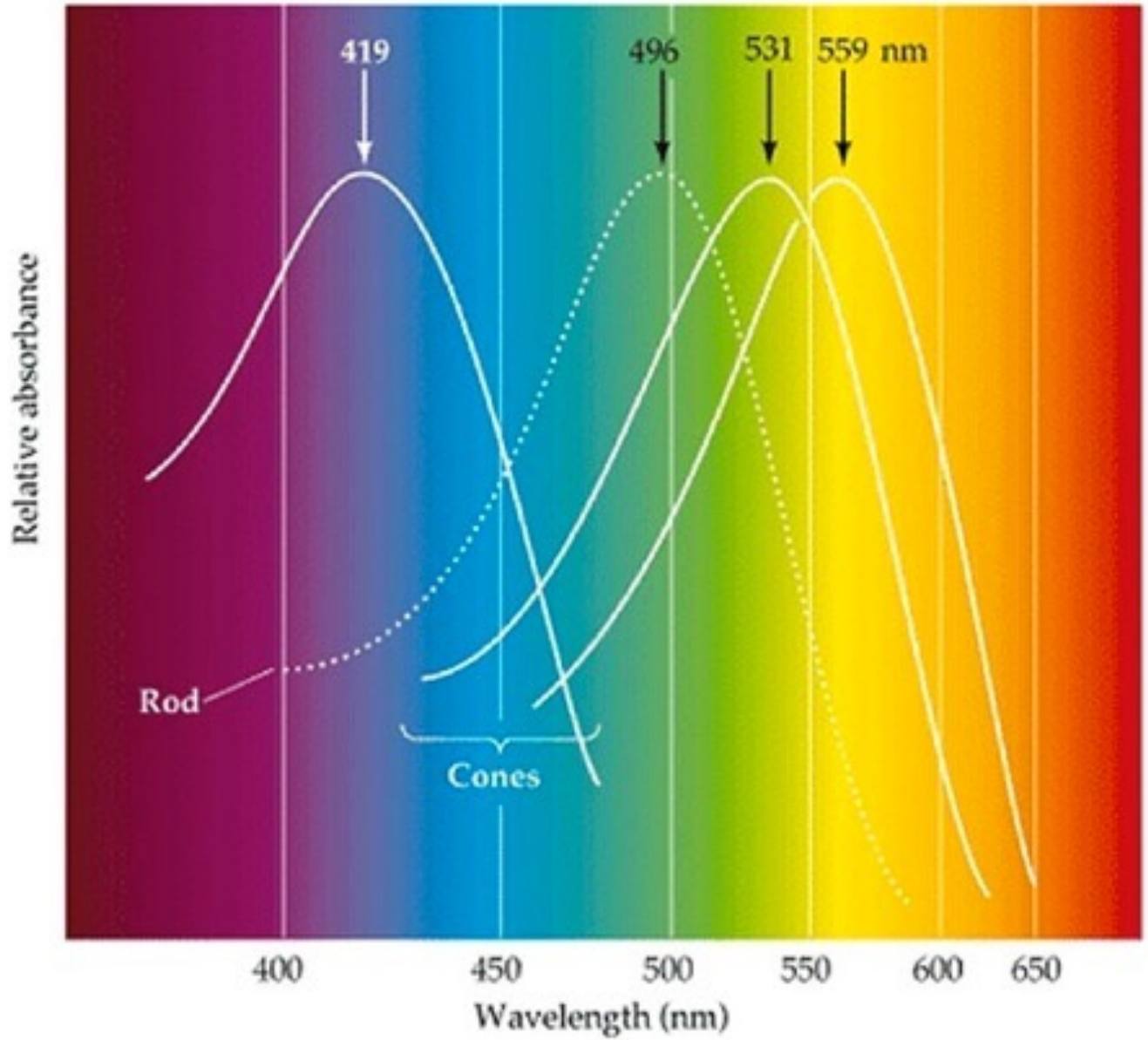
Insufficient bandwidth of optic nerve implies coding

Rod and cone densities



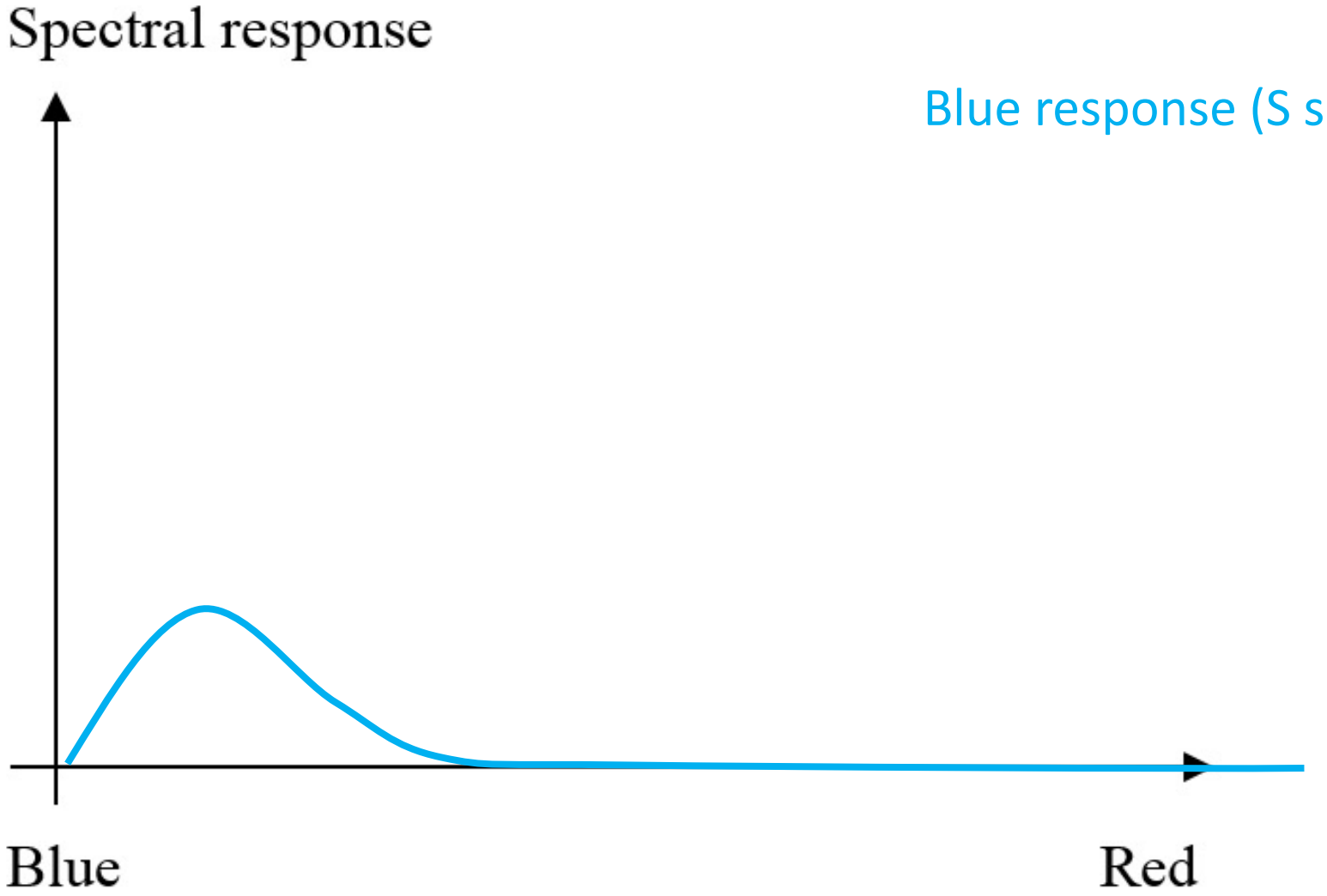
No sensors on blind spot
Most cones on fovea
Rods elsewhere

http://webvision.med.utah.edu/imageswv/Ostergr.jpeg



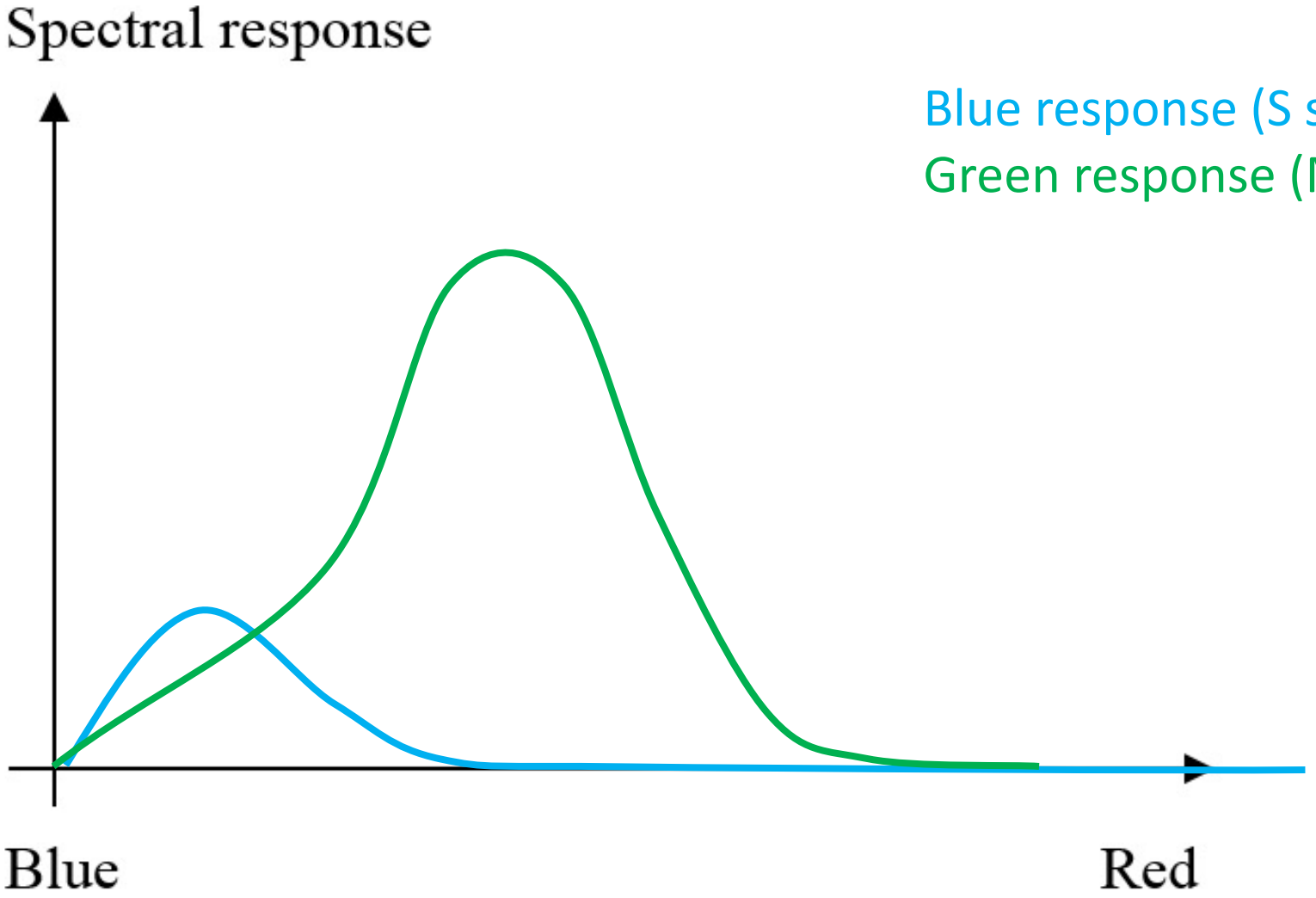
http://webvision.med.utah.edu/wp-content/uploads/2011/03/Spectrum.jpeg

Spectral responses



Blue response (S sensors) is poor

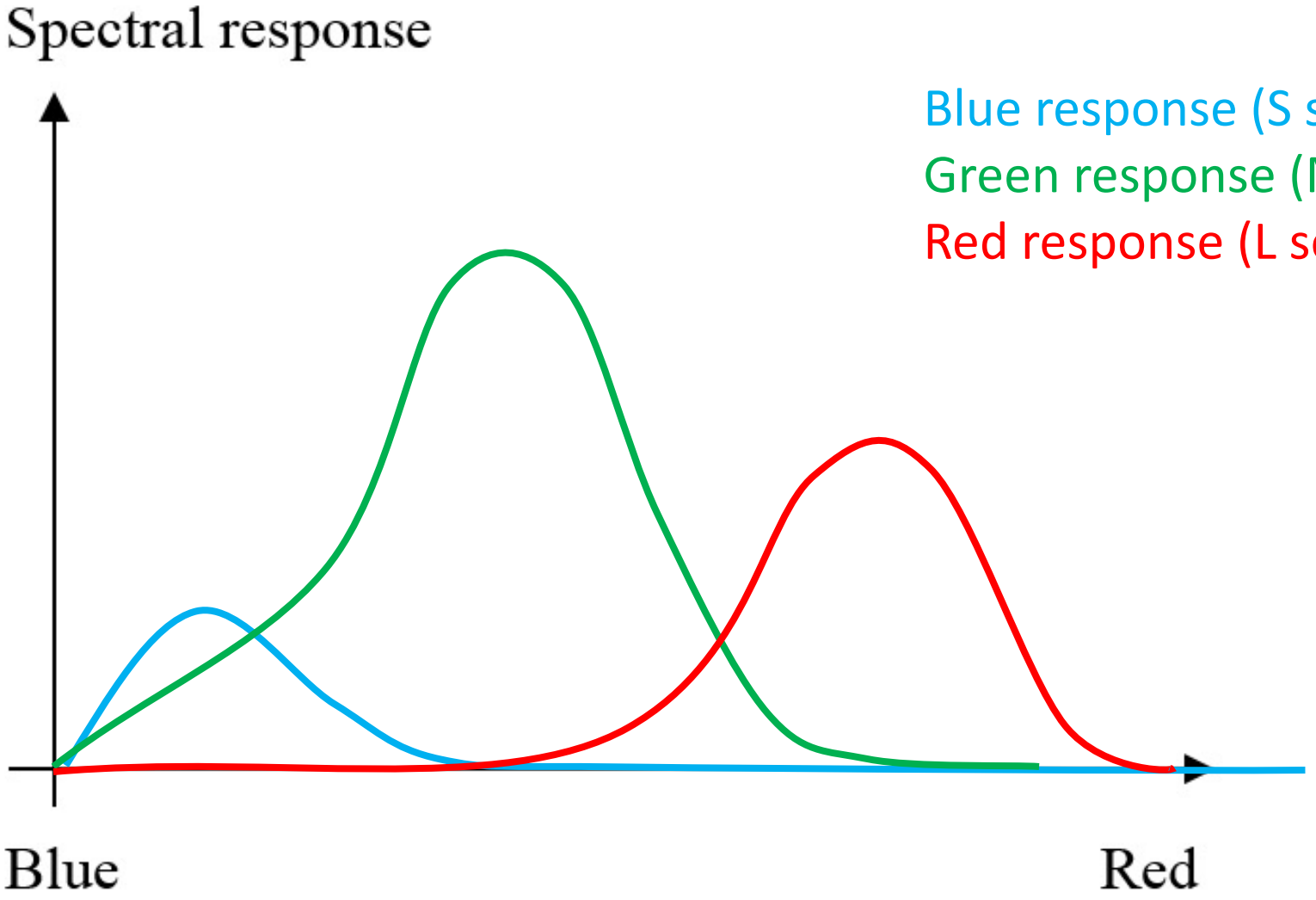
Spectral responses



Blue response (S sensors) is poor

Green response (M sensors) dominates

Spectral responses

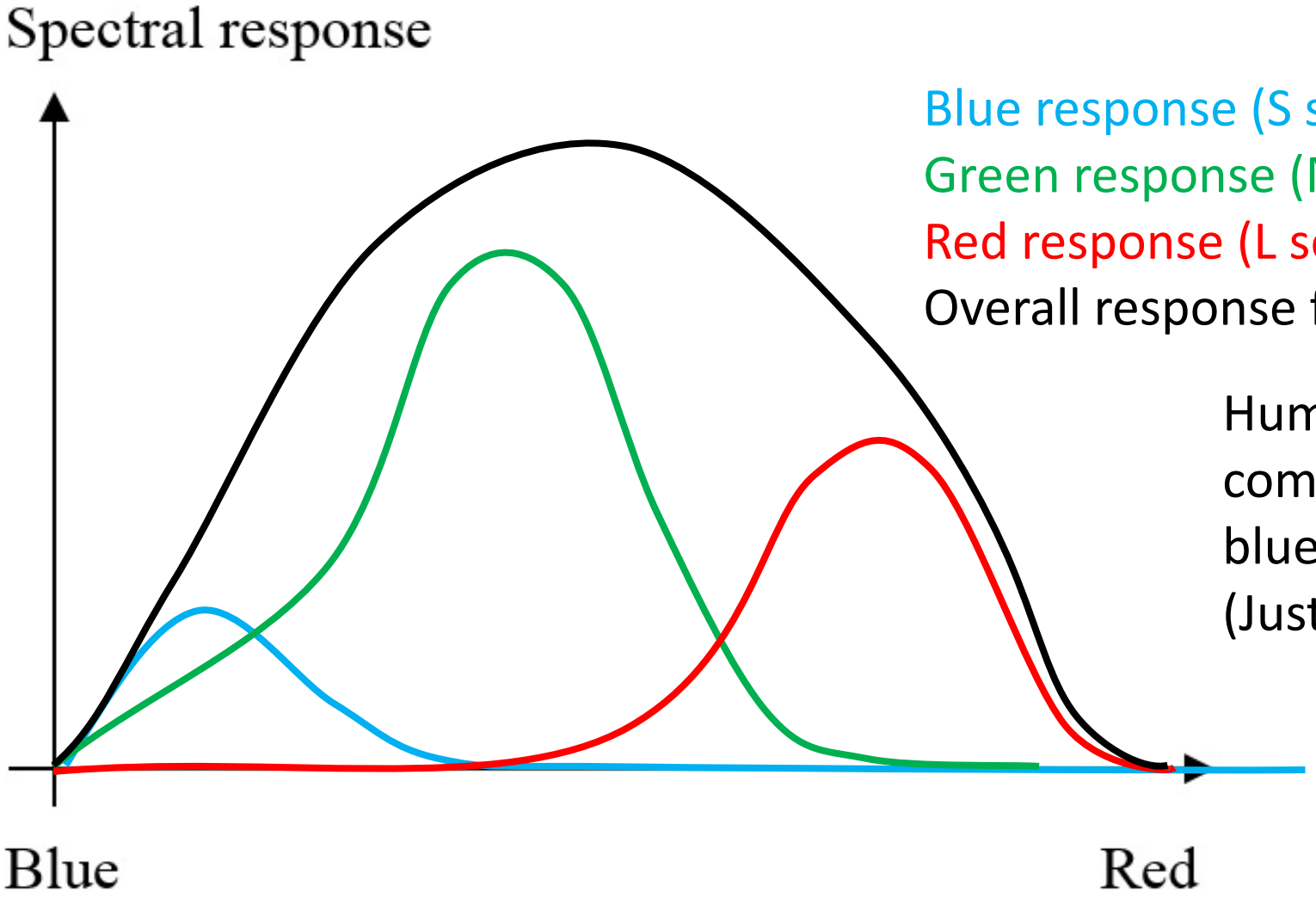


Blue response (S sensors) is poor

Green response (M sensors) dominates

Red response (L sensors) close to heat

Spectral responses



Blue response (S sensors) is poor

Green response (M sensors) dominates

Red response (L sensors) closer to heat

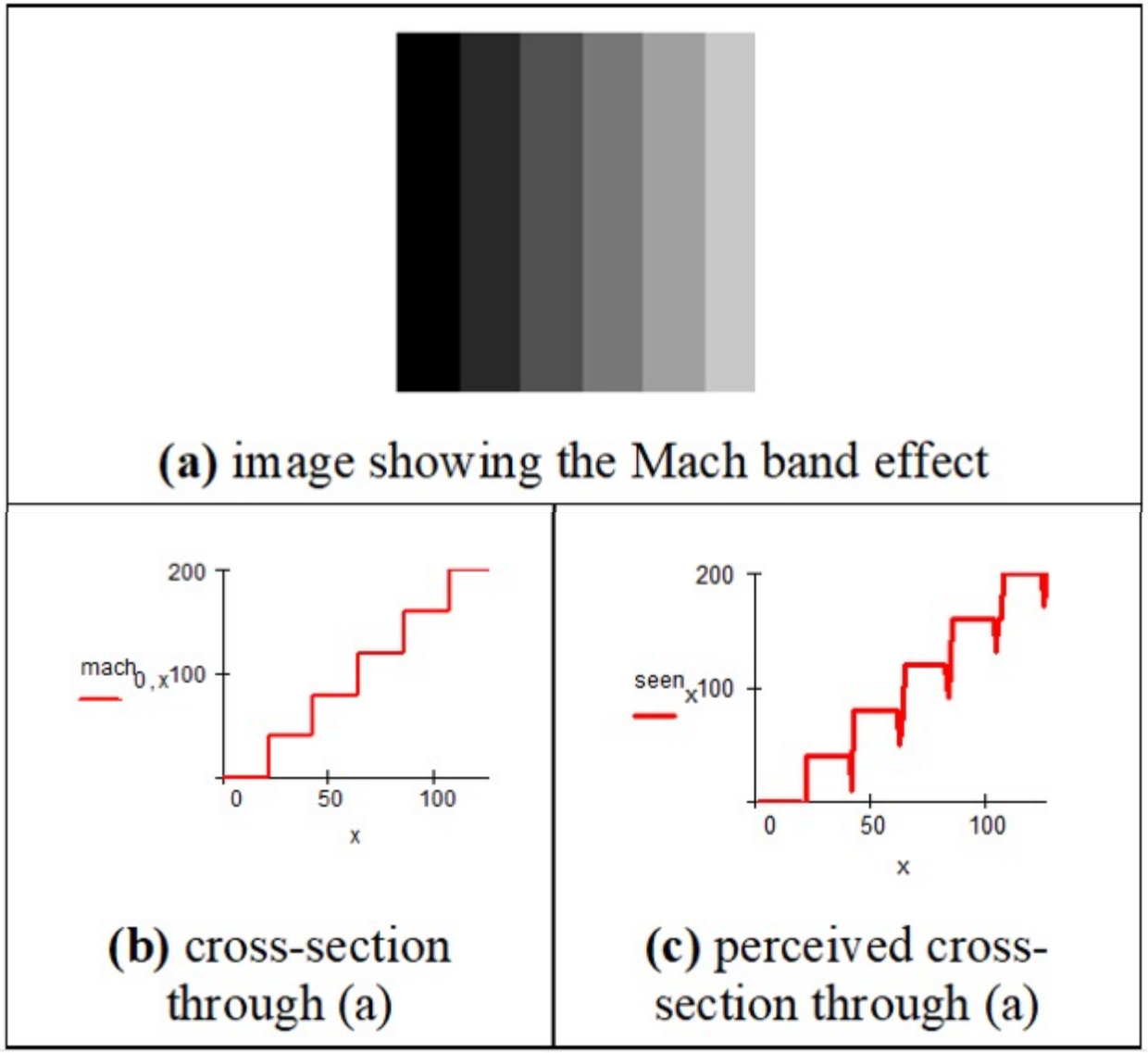
Overall response from S, M and L

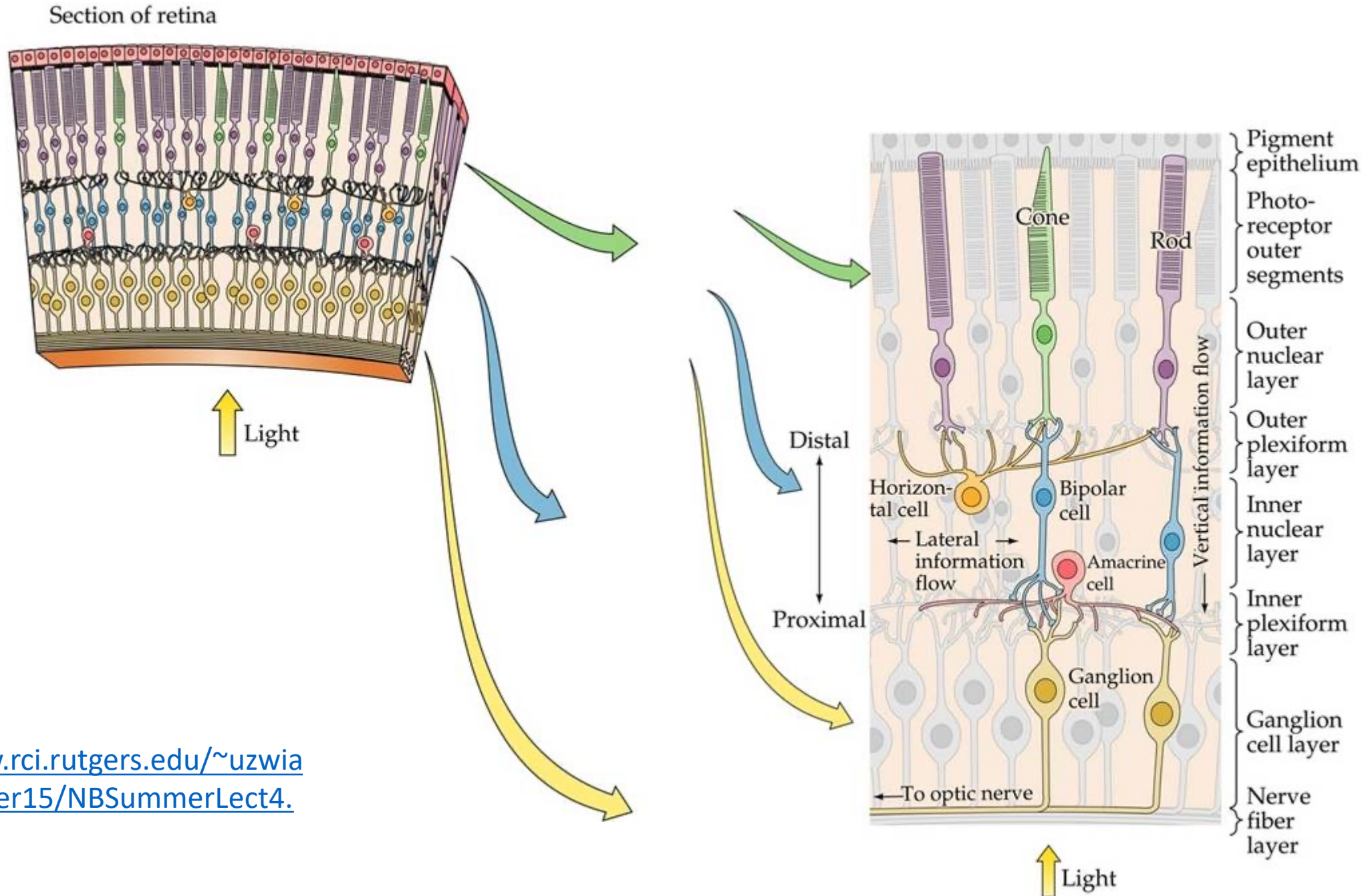
Human vision must compensate for the poor blue sensors
(Just like a camera)

Mach bands

Mach bands are not in the image: your vision introduces them

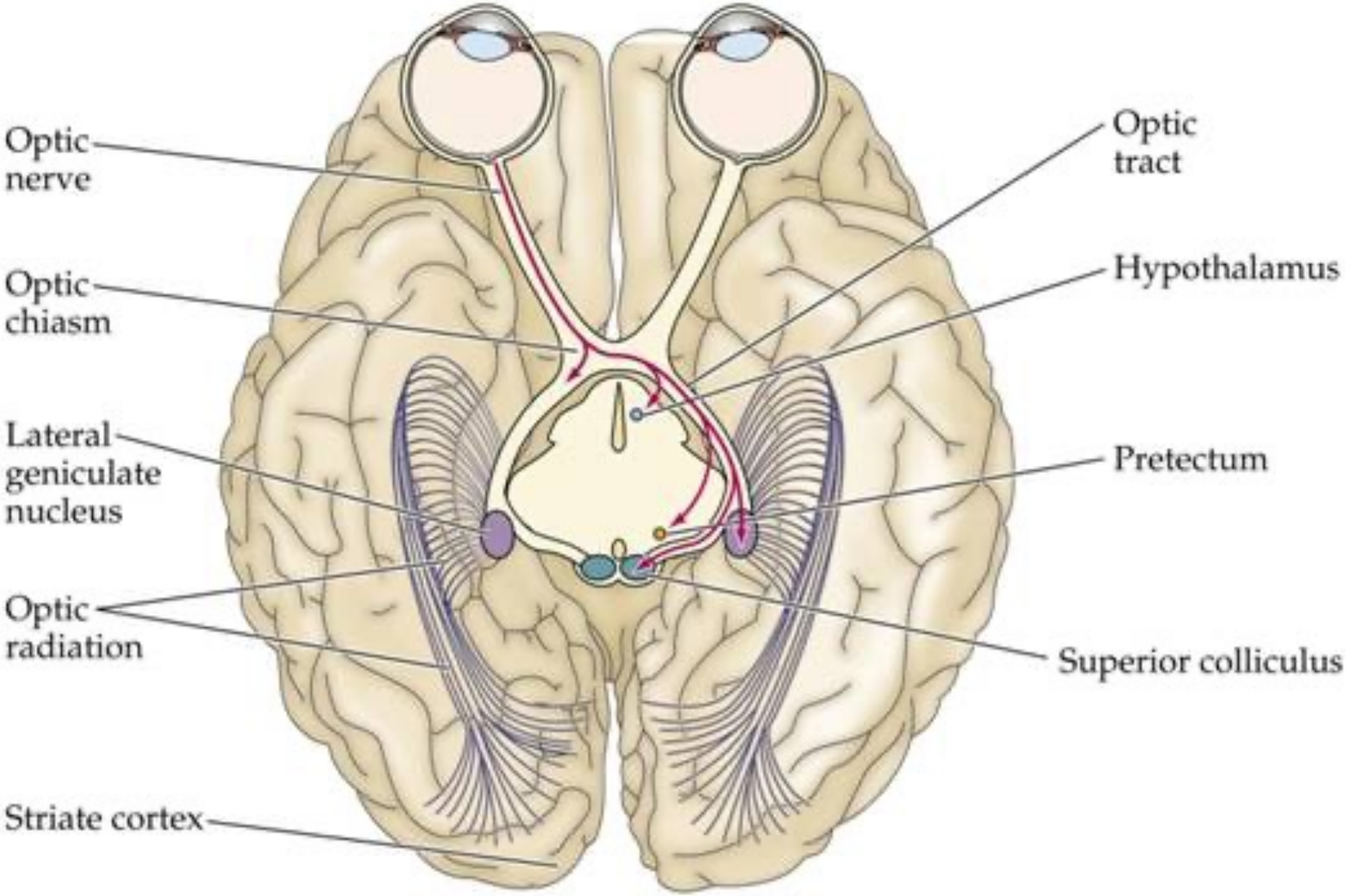
Result of brightness adaption





http://www.rci.rutgers.edu/~uzwiak/NBSummer15/NBSummerLect4.html

Cortices

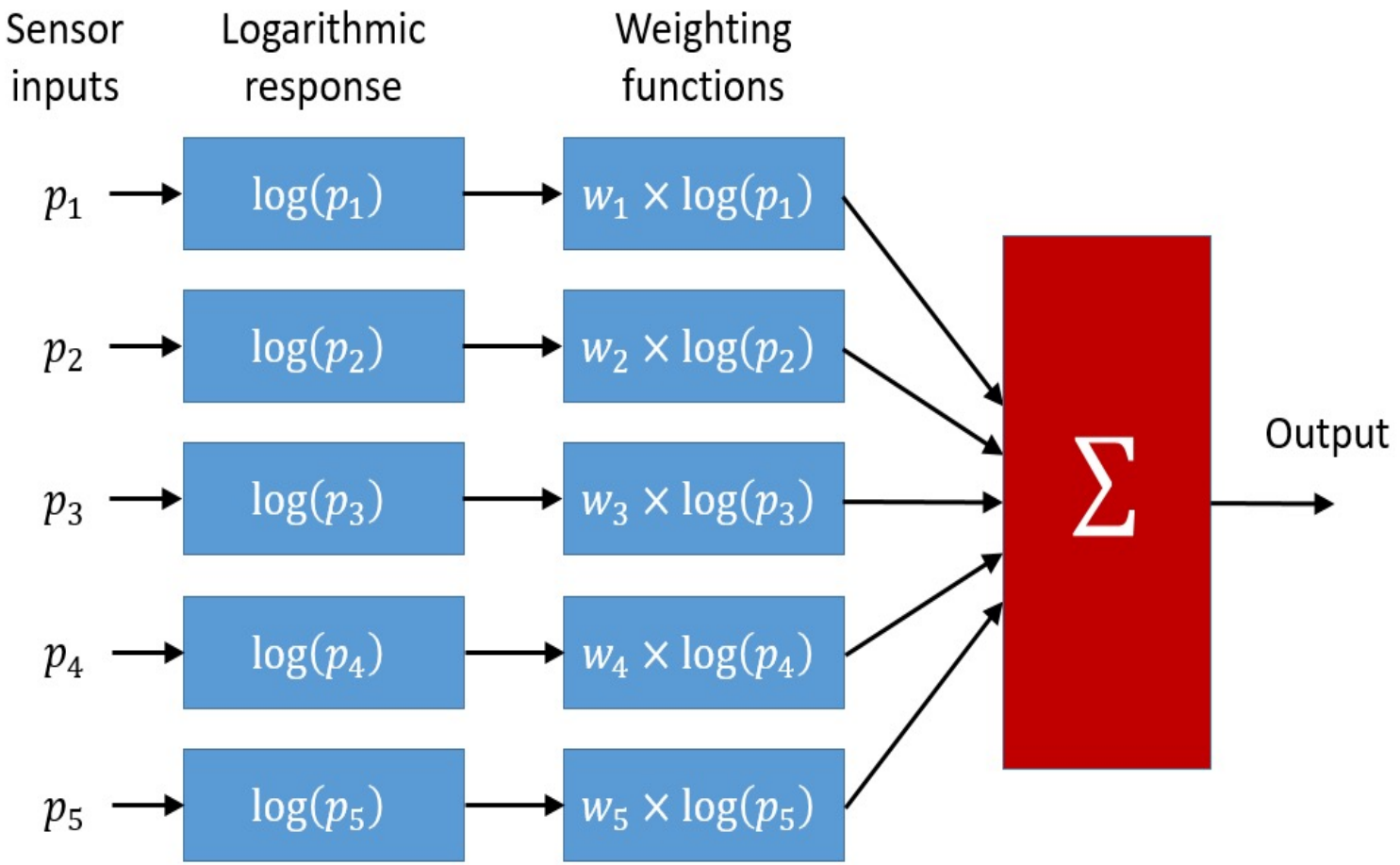


http://www.rci.rutgers.edu/~uzwiak/NBSummer15/NBSummerLect4.html

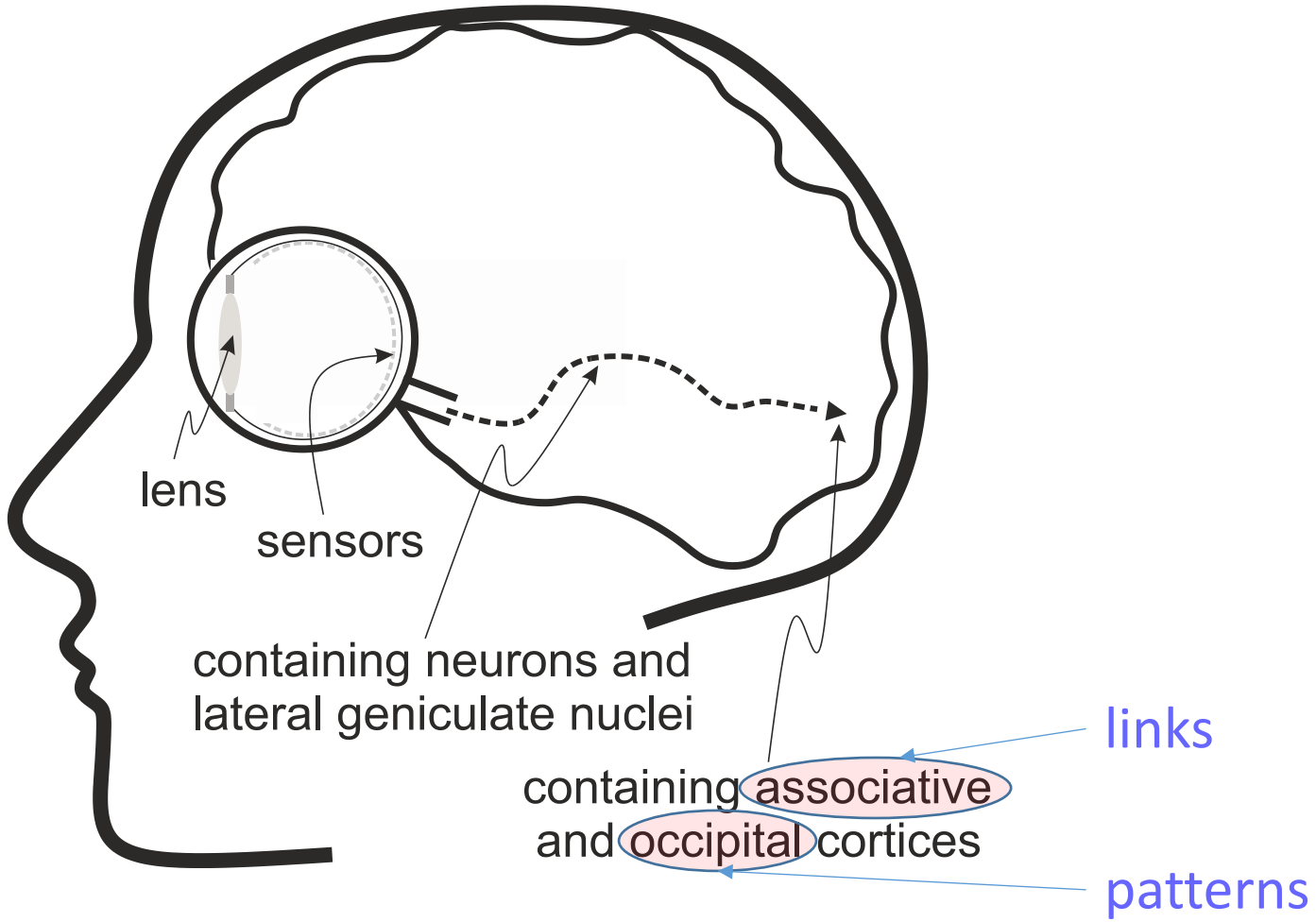
Neural processing

Sensor information must be combined

Note Weber's law



Where are we?

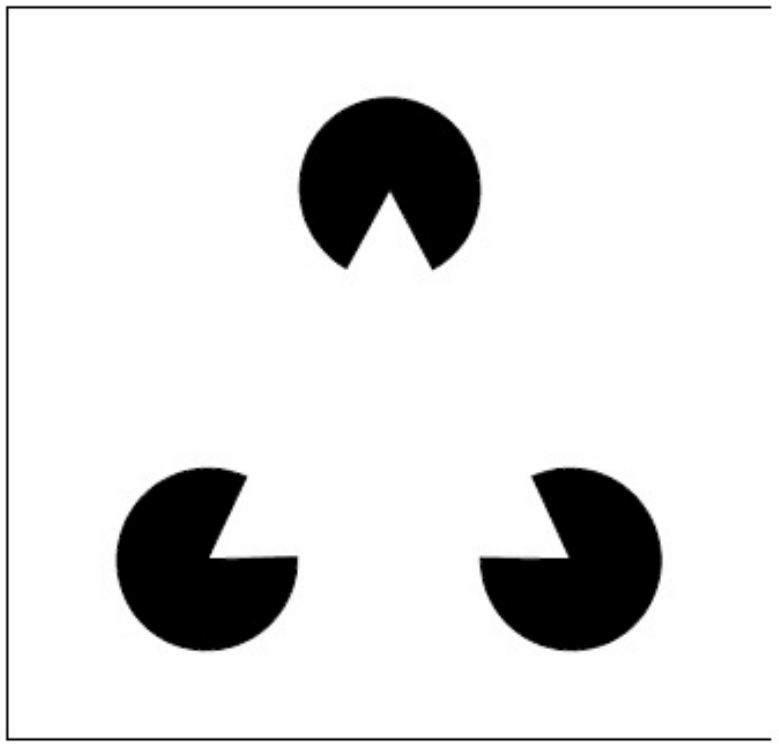

lens
sensors
containing neurons and
lateral geniculate nuclei
containing associative
and occipital cortices
links
patterns


FEATURE EXTRACTION
AND IMAGE PROCESSING
FOR COMPUTER VISION

How human vision uses edges

The human eye needs training and can be deceived

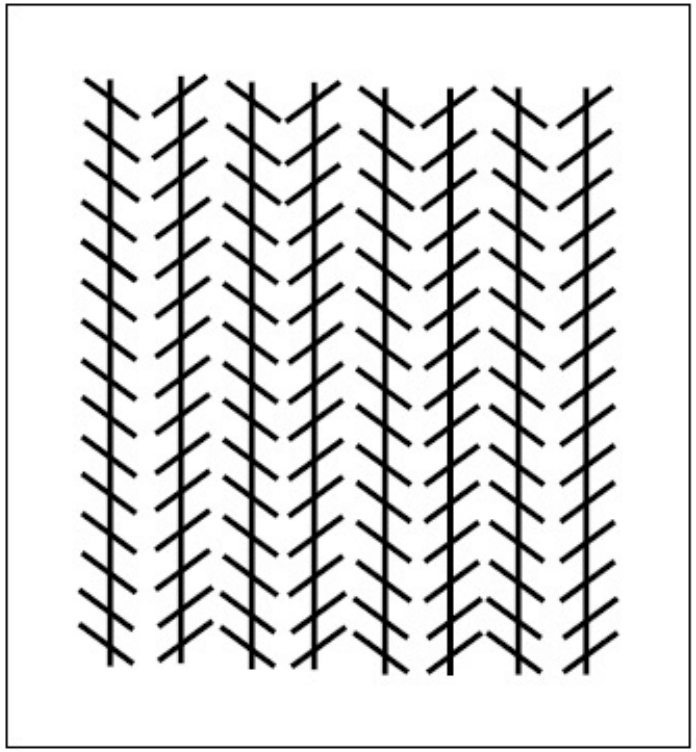
(a) word?



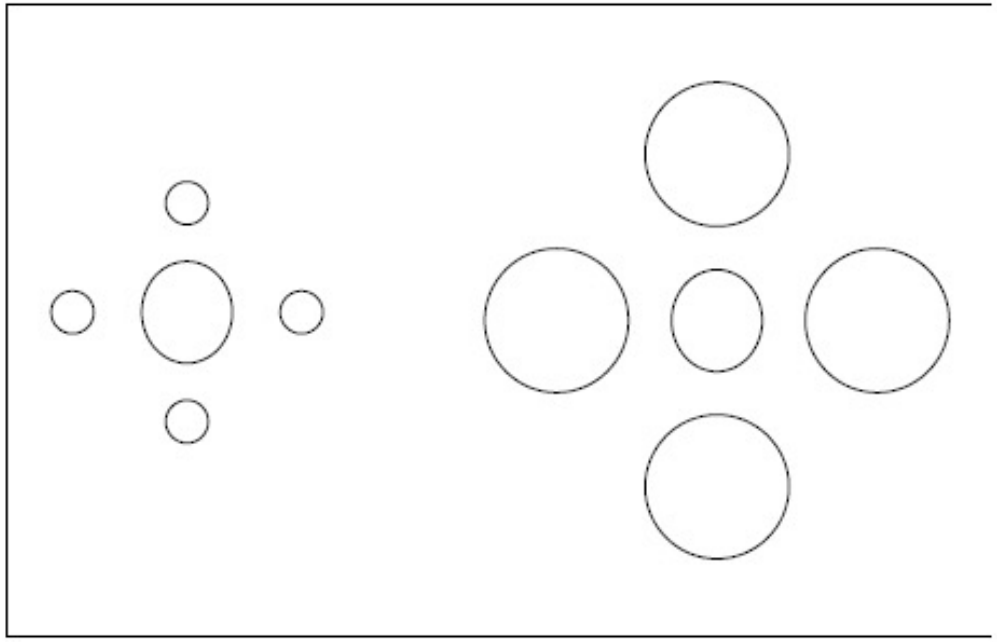
(b) Pacmen?

Static illusions

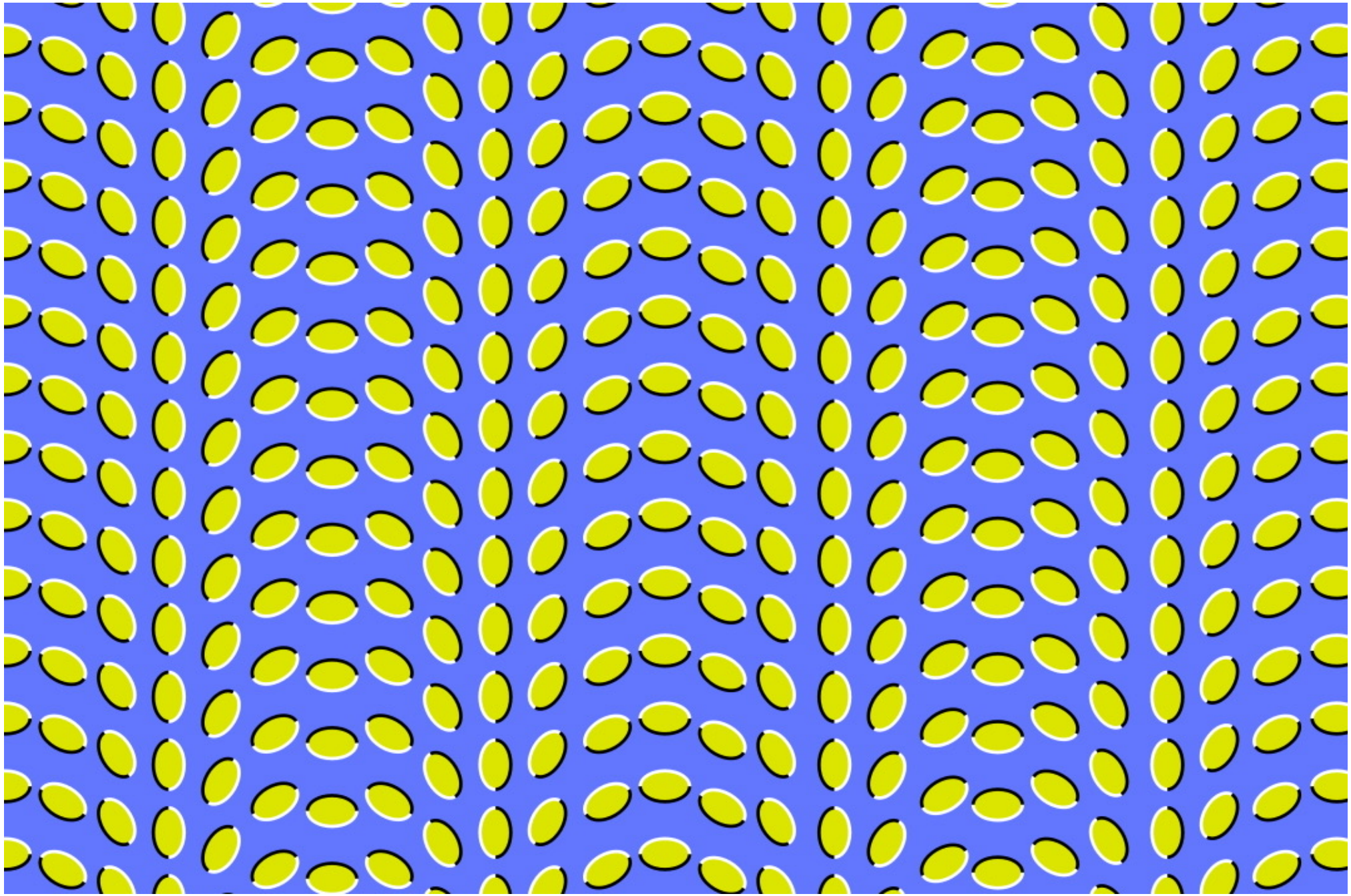
Measurement needs comparison

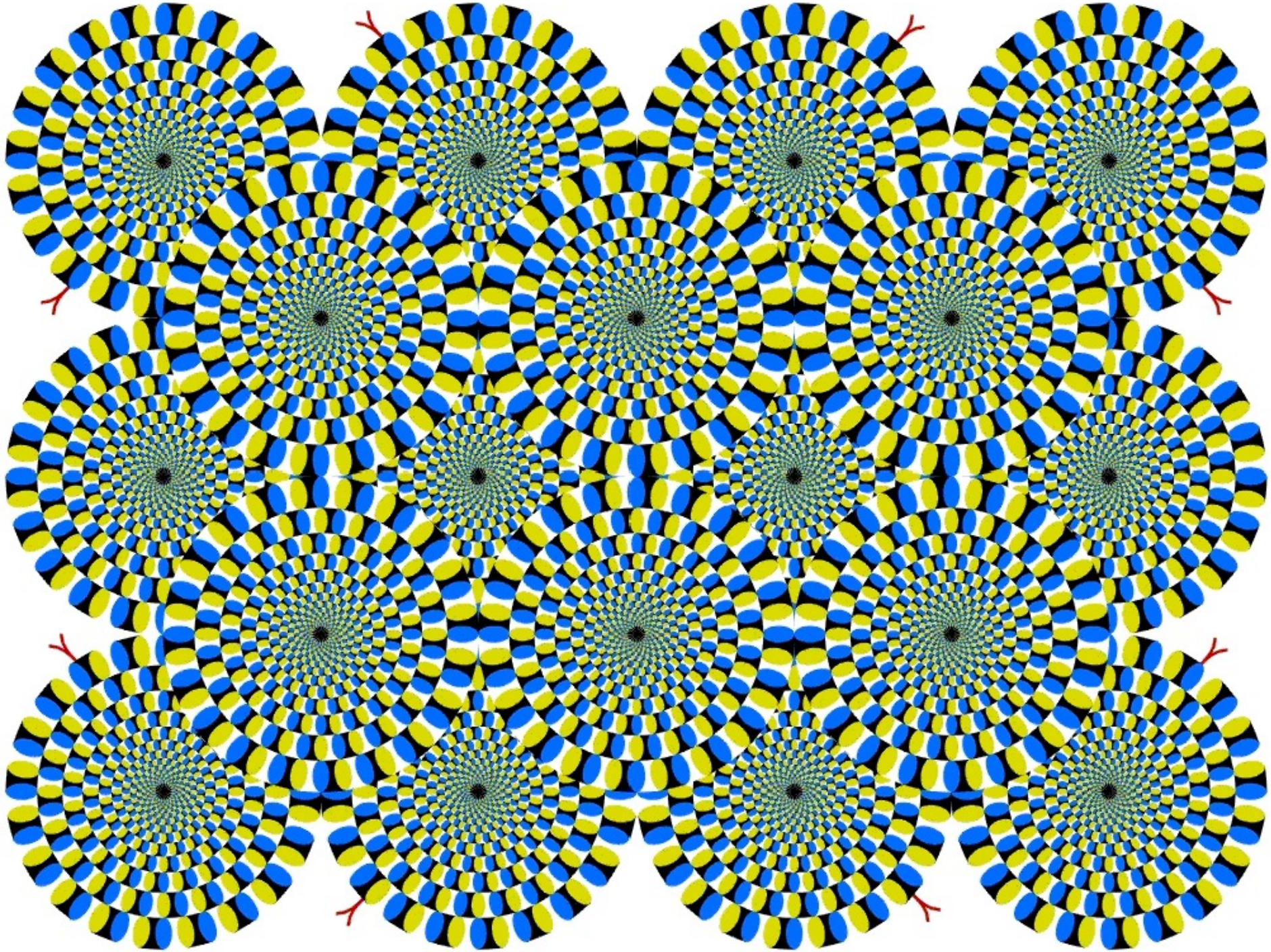


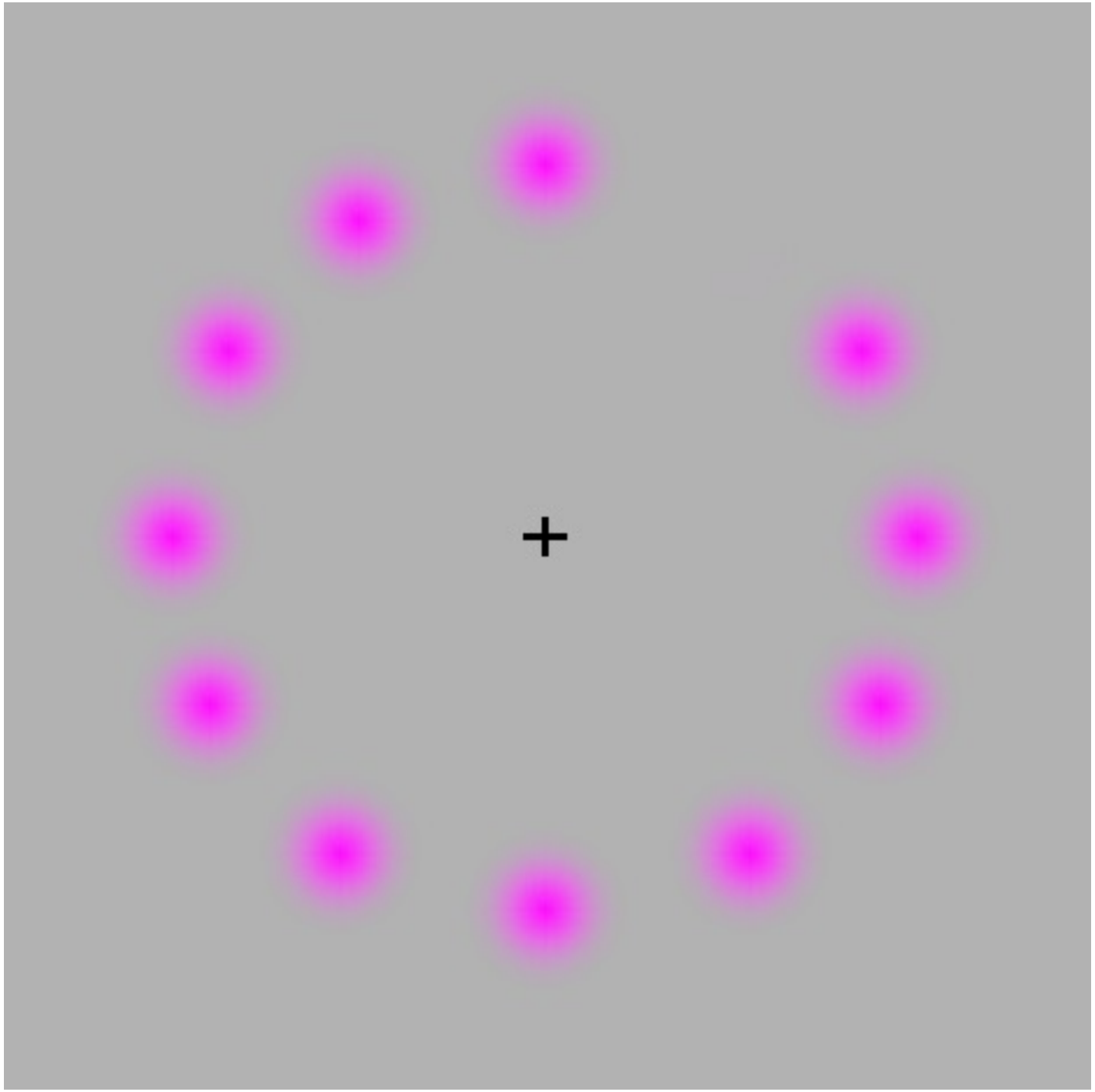
(a) Zollner



(b) Ebbinghaus

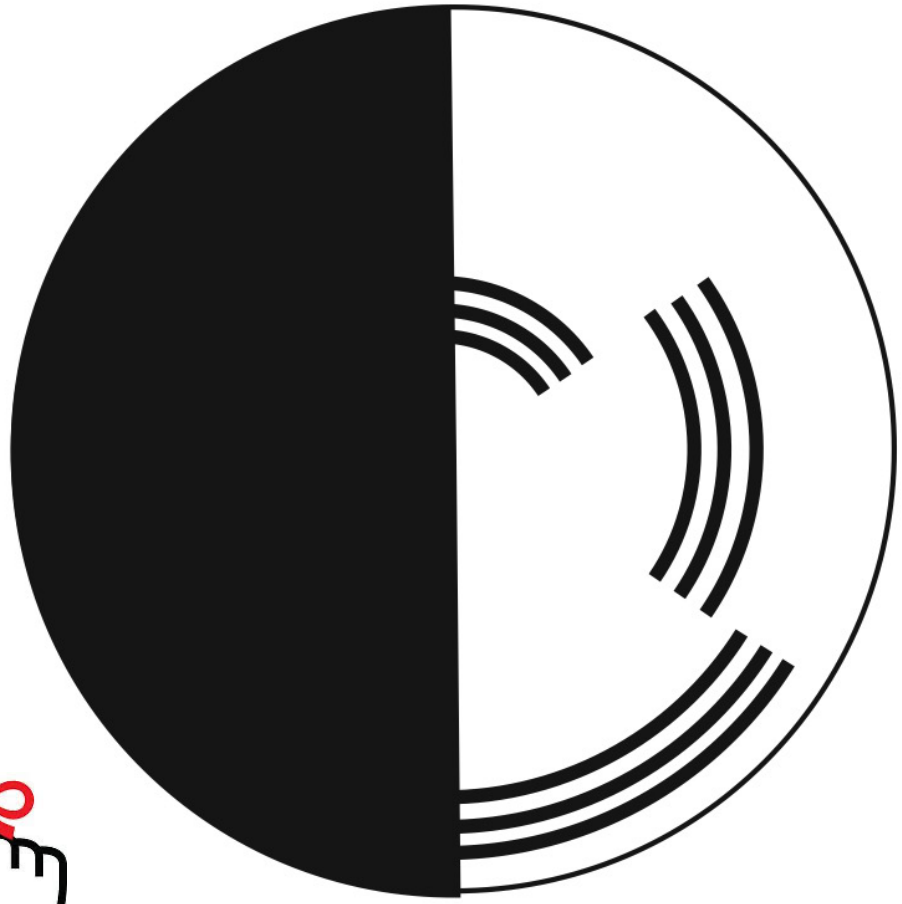


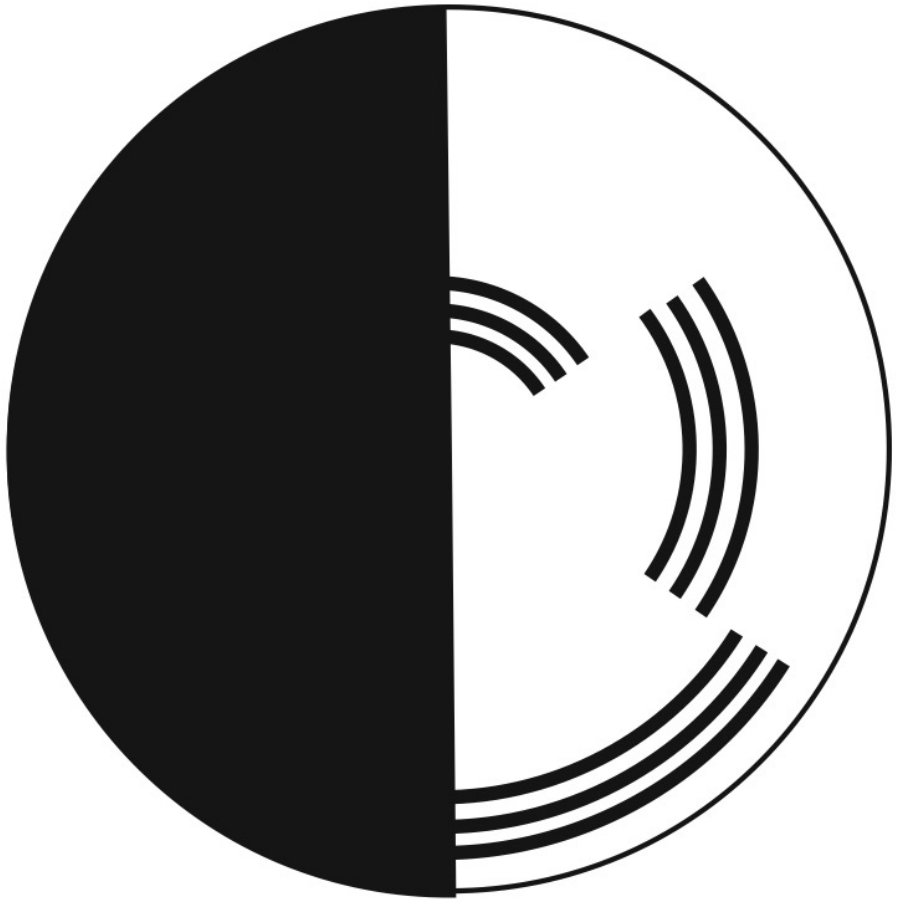




Benham's disk

Illusions are a consequence of complex function





Main points so far

1 – human eye can be modelled in three sections

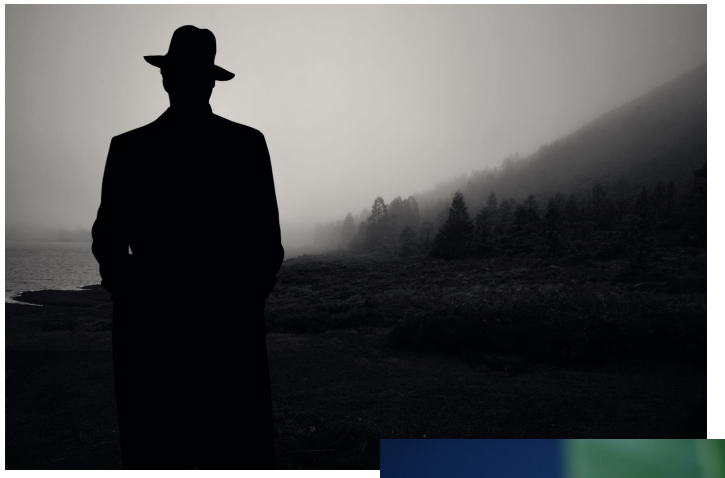
2 – it works very well

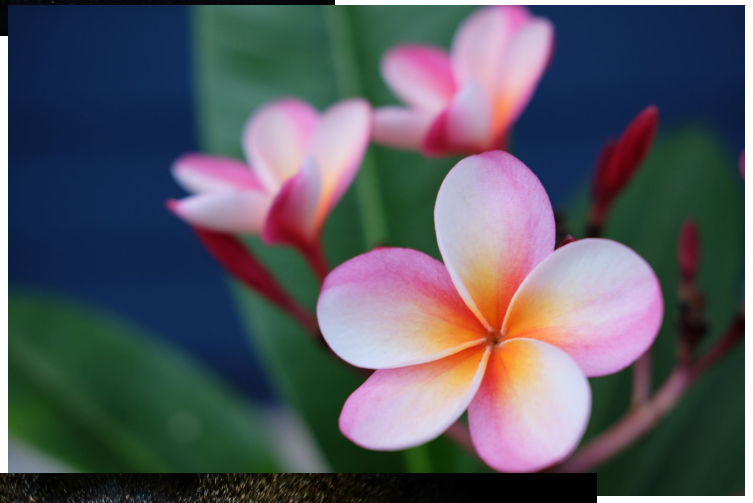
3 – …… but it can be deceived

4 – is it a good model for computer vision?

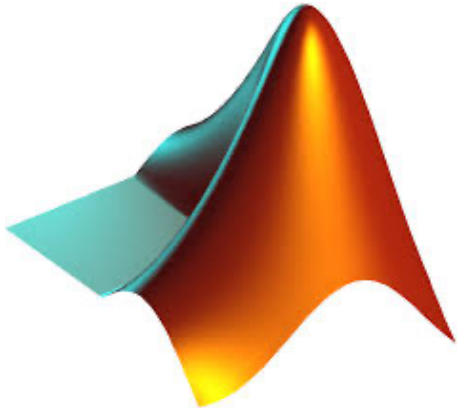
Next up, how images are formed

Human to Computer Vision





Software languages



Matlab

Python

Associated literatures

References of each Chapter

Other books:

- CVOnline: homepages.inf.ed.ac.uk/rbf/CVonline/books.htm
- Digital Signal Processing: dspguide.com

Journals, magazines and conferences:

- IEEE, SIAM, Springer, Elsevier, IET
- CVPR, ICCV, ECCV, etc.

Computer Vision News:
https://www.rsipvision.com/computer-vision-news/