Lecture 1 Eye and Human Vision

COMP3204 Computer Vision

Is human vision a good model for computer vision?

Book pp 2-12

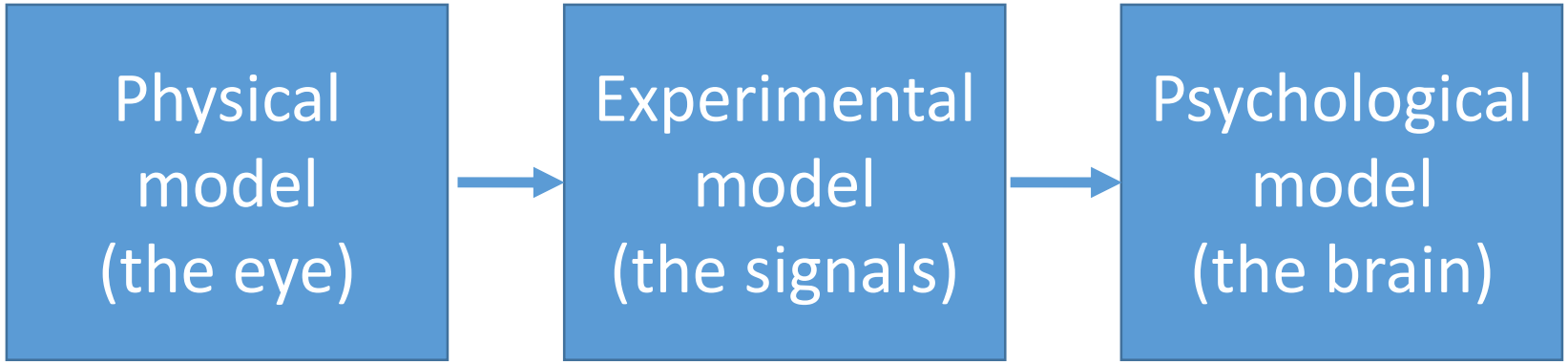
Department of Electronics and Computer Science

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)?

Modelling the eye in three parts



Each is not fully understood, especially the brain ……

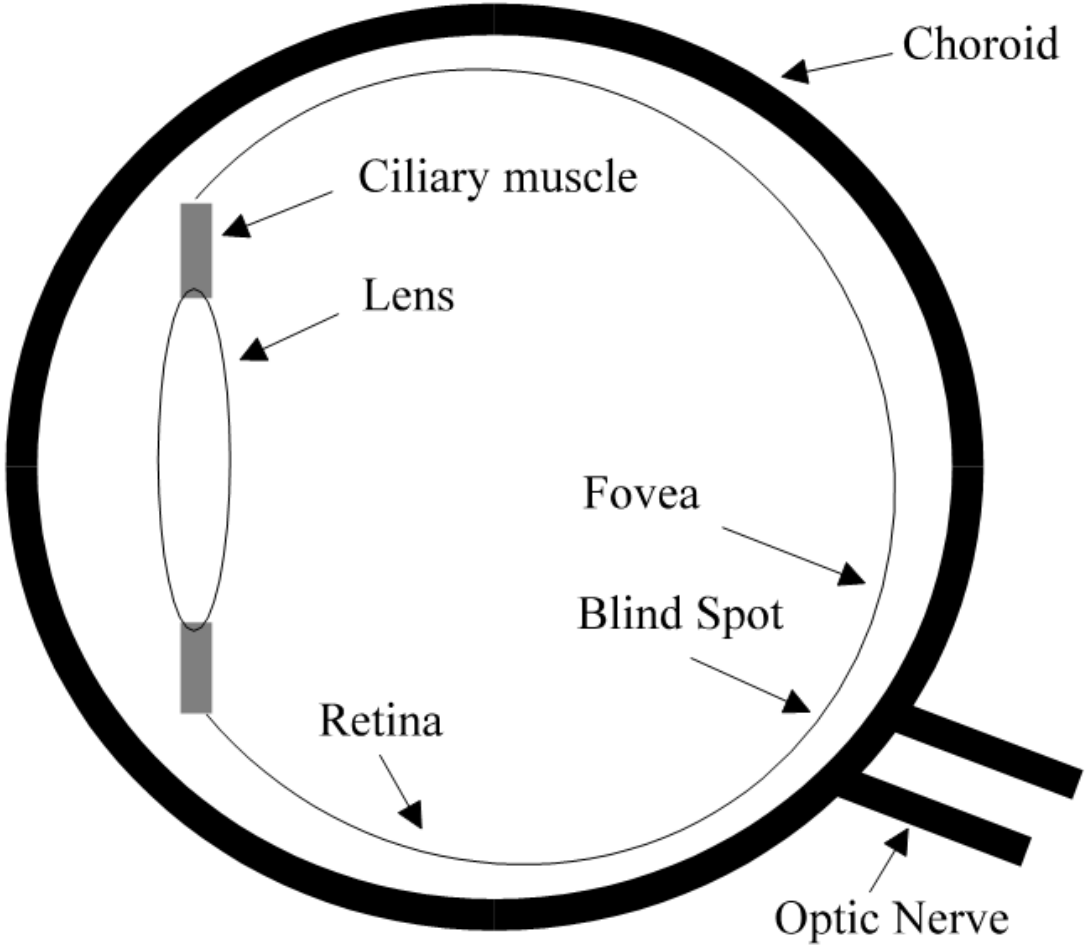
Human eye

Evolved for survival

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

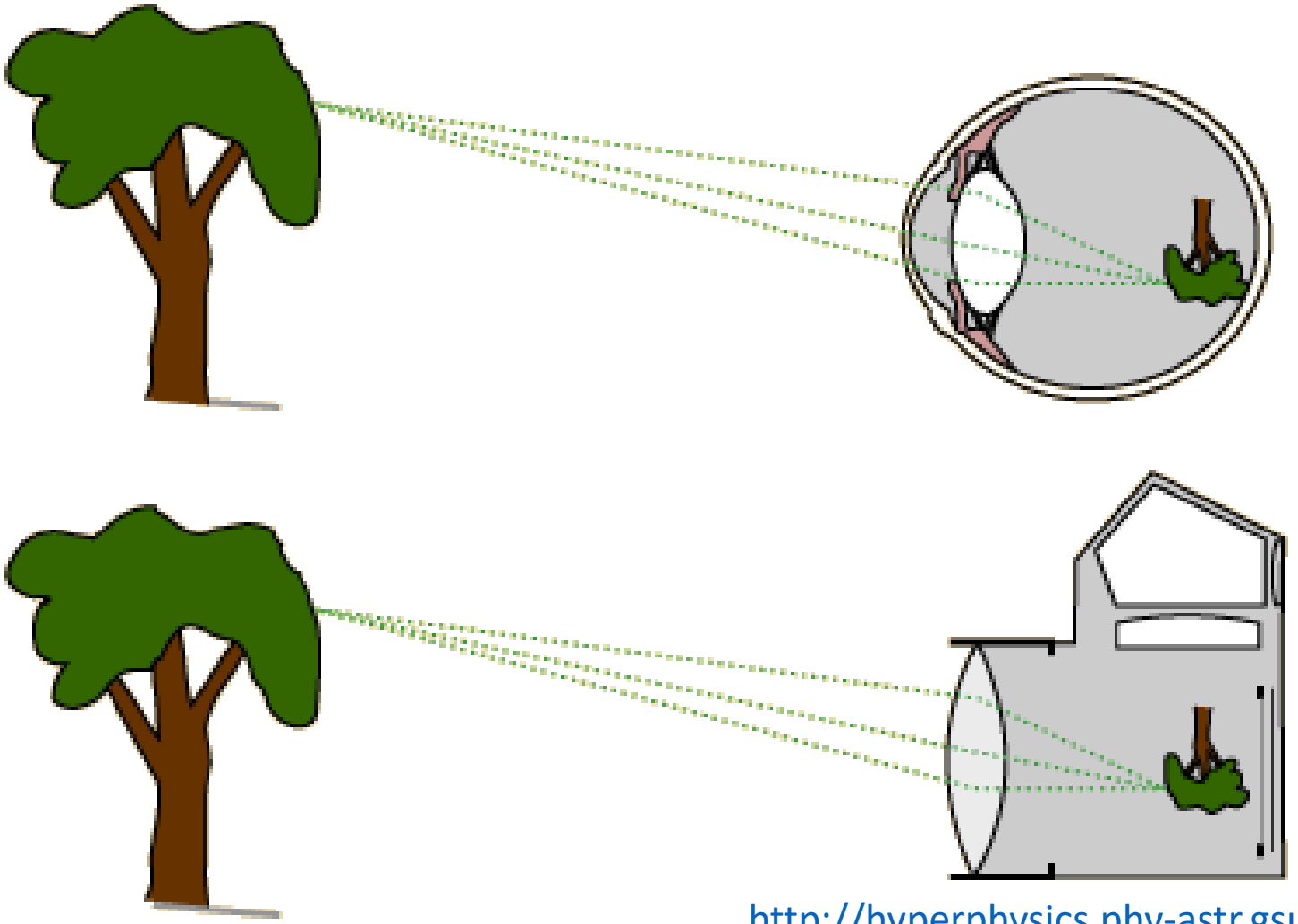
The lens is shaped, rather than moved

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

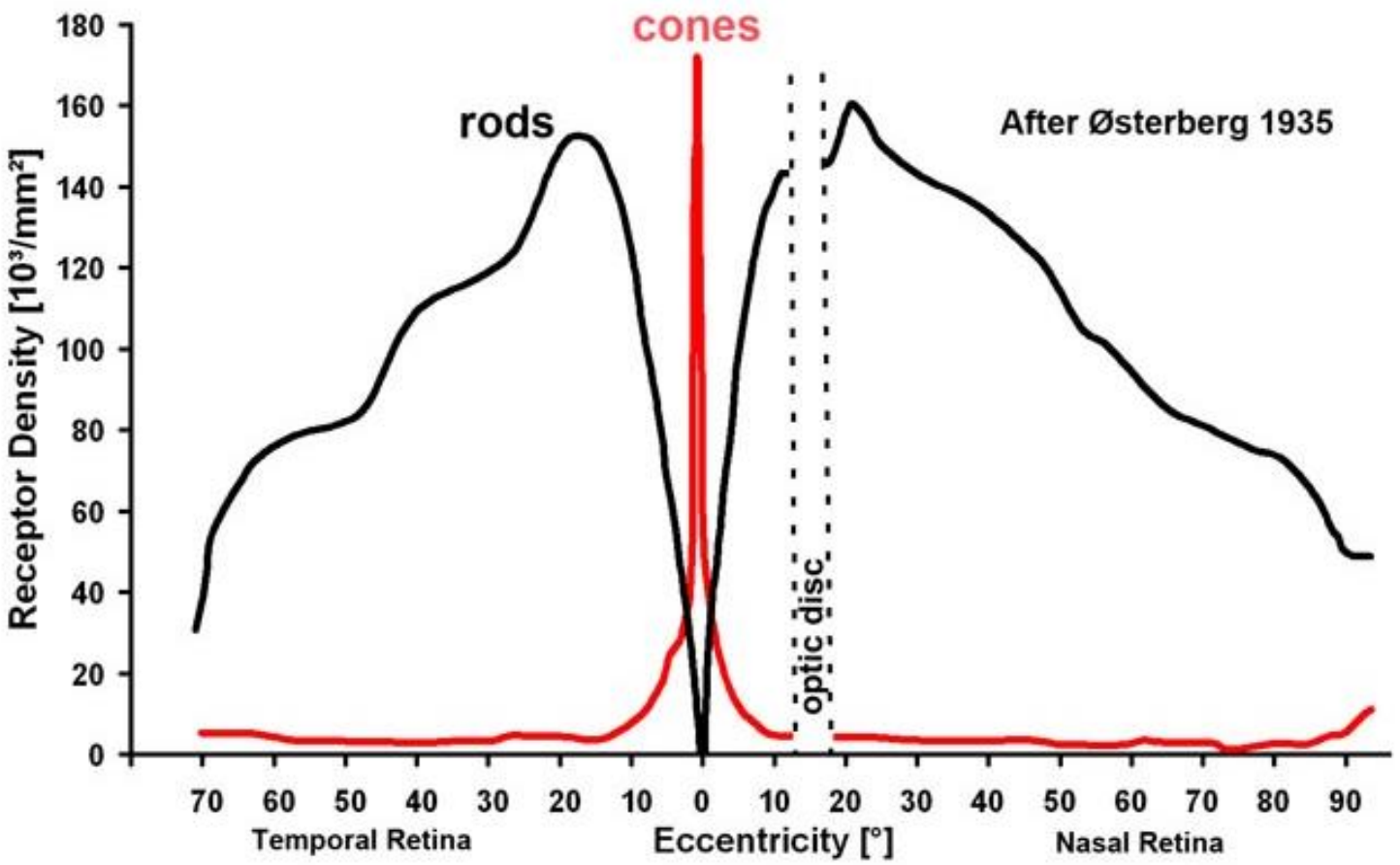
photopic scotopic

Cones come in three types

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

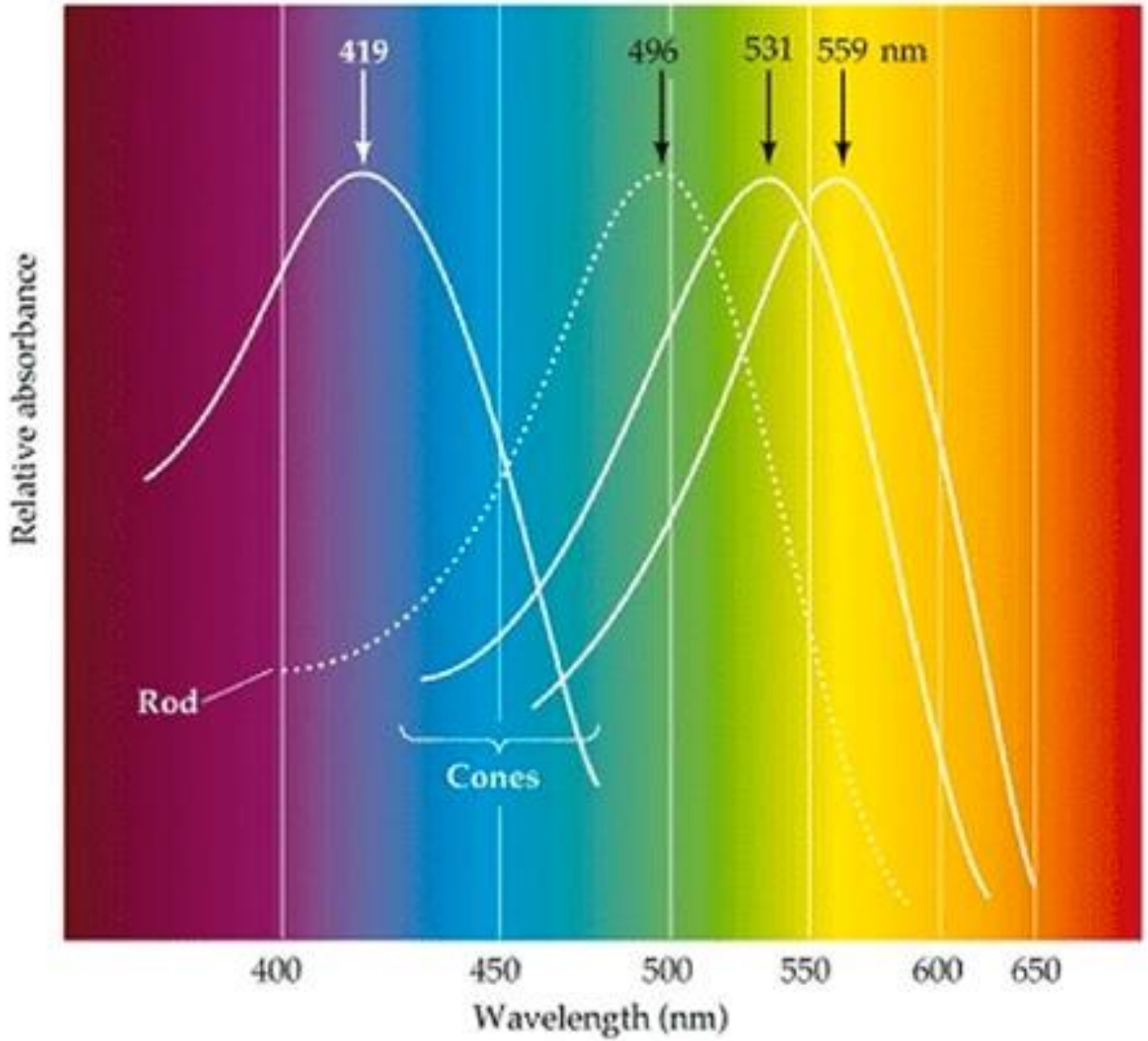
Insufficient bandwidth of optic nerve implies coding

Rod and cone densities



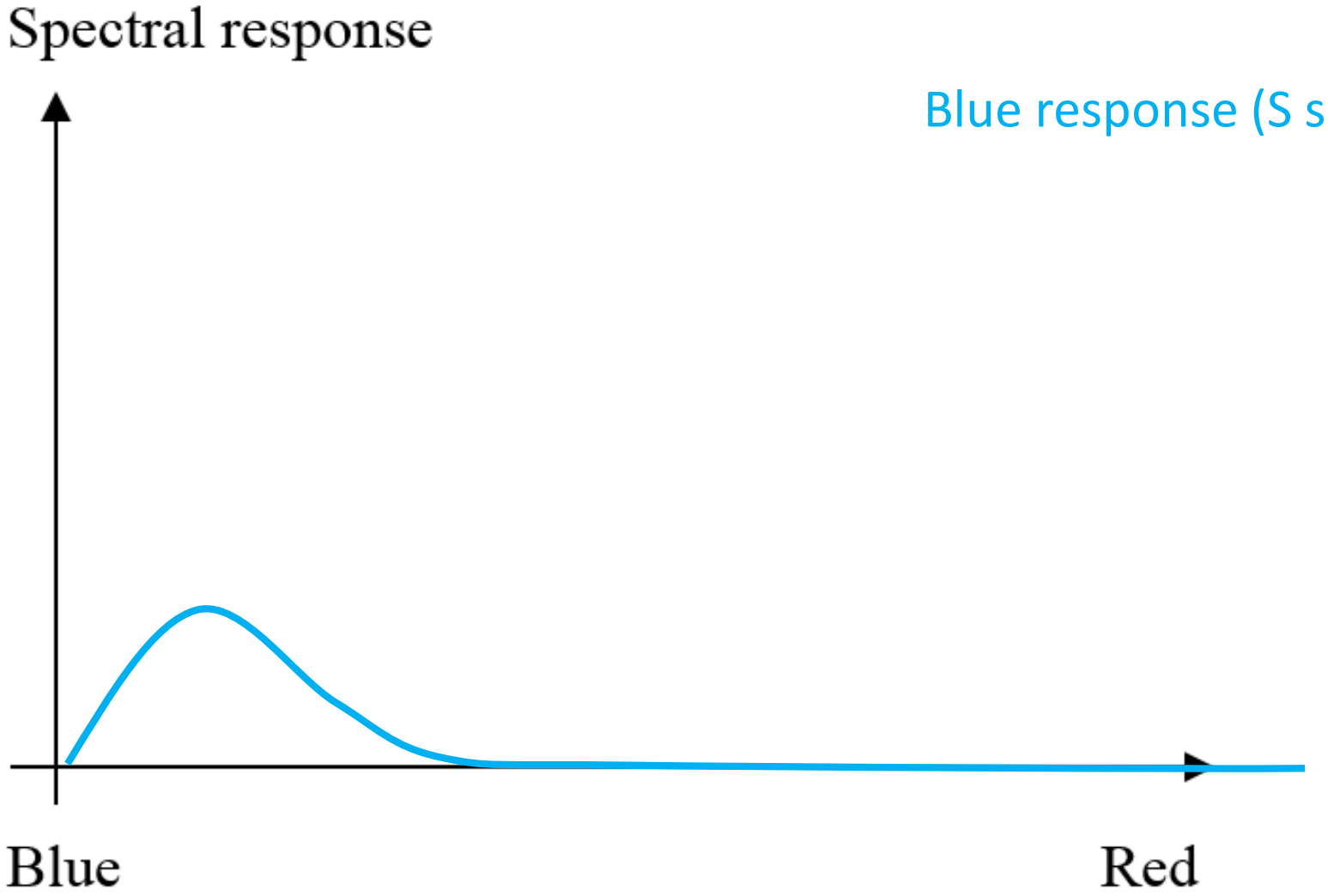
No sensors on blind spot
Most cones on fovea
Rods elsewhere

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



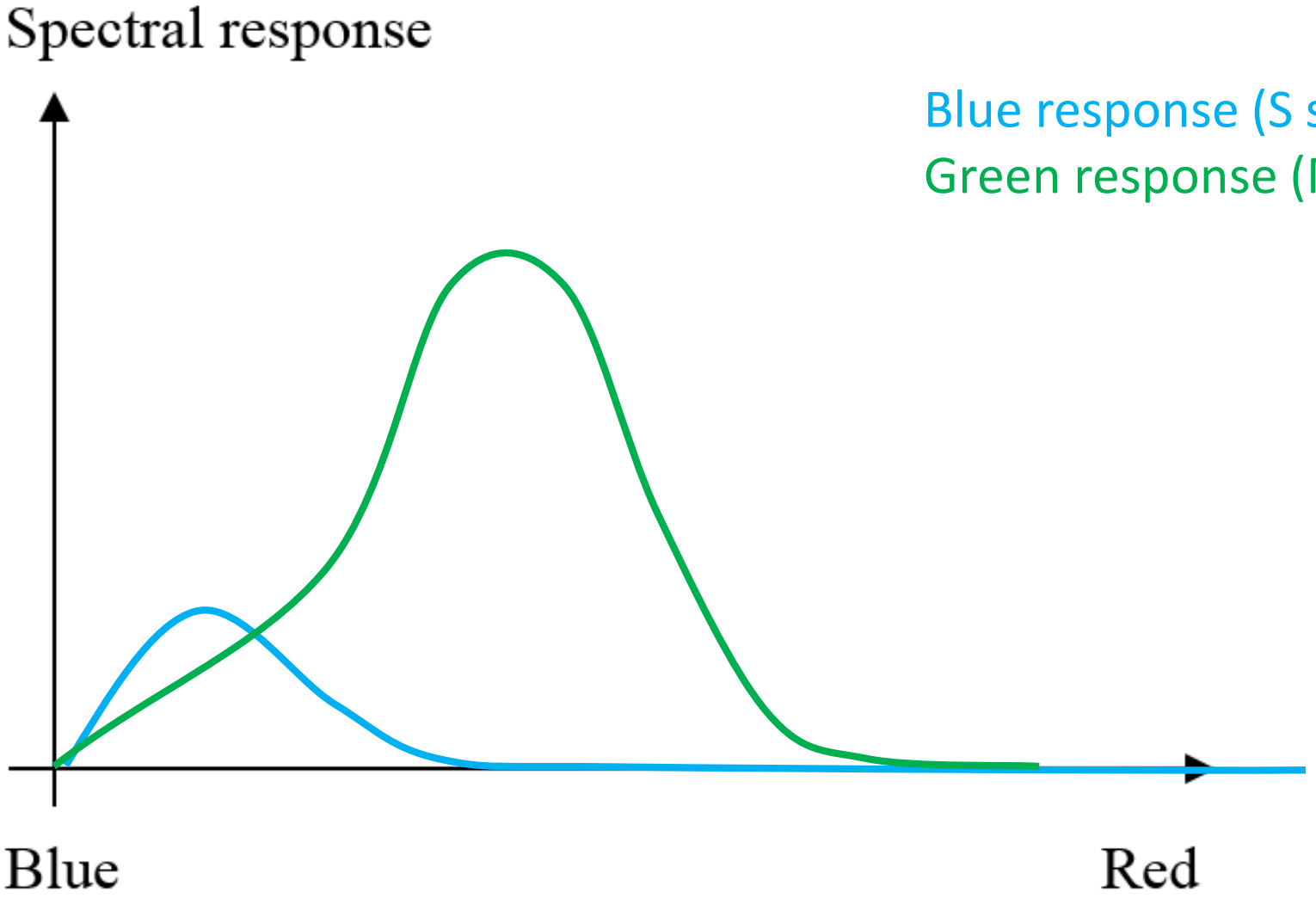
http://webvision.med.utah.edu/wp-content/uploads/2011/03/Spectrum.jpeg

Spectral responses



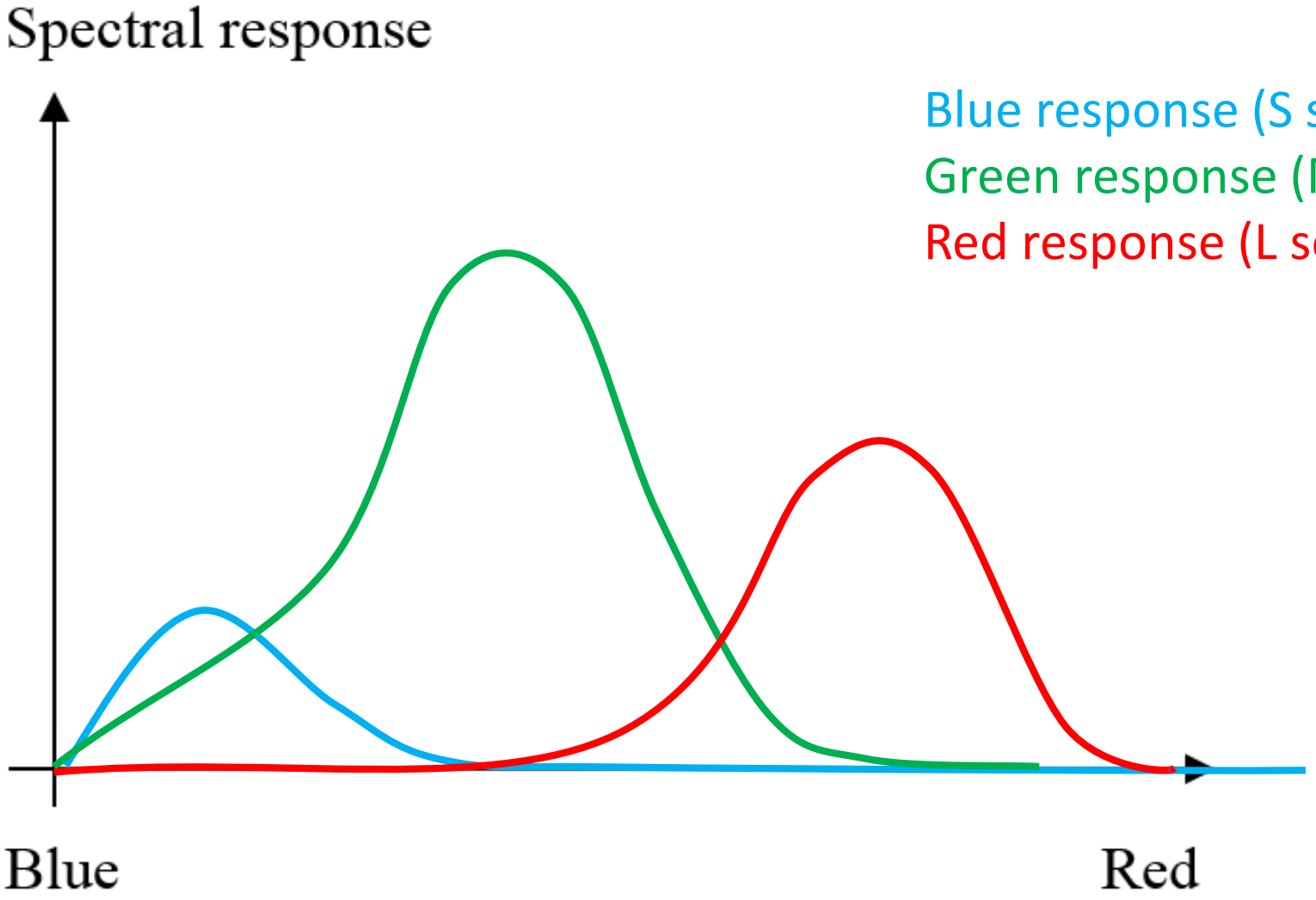
Blue response (S sensors) is poor

Spectral responses



Blue response (S sensors) is poor
Green response (M sensors) dominates

Spectral responses

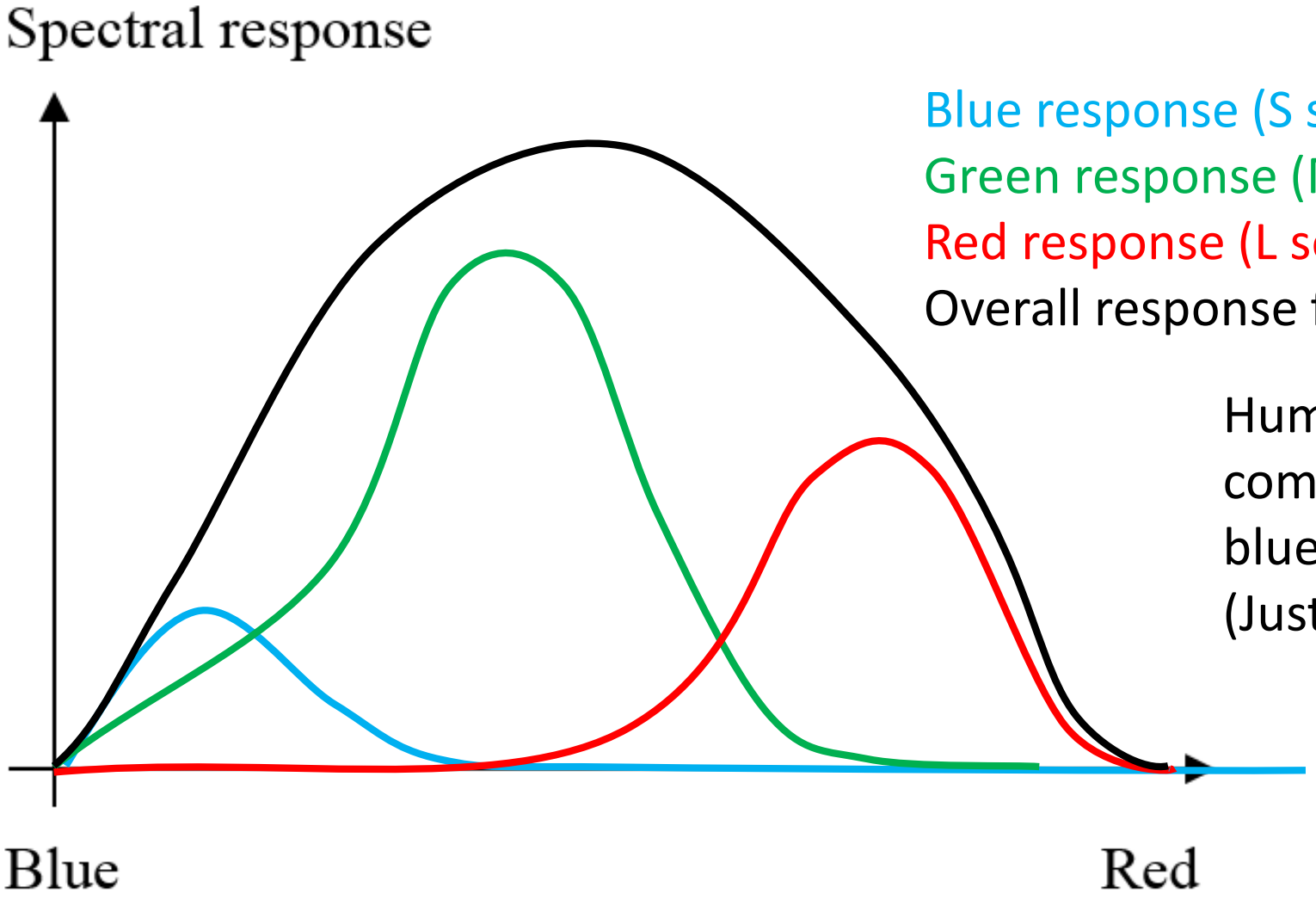


Blue response (S sensors) is poor

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

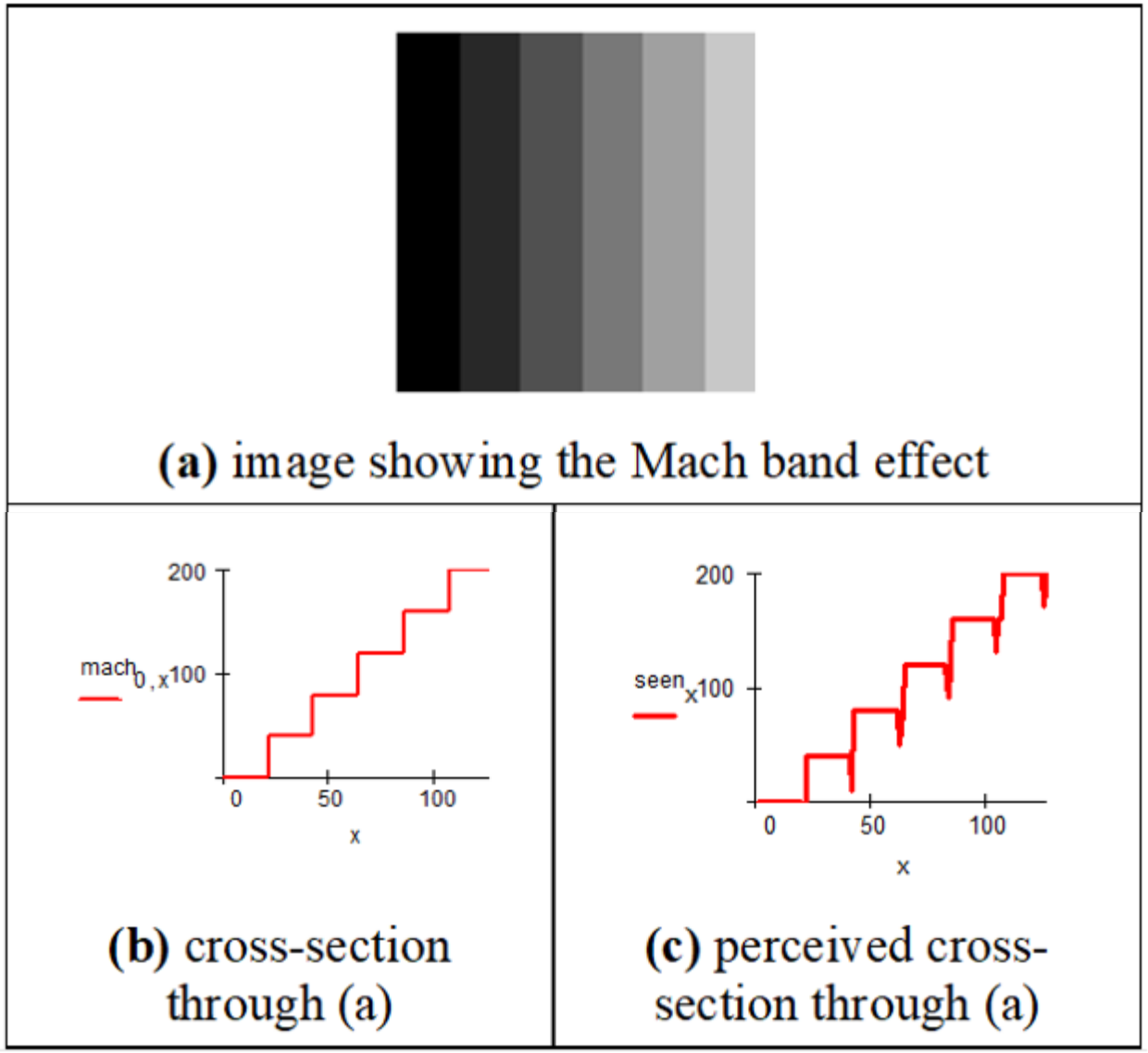
Overall response from S, M and L

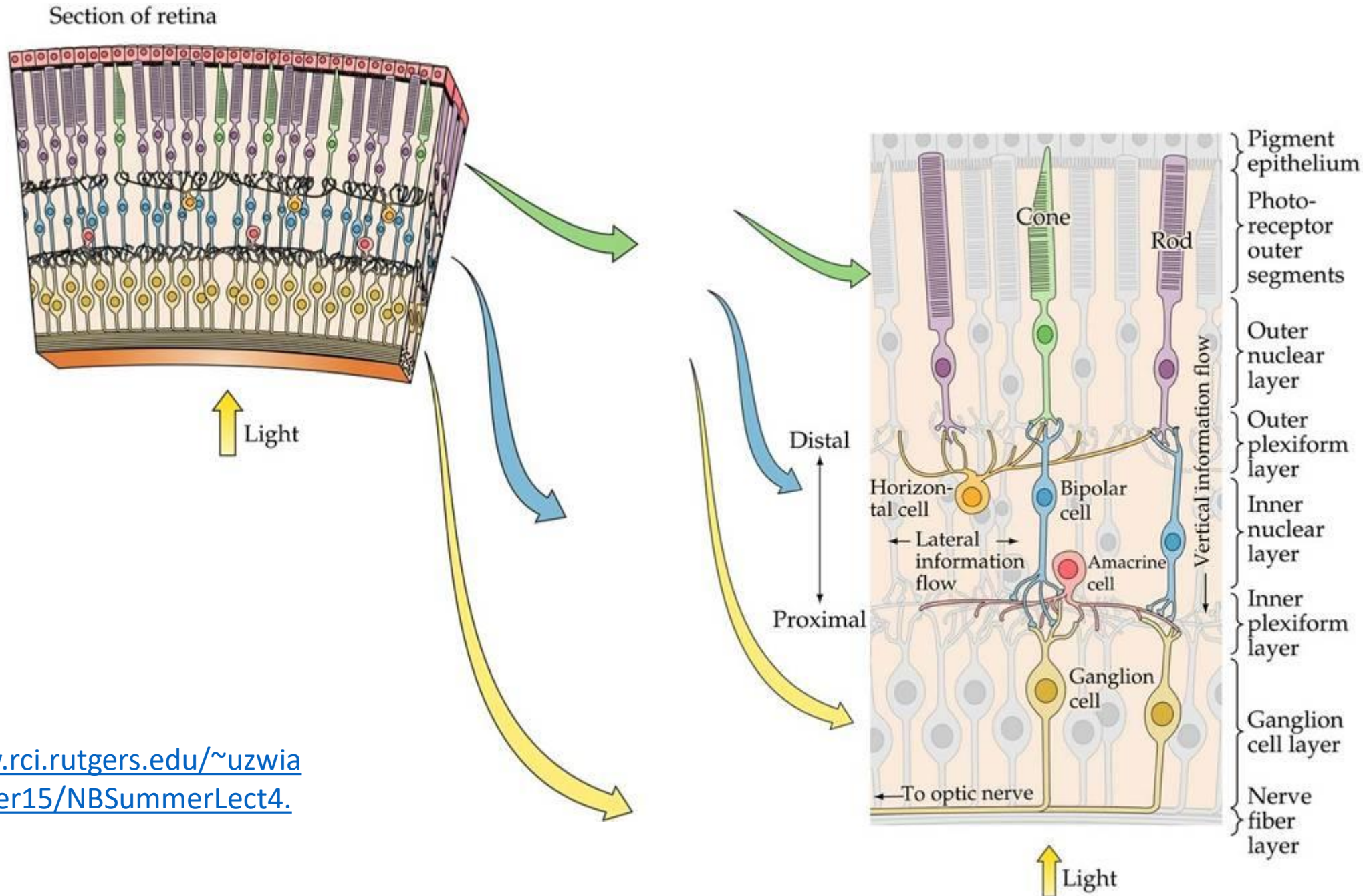
Human vision must compensate for the poor blue sensors
(Just like a camera)

Mach bands

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

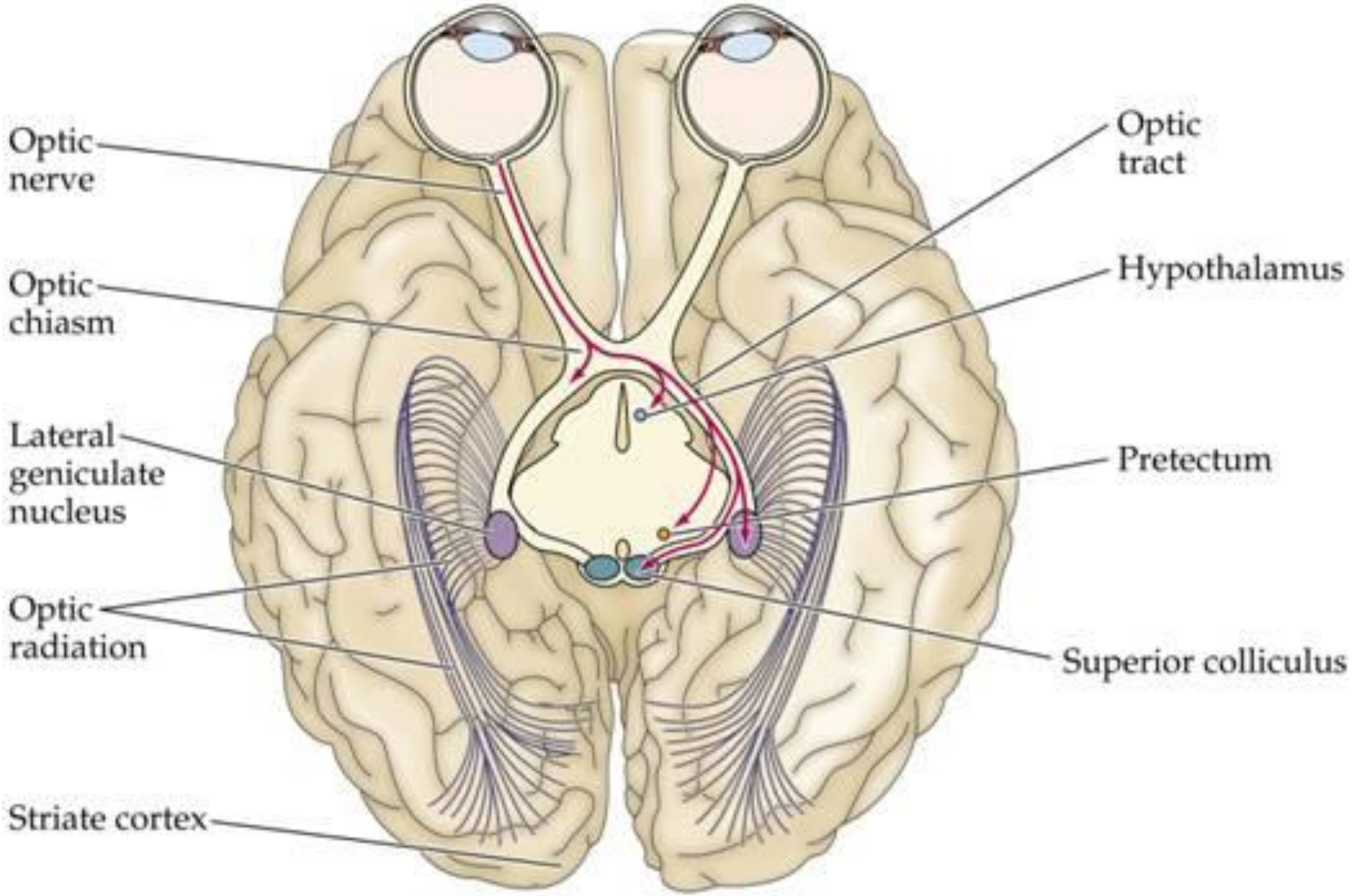
Result of brightness adaption





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

Cortices

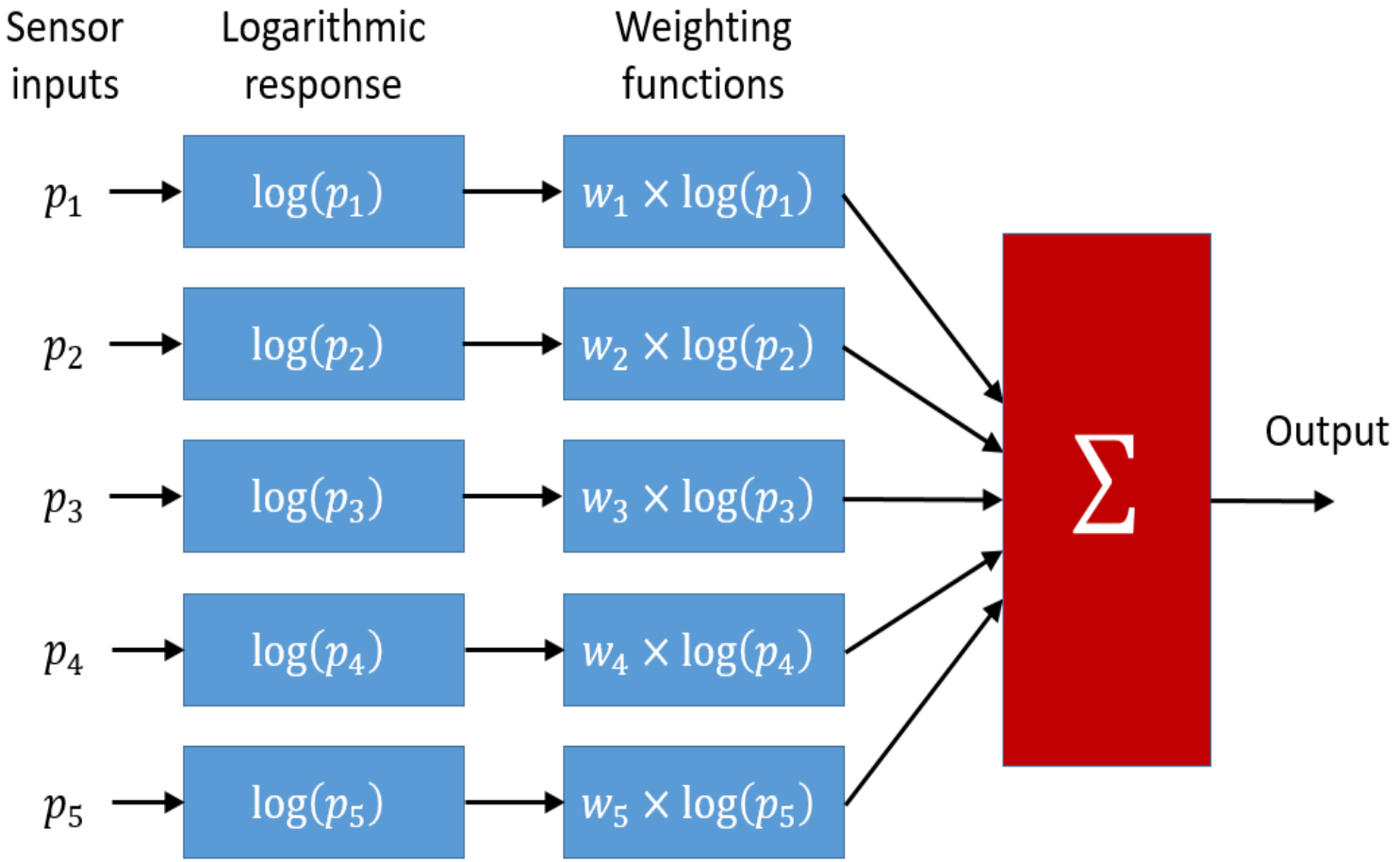


http://www.rci.rutgers.edu/~uzwiak/NBSummer15/NBSummerLect4.html

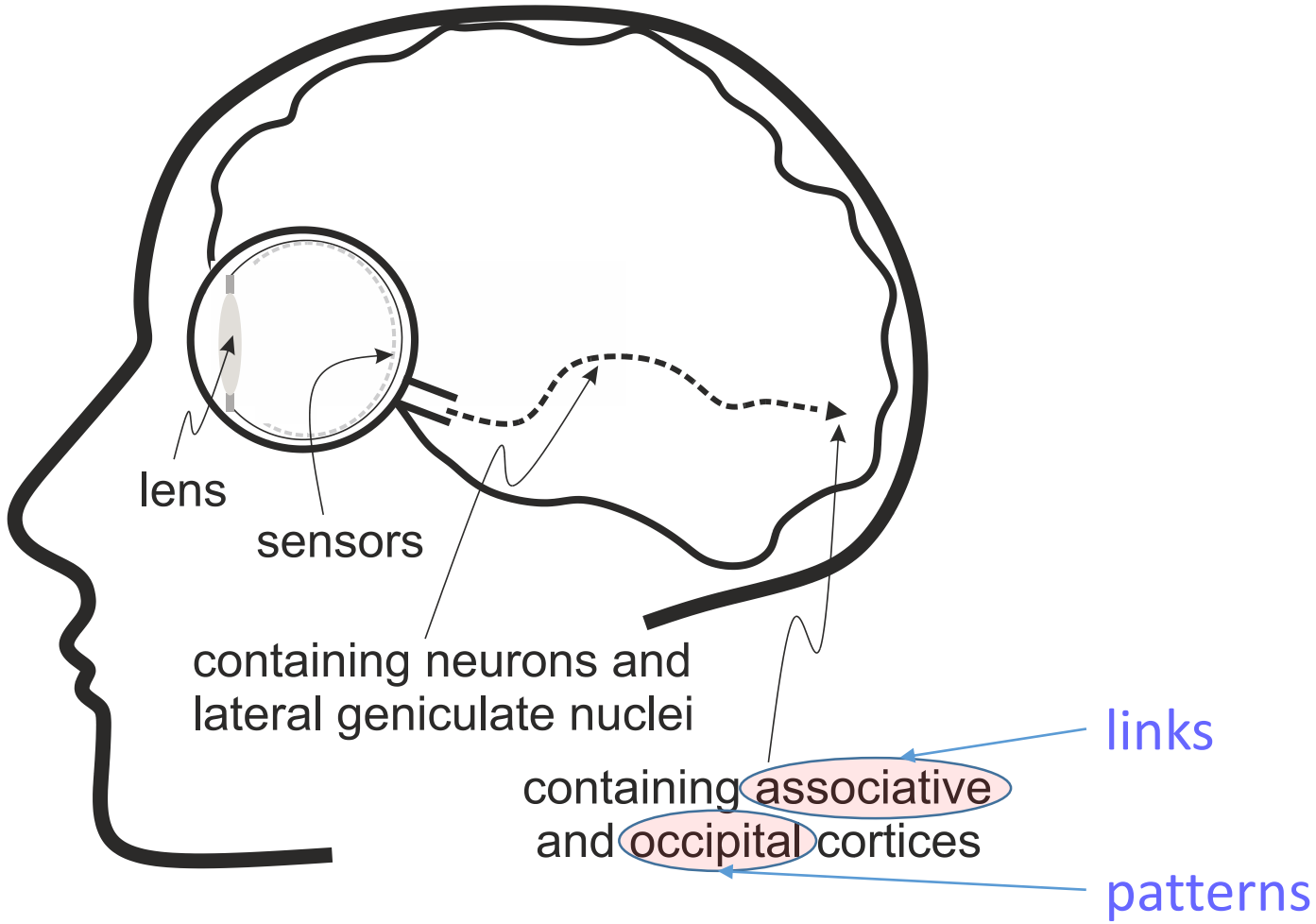
Neural processing

Sensor information must be combined

Note Weber's law



Where are we?

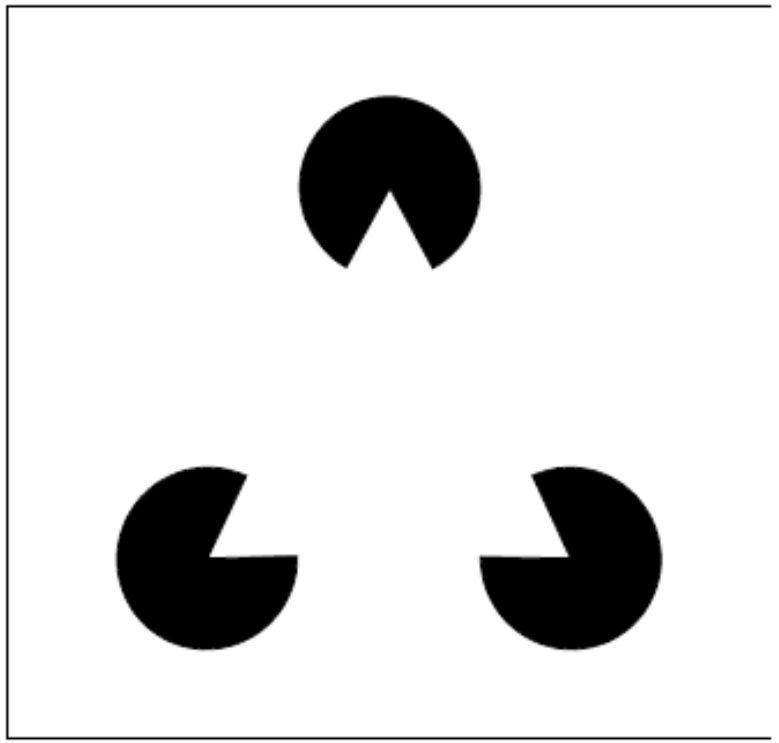

lens
sensors
containing neurons and
lateral geniculate nuclei
containing associative
and occipital cortices
links
patterns


FEATURE EXTRACTION
AND IMAGE PROCESSING
FOR COMPUTER VISION

How human vision uses edges

The human eye needs training and can be deceived

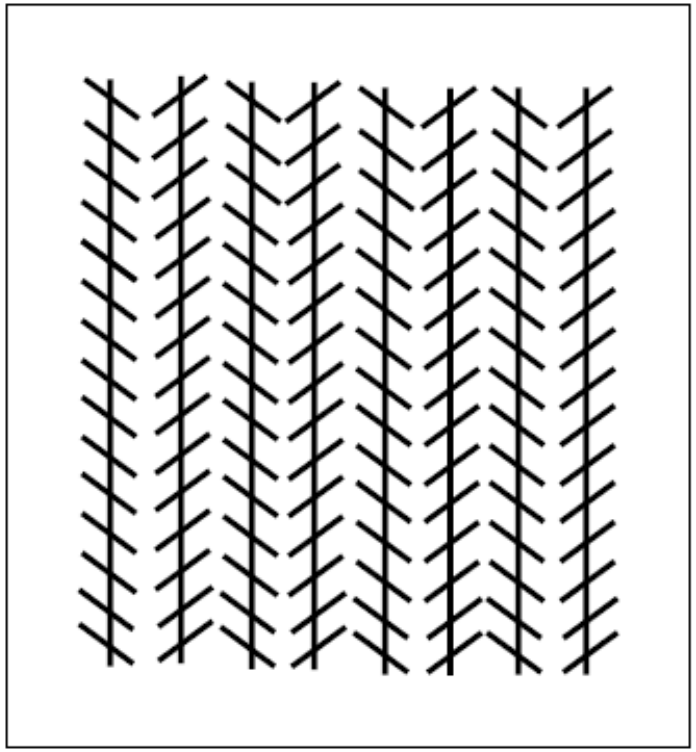
(a) word?



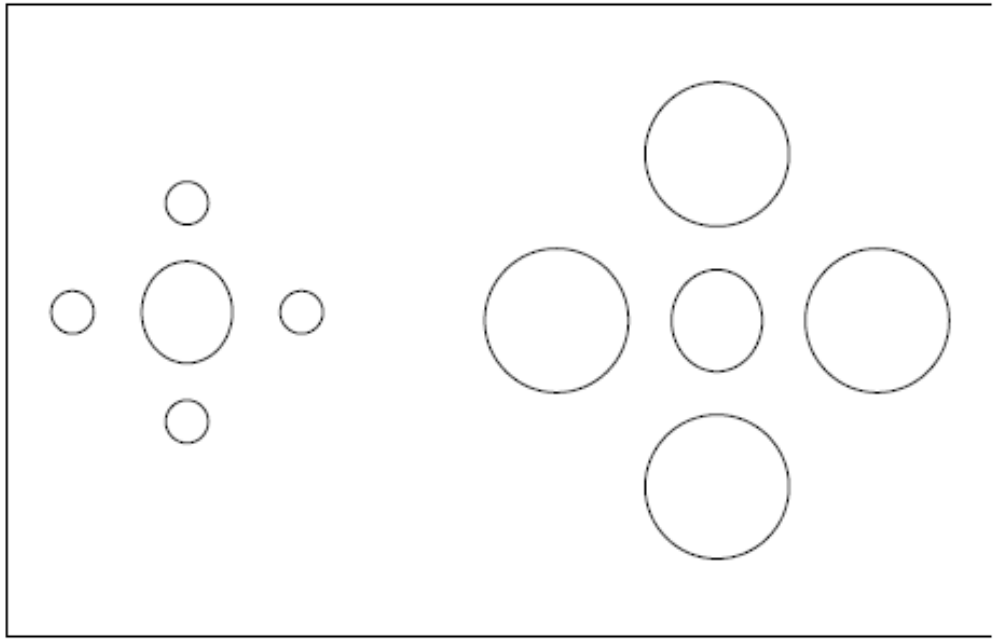
(b) Pacmen?

Static illusions

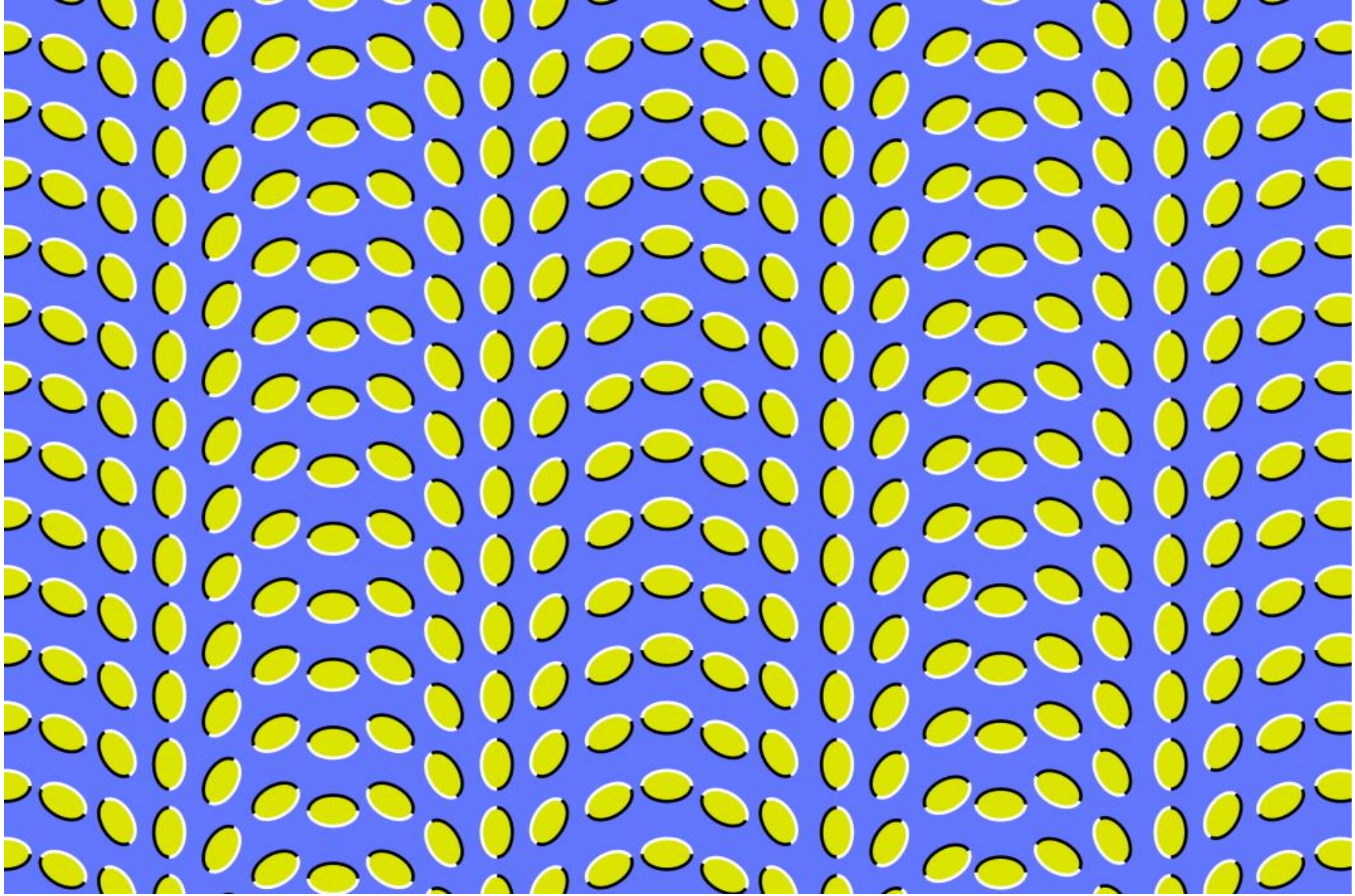
Measurement needs comparison

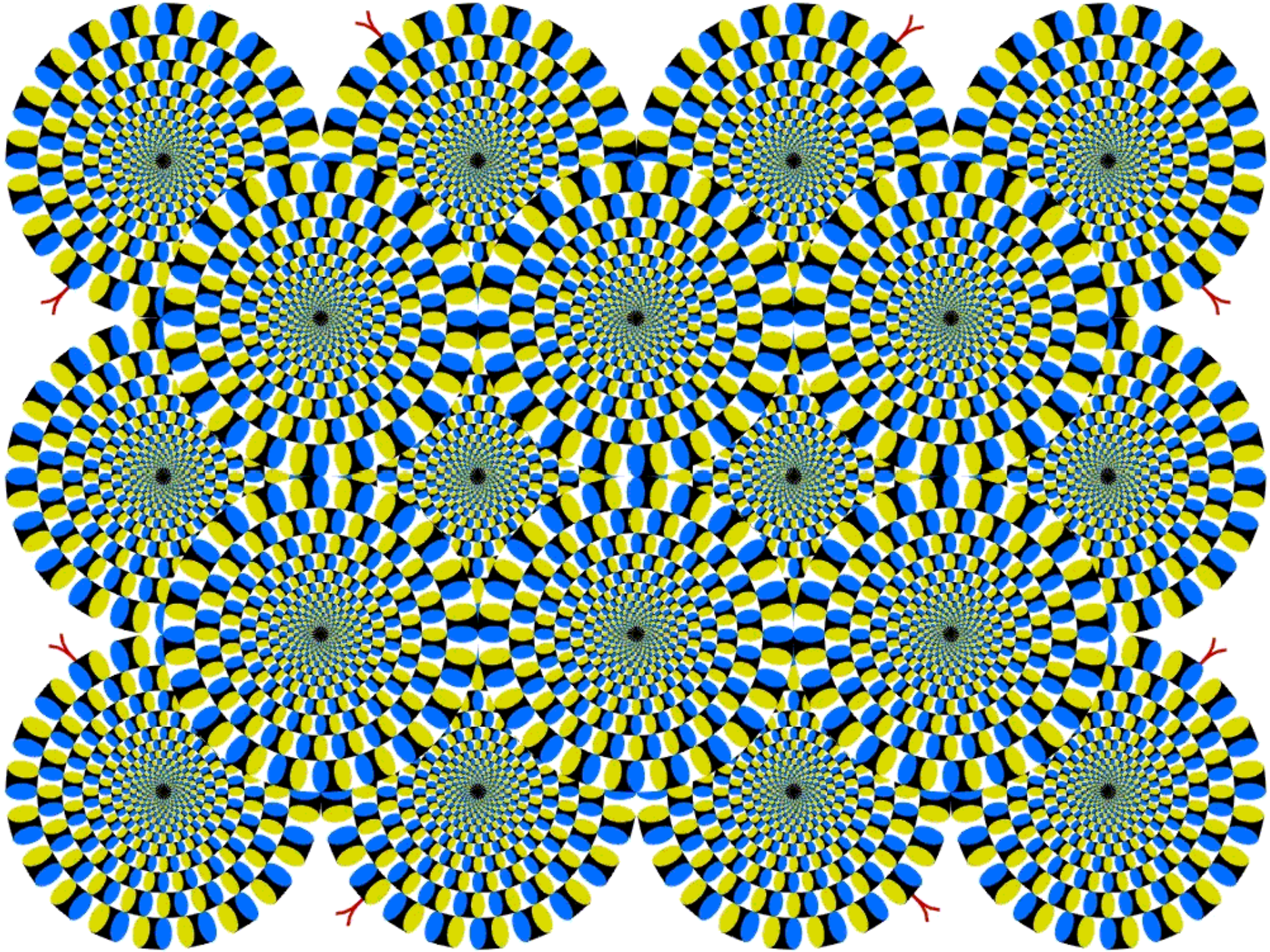


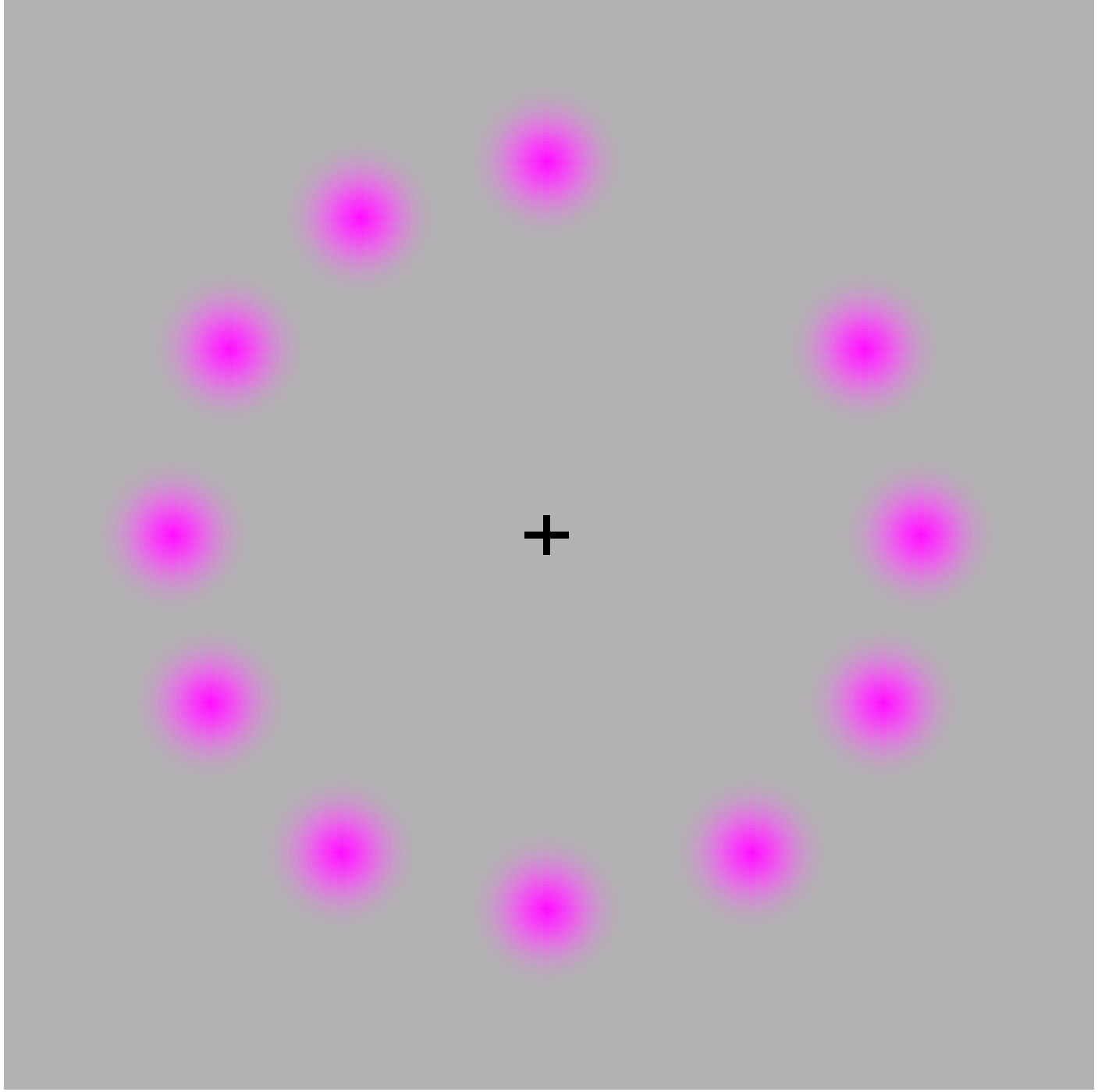
(a) Zollner



(b) Ebbinghaus

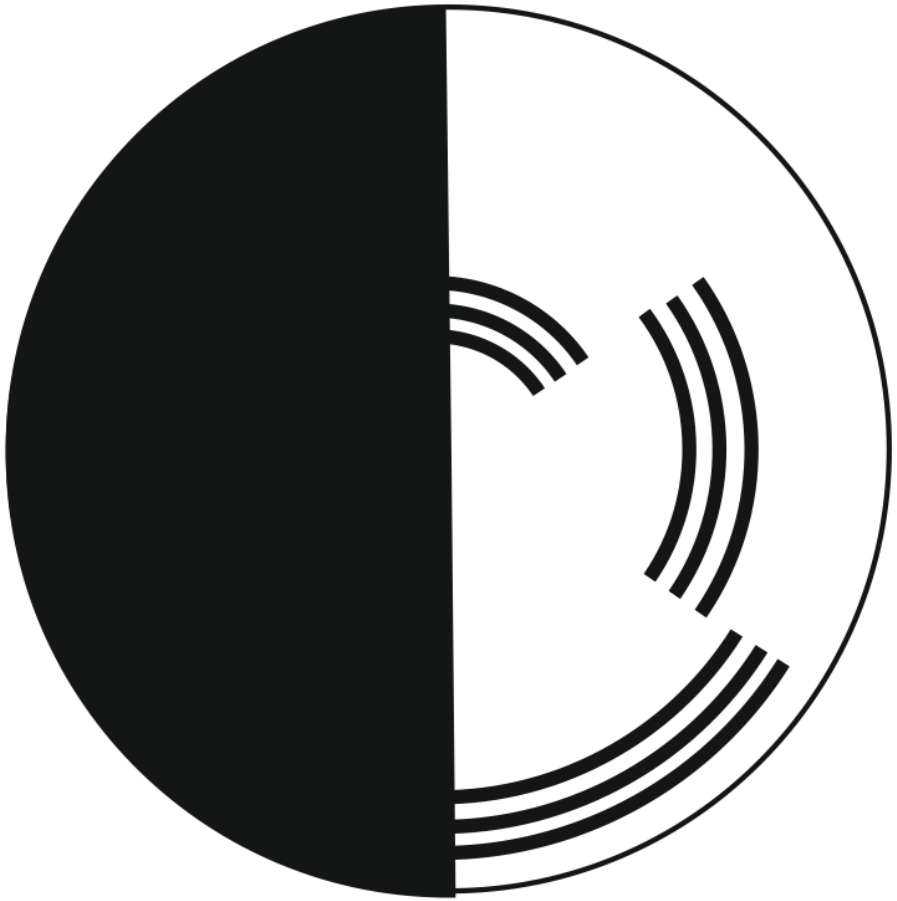


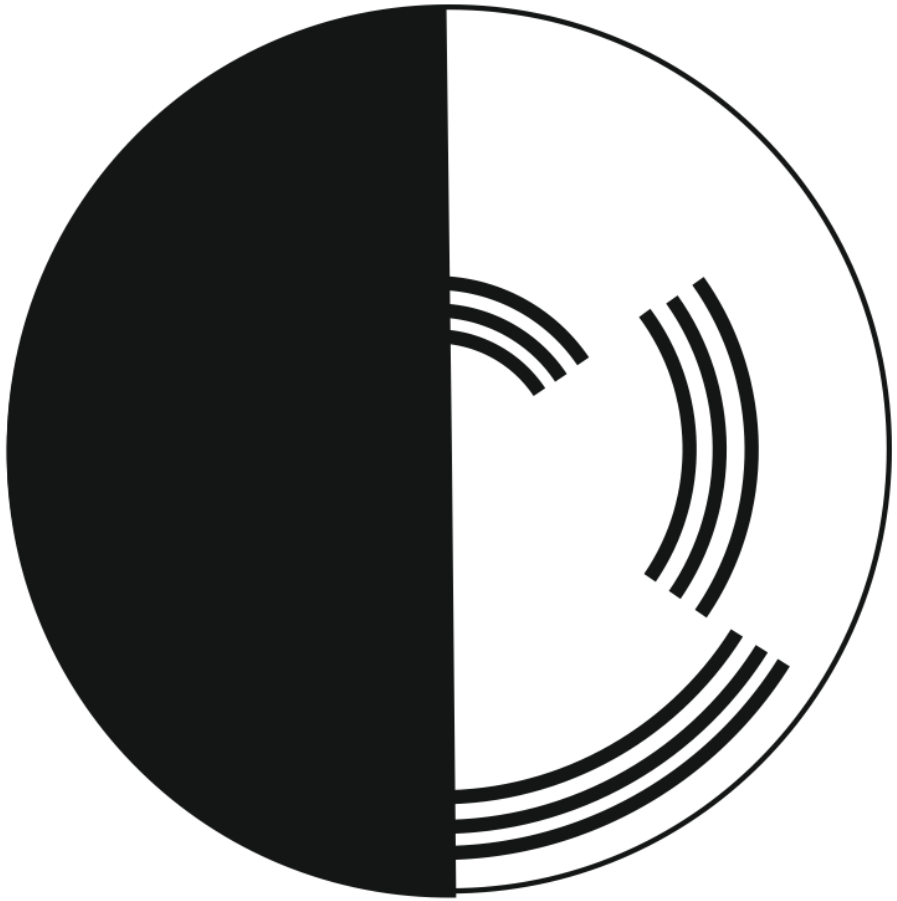




Benham's disk

Illusions are a consequence of complex function





Combining Computer and Human Vision

Eyewitness statement

"24 year old male average height wearing shirt"

Human vision with notions of psychology

Database of images

Generate descriptions

Computer vision by human vision

Computer vision by human vision

Generate description

Image of crime

Subject	Gender	Age	Height	Nose W	Top
?	M	24	171	2.4	Shirt

Subject	Gender	Age	Height	Nose W	Top
123456	M	25	172	2.3	Shirt
123457	F	36	156	2.2	Blouse
123458	M	58	182	1.2	T shirt

Database of descriptions

Martinho-Corbishley, Nixon and Carter, *IEEE TPAMI* 2019

Takeaway time – four main points

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