# Lecture 1 Eye and Human Vision

COMP3204 Computer Vision

**Is human vision a good model for computer vision?**


**Book pp 2-10**

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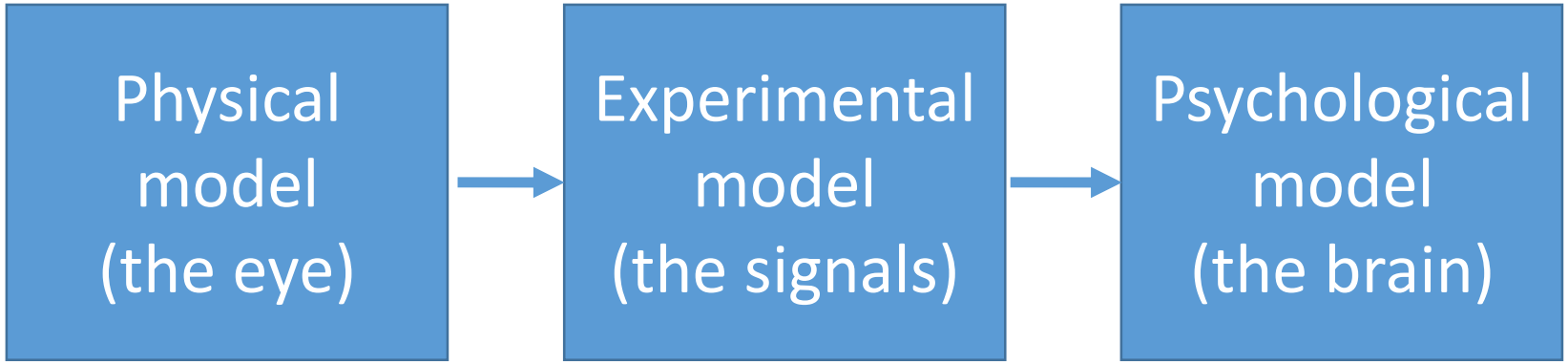
School of Electronics and Computer Science

# 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 ……

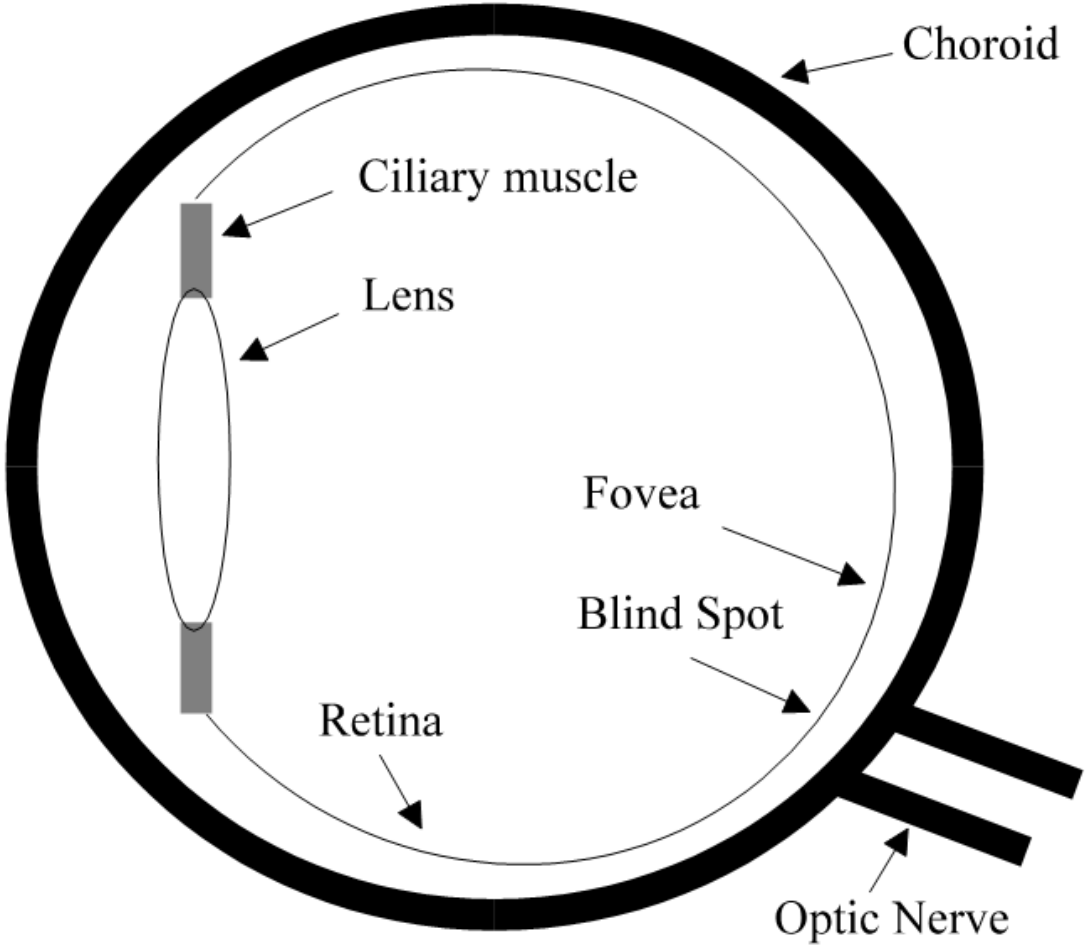
# Human eye

Evolved for survival

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

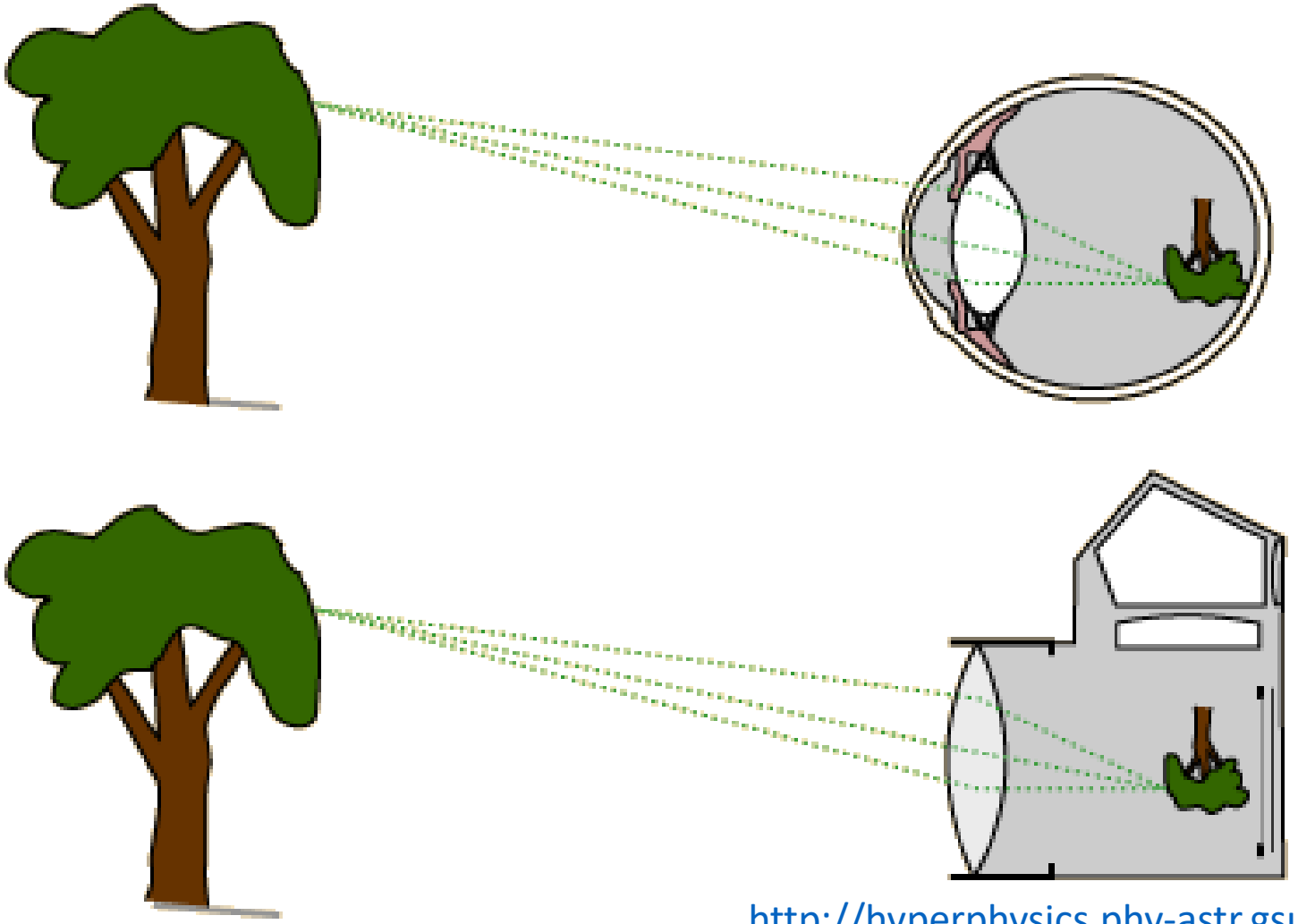
The lens is shaped, rather than moved

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

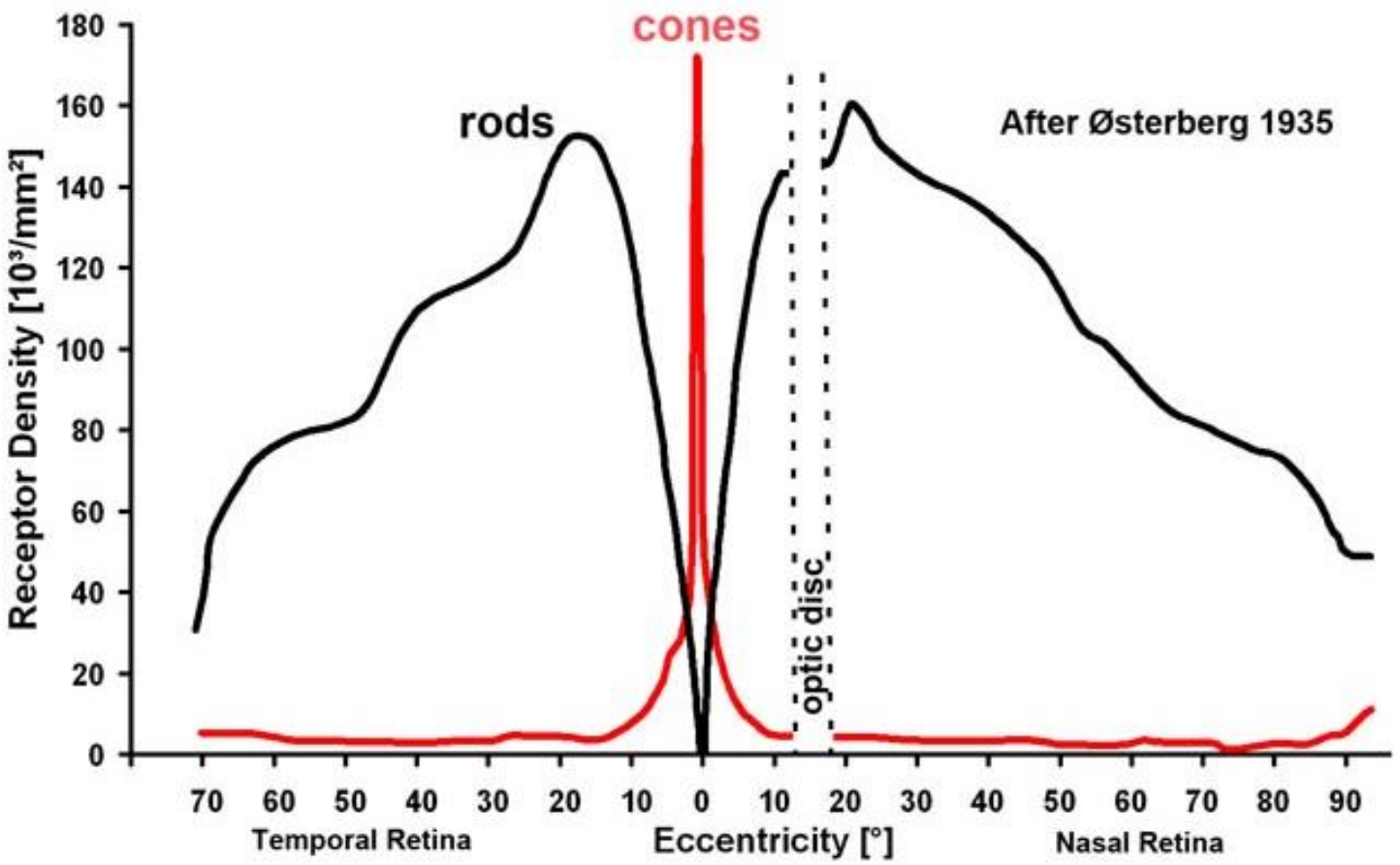
photopic scotopic

Cones come in three types

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

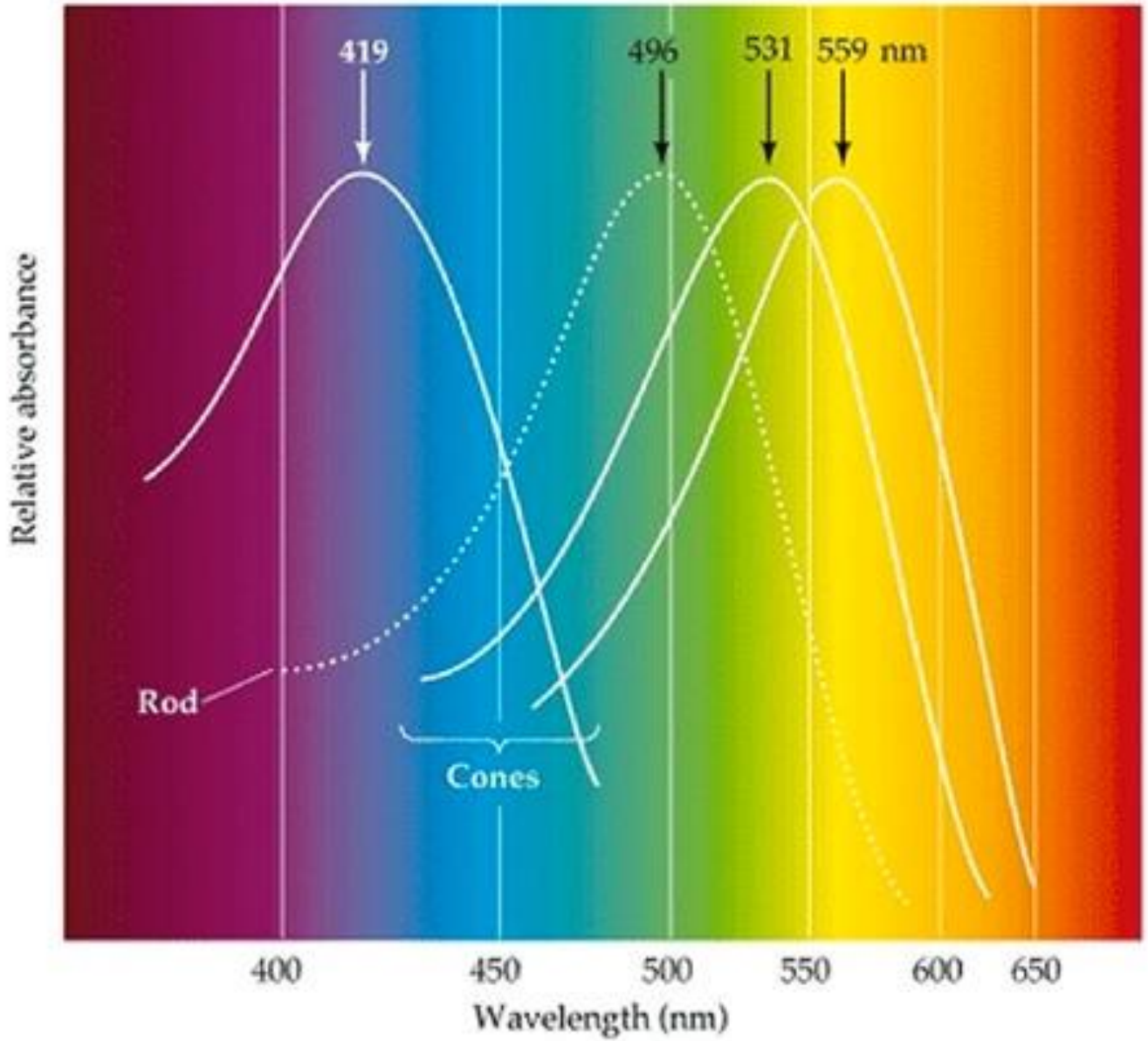
Insufficient bandwidth of optic nerve implies coding


# Rod and cone densities



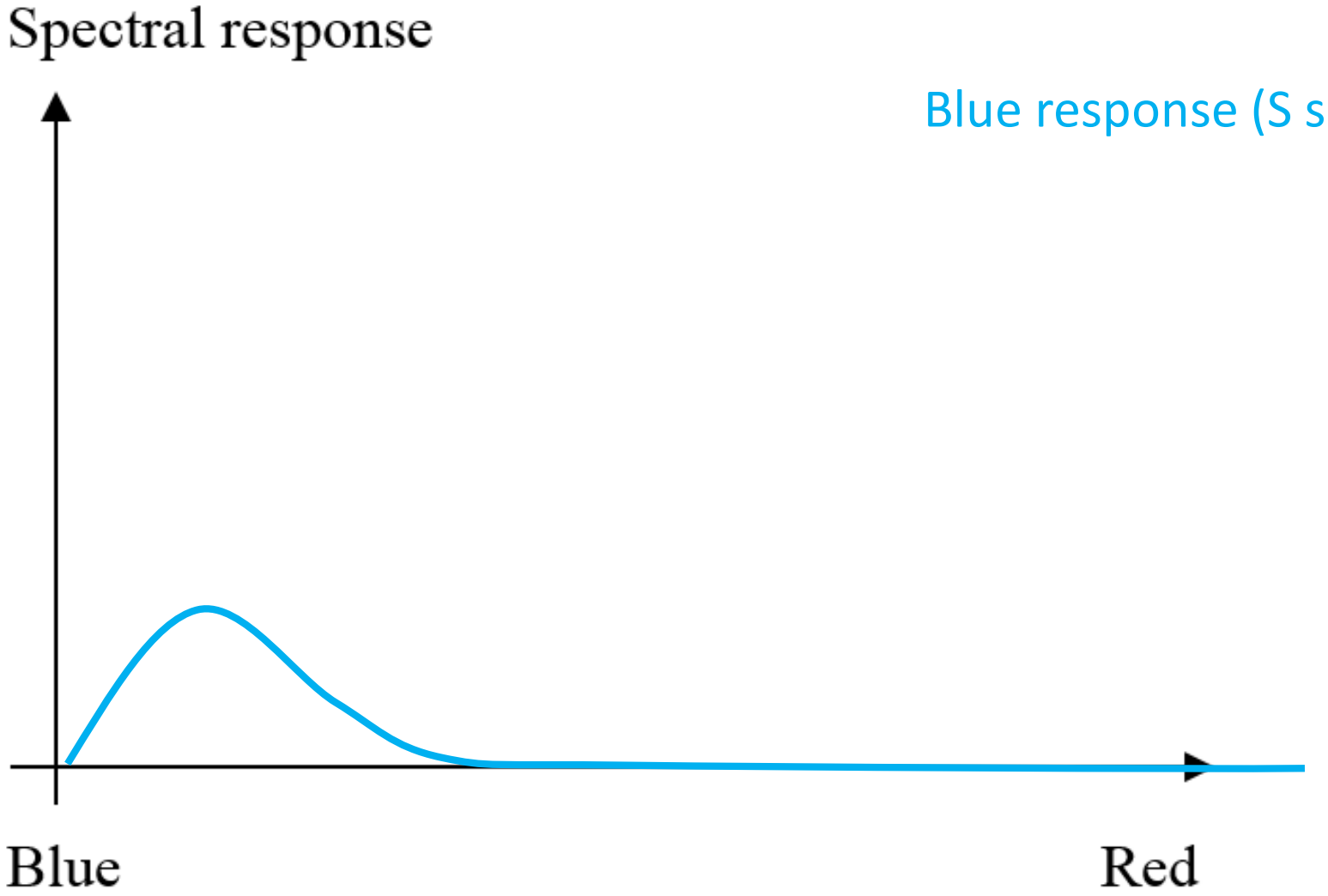

No sensors on blind spot
Most cones on fovea
Rods elsewhere

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



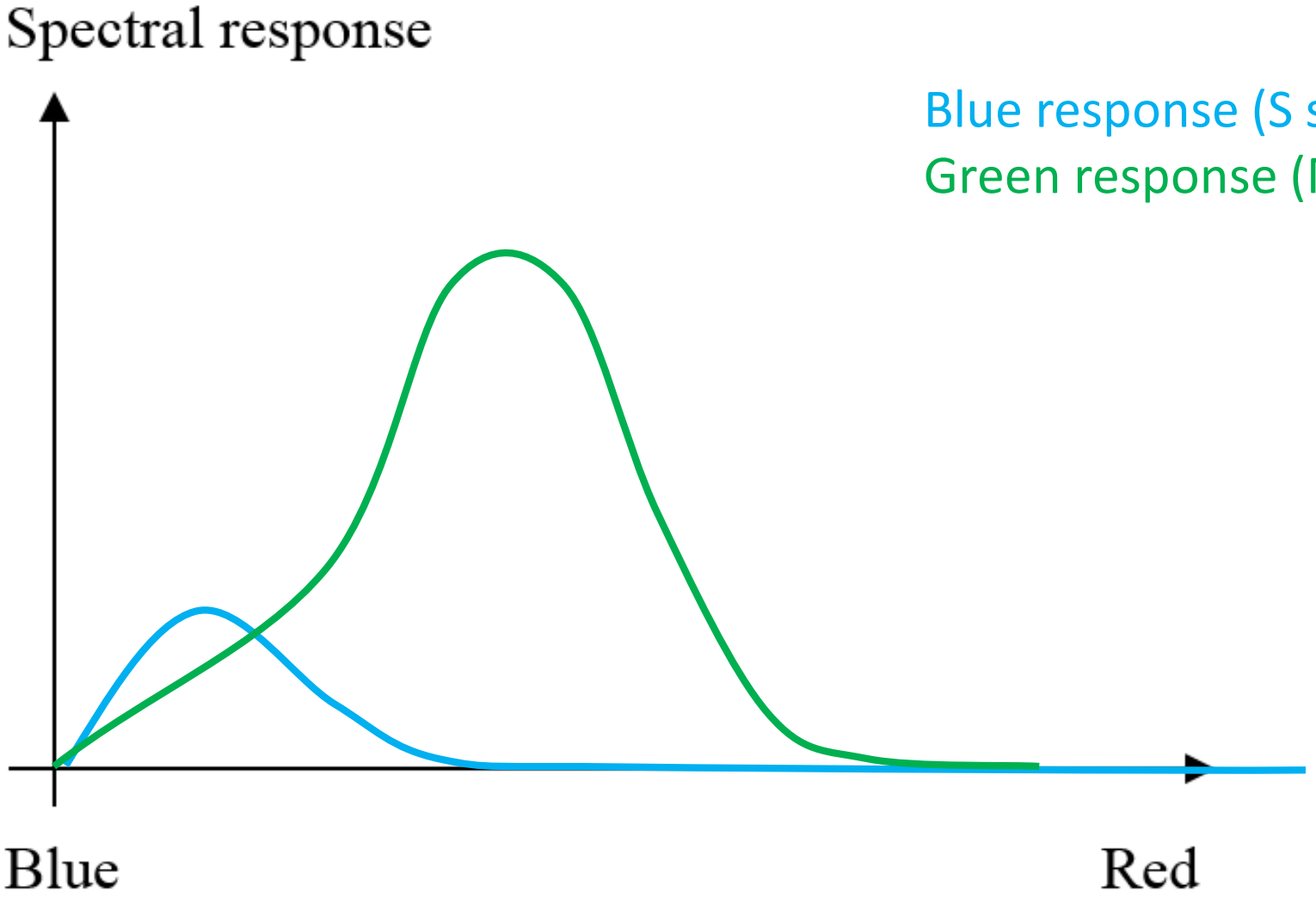

http://webvision.med.utah.edu/wp-content/uploads/2011/03/Spectrum.jpeg

# Spectral responses



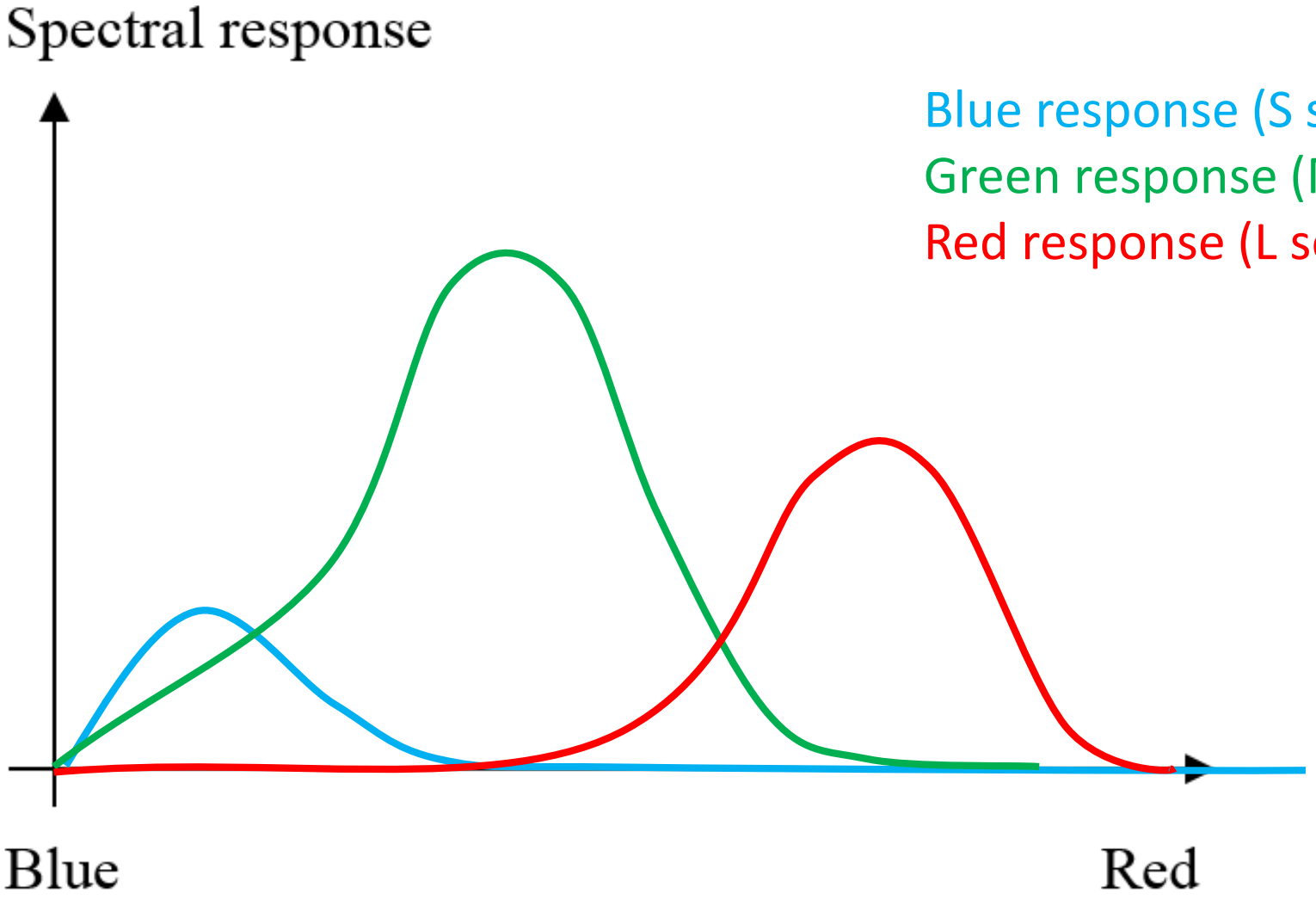

Blue response (S sensors) is poor

# Spectral responses




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

# Spectral responses

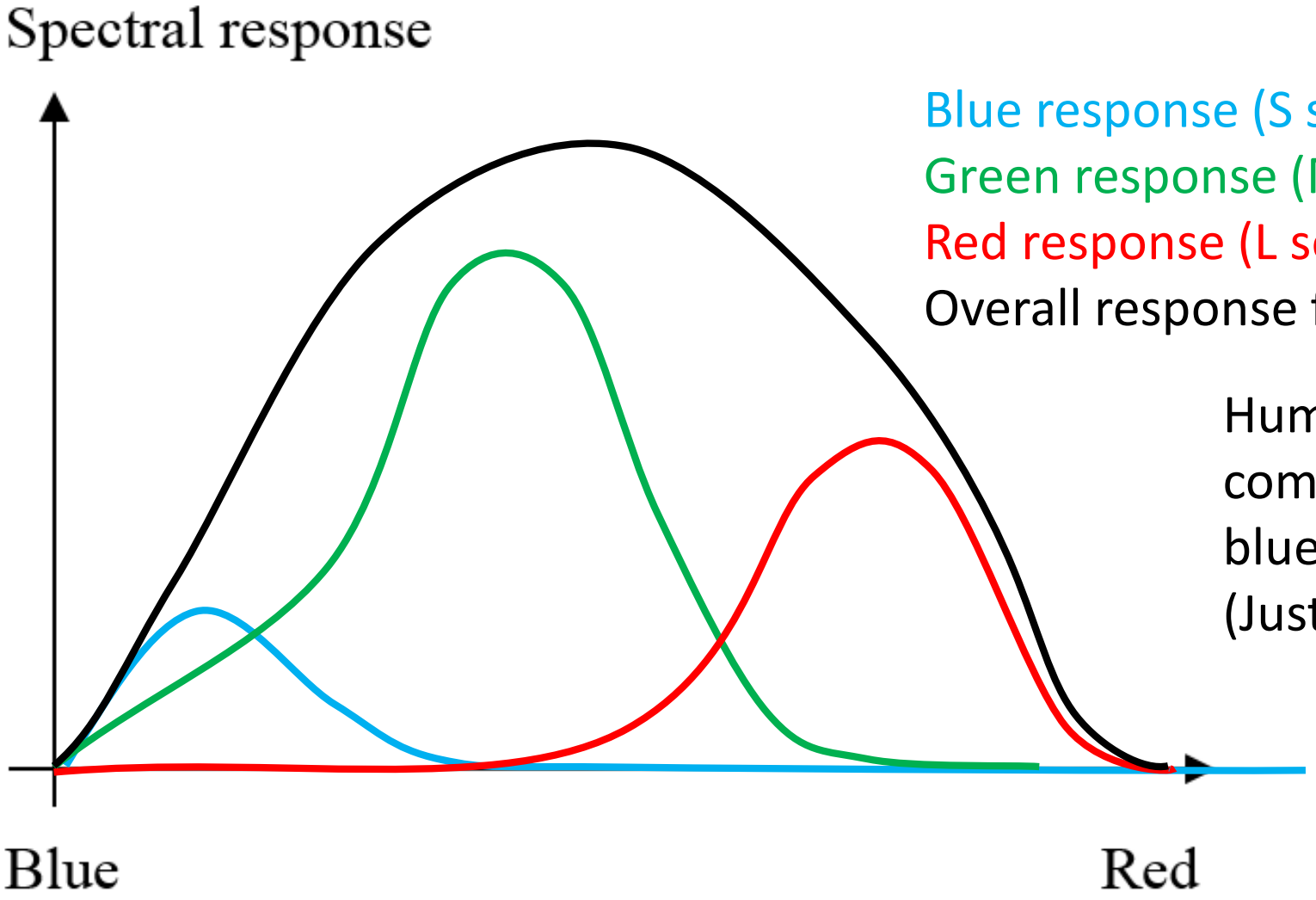



Blue response (S sensors) is poor

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

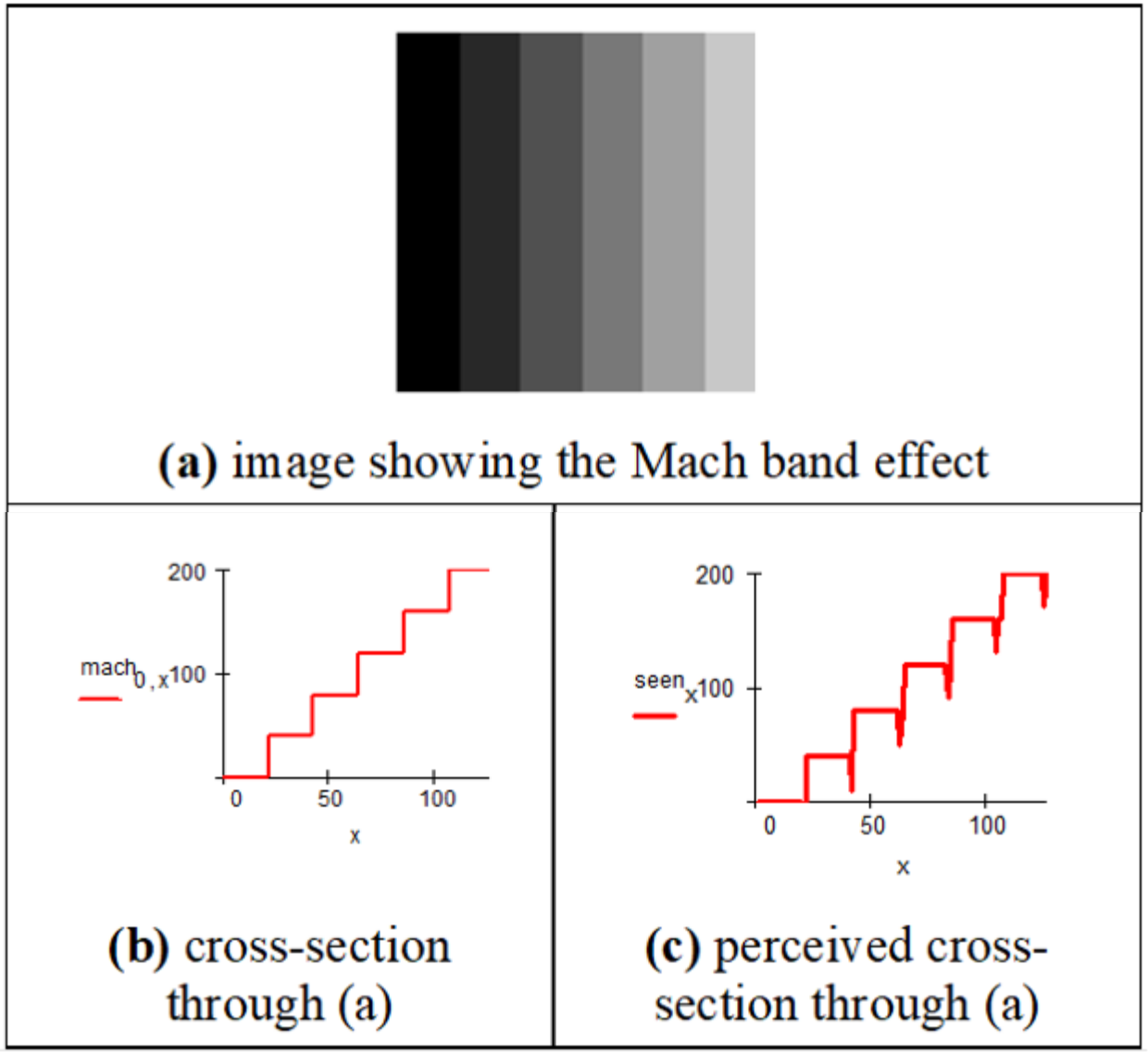
Overall response from S, M and L

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

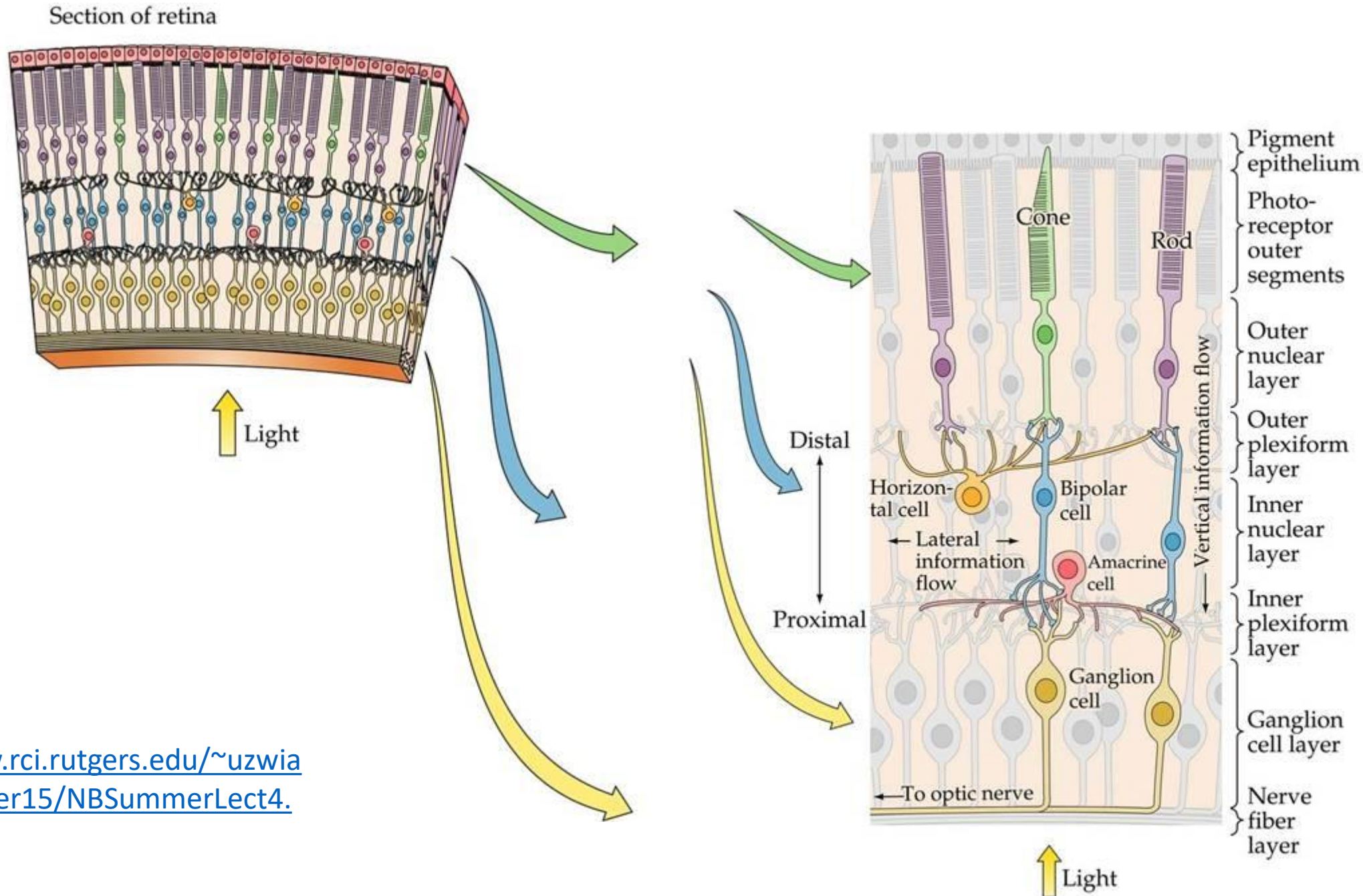
# Mach bands

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

Result of brightness adaption

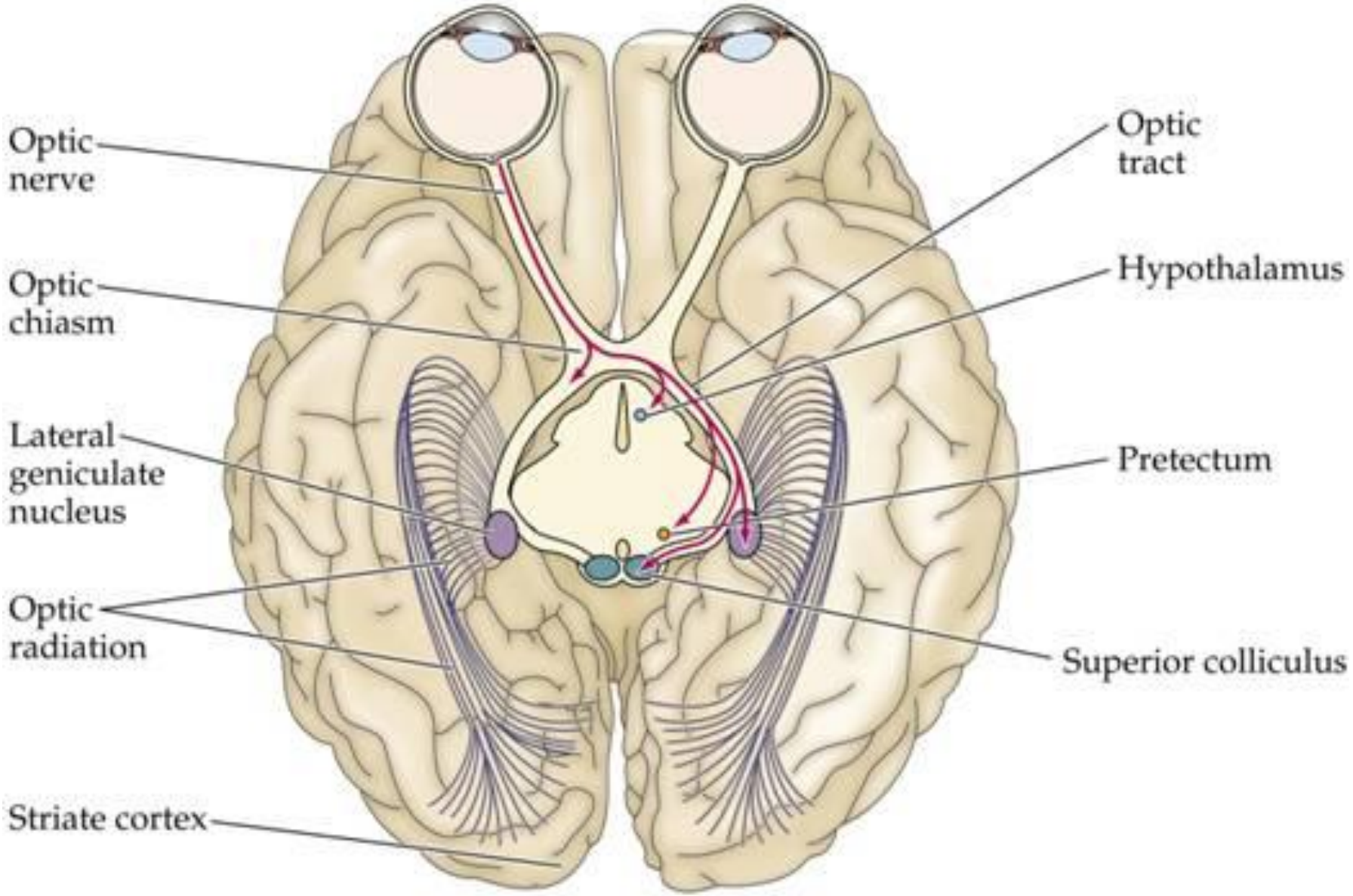







http://www.rci.rutgers.edu/~uzwiak/NBSummer15/NBSummerLect4.html

# Cortices

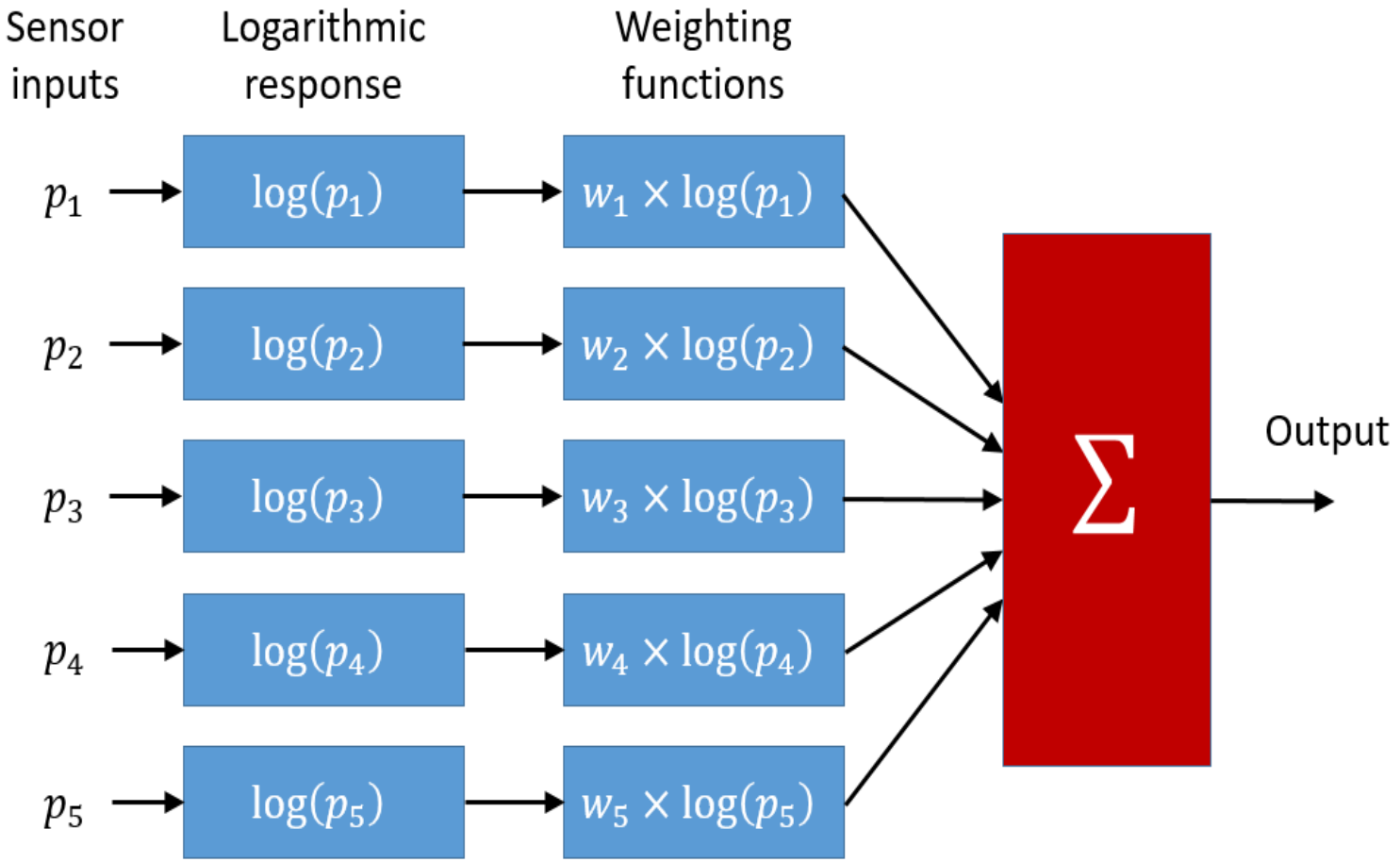



http://www.rci.rutgers.edu/~uzwiak/NBSummer15/NBSummerLect4.html

# Neural processing

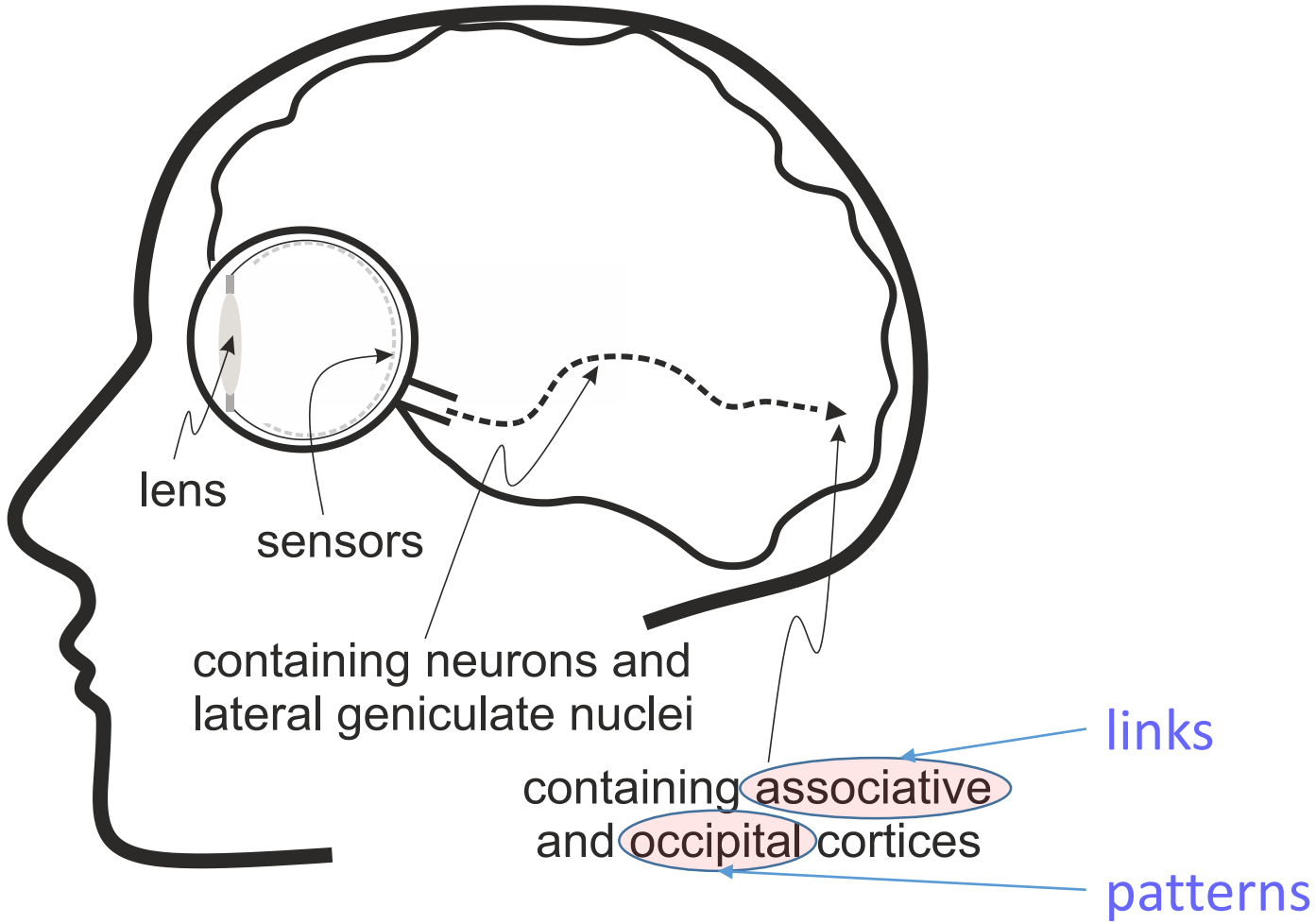
Sensor information must be combined

Note Weber's law





# Where are we?

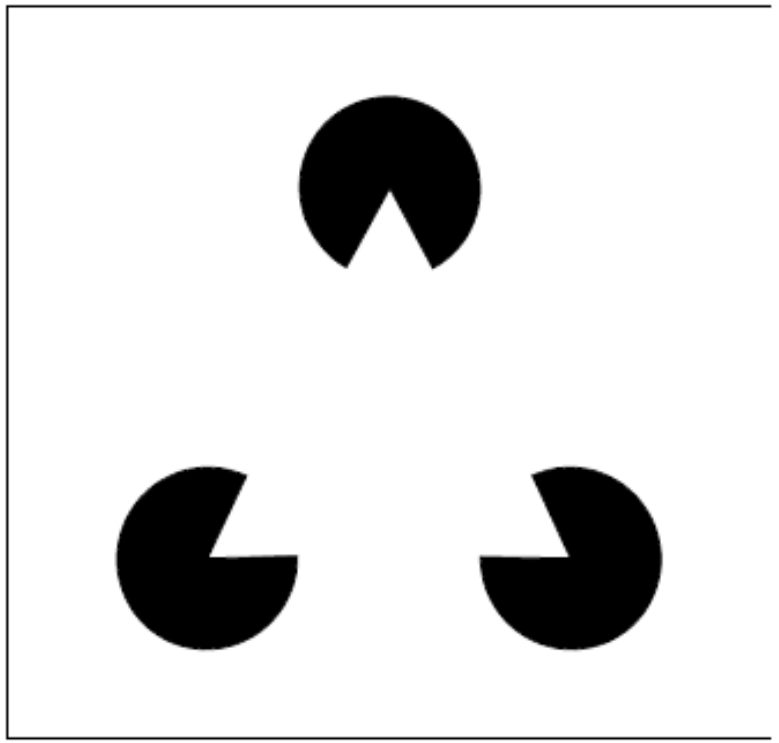

lens
sensors
containing neurons and
lateral geniculate nuclei
containing associative
and occipital cortices
links
patterns


FEATURE EXTRACTION
AND IMAGE PROCESSING
FOR COMPUTER VISION

# How human vision uses edges

The human eye needs training and can be deceived

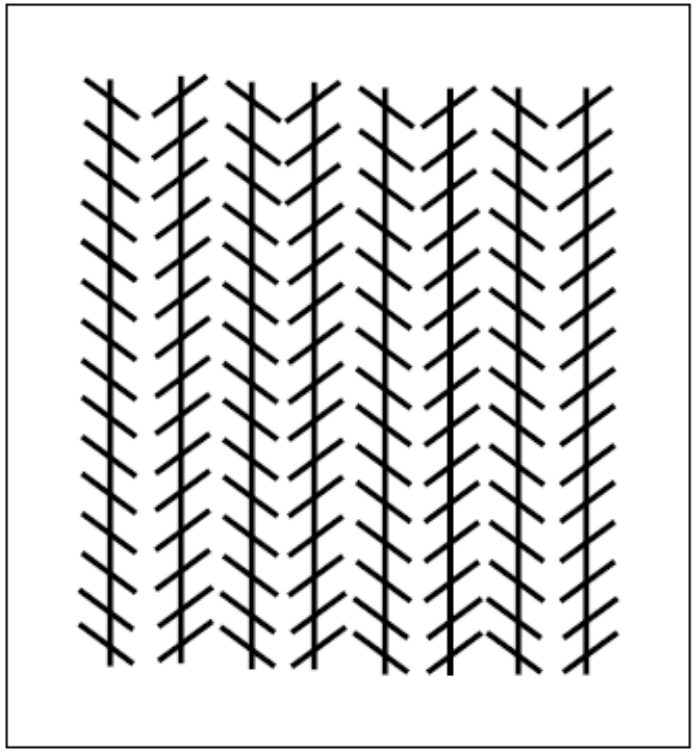

(a) word?



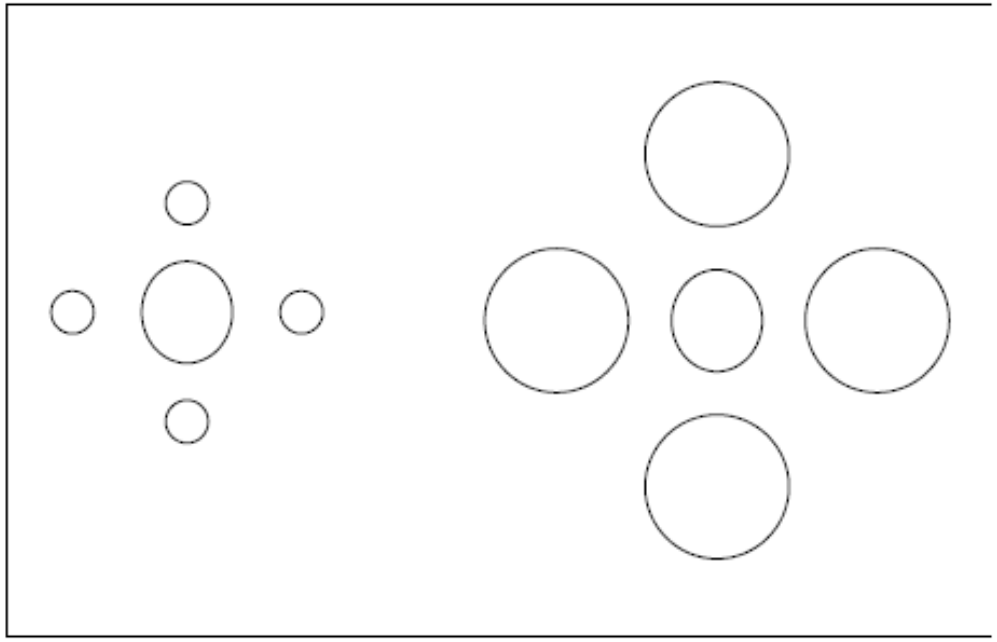
(b) Pacmen?


# Static illusions

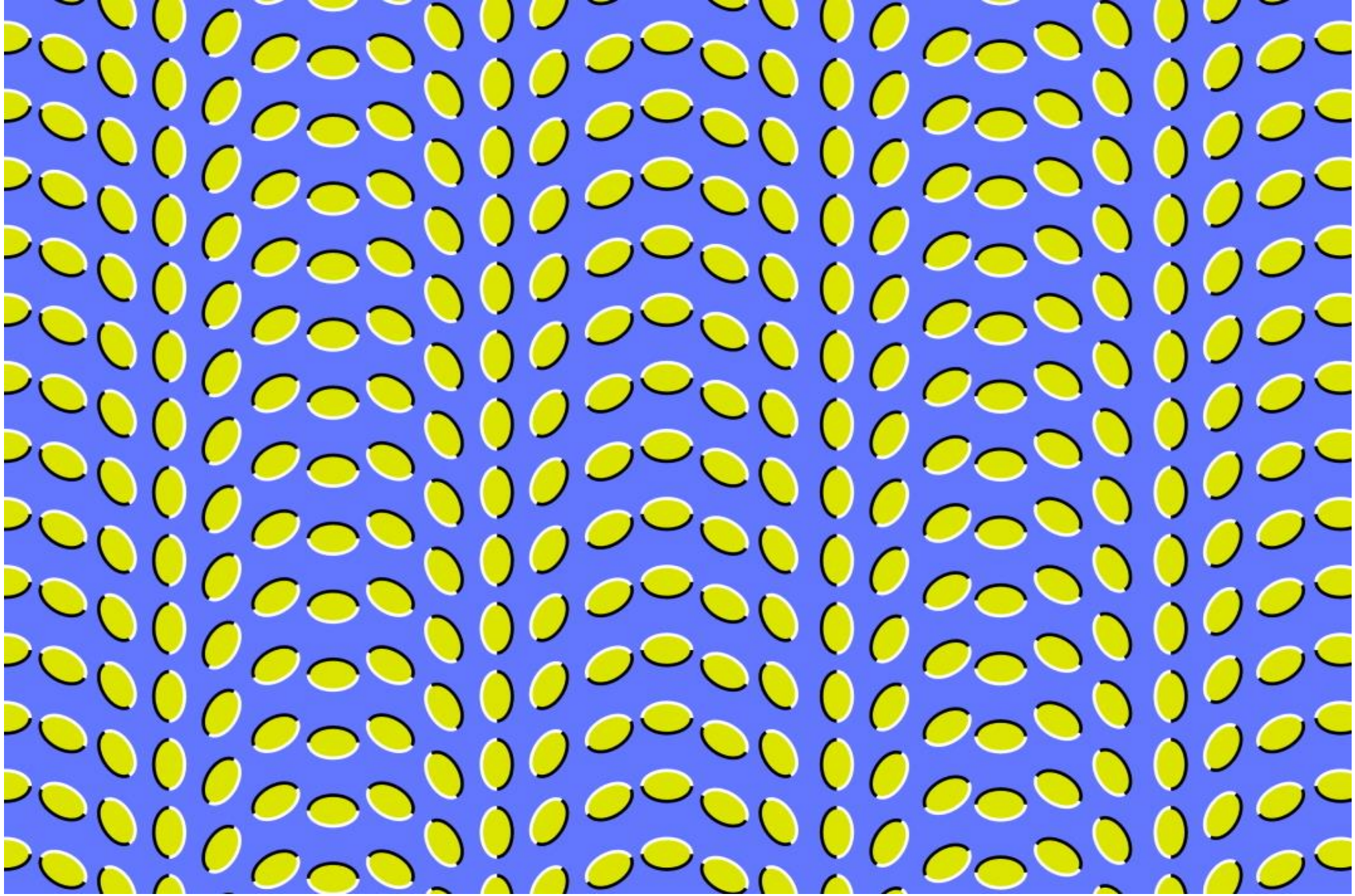
Measurement needs comparison

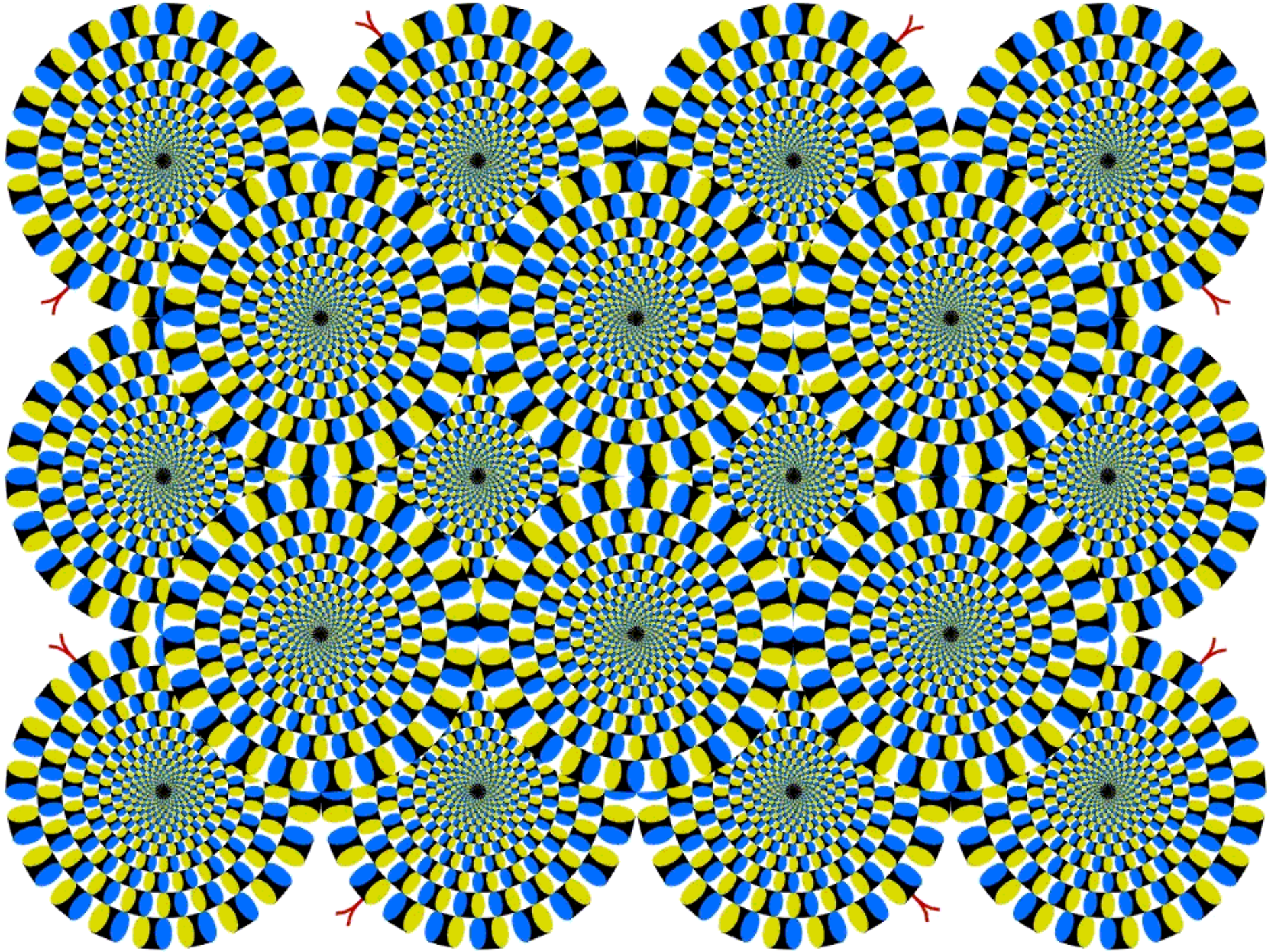


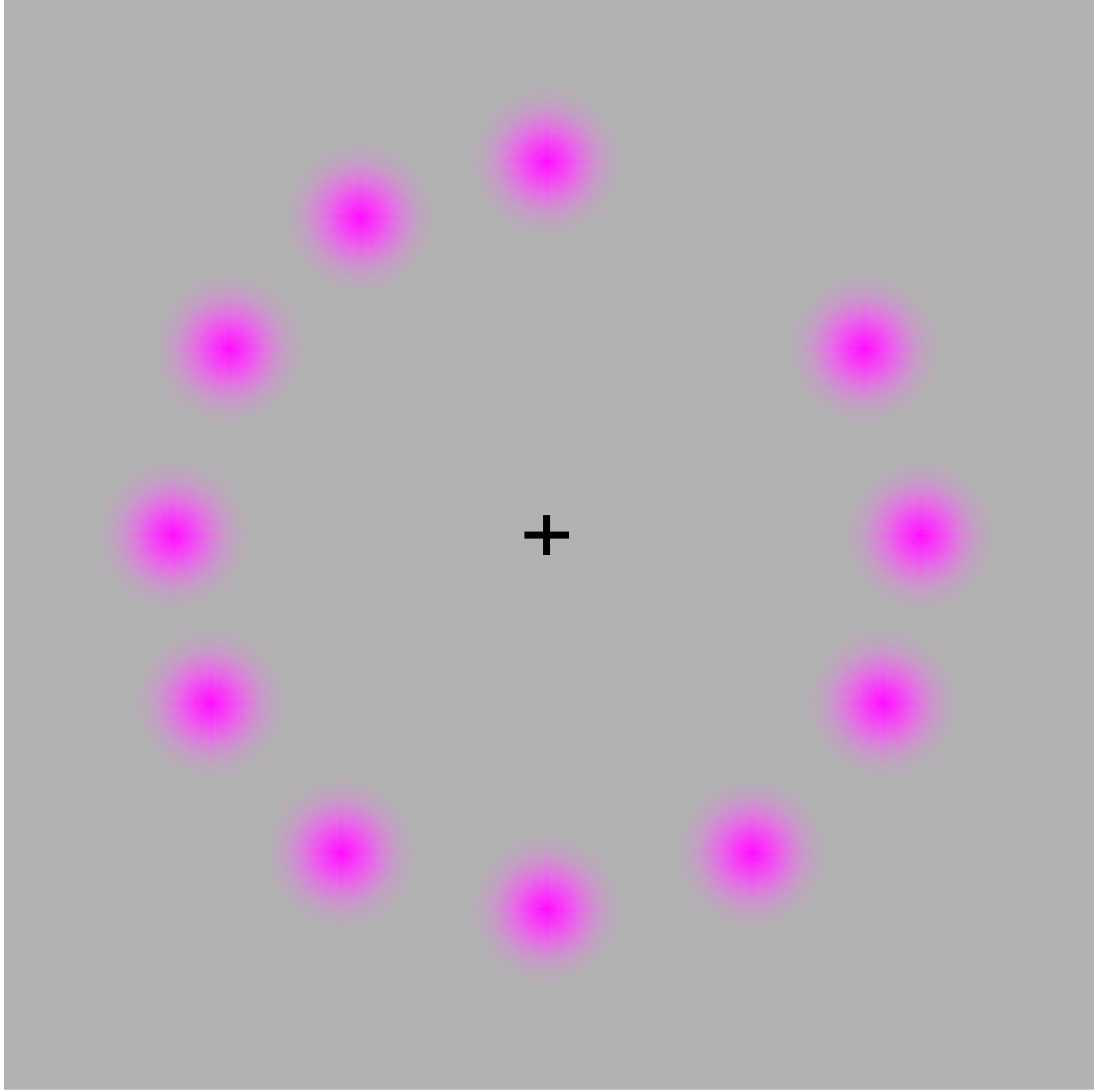
(a) Zollner



(b) Ebbinghaus

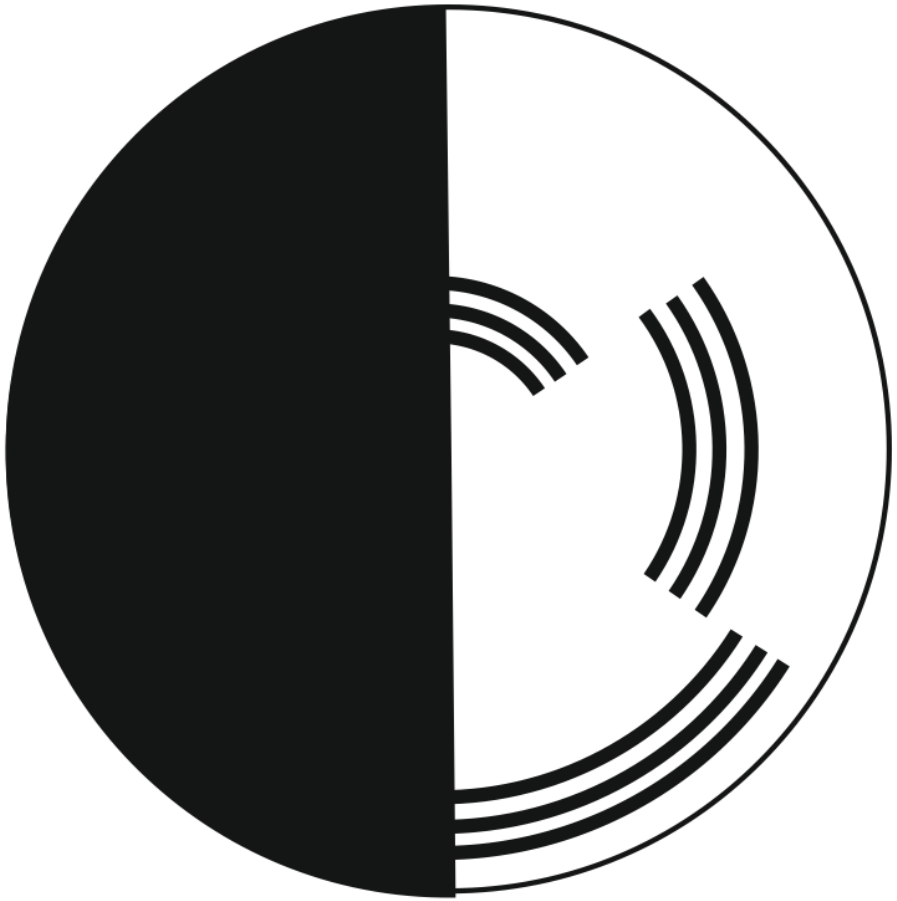



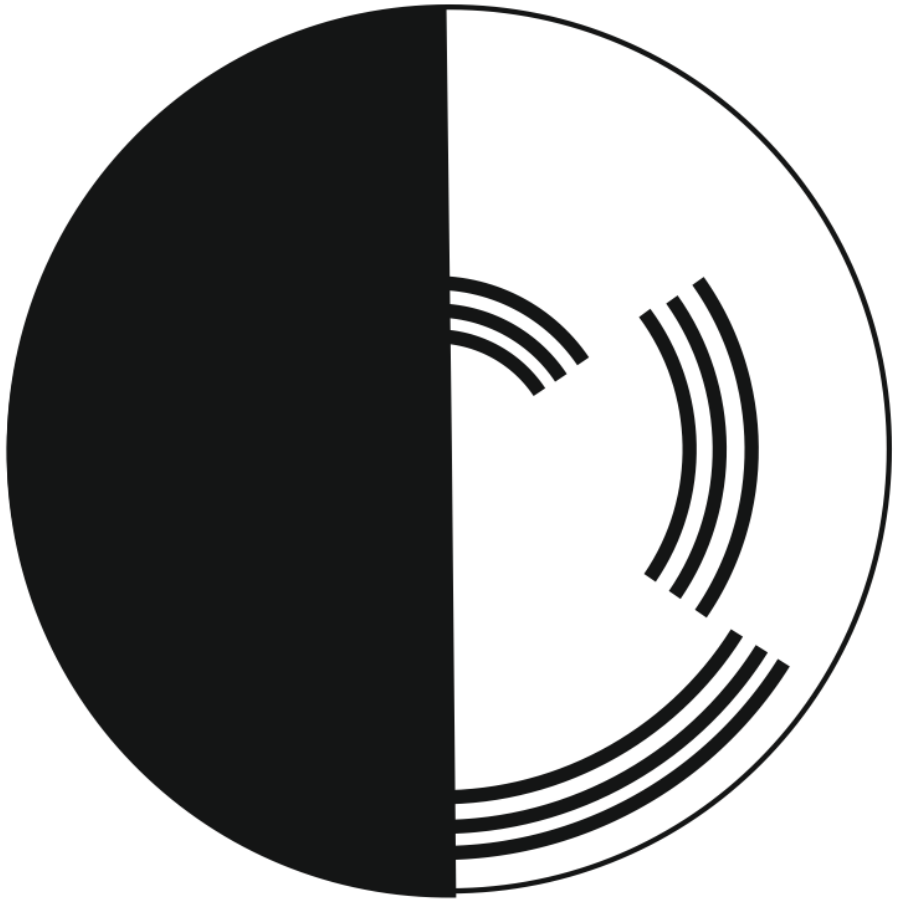




# Benham's disk

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