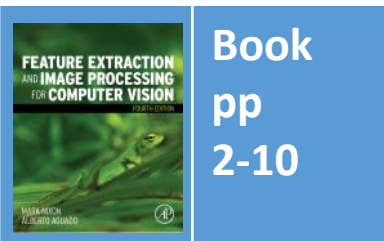


Lecture 1 Eye and Human Vision

COMP3204 Computer Vision

Is human vision a good model for computer vision?



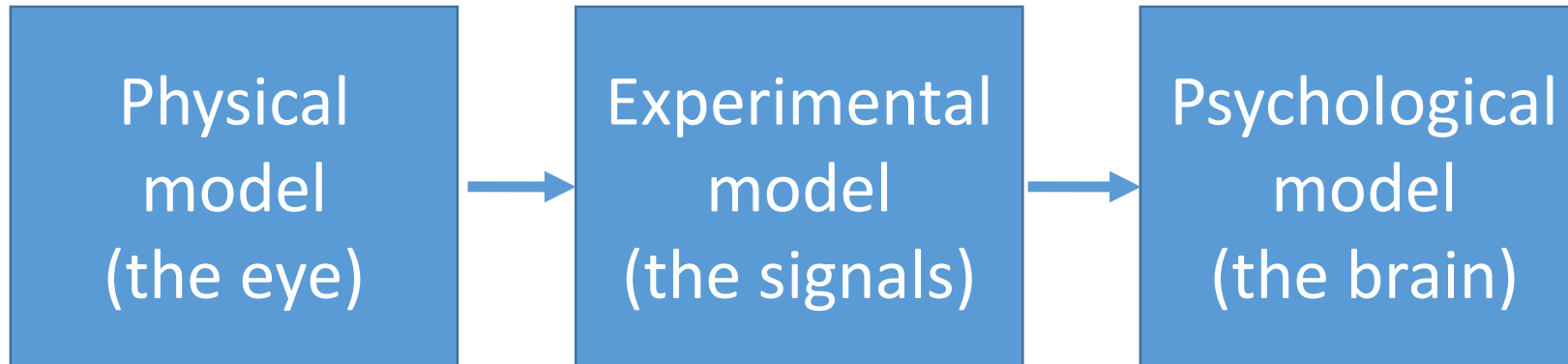
Department of
Electronics and
Computer Science

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

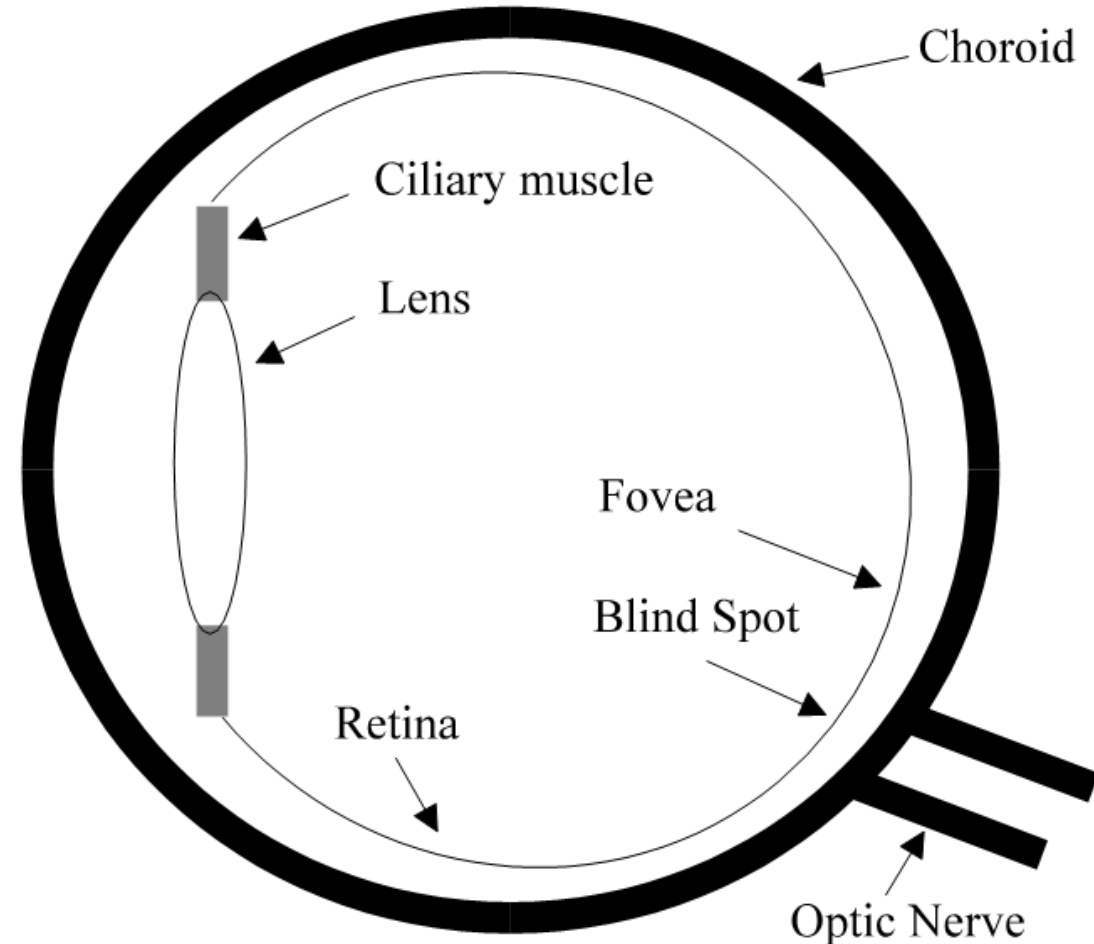
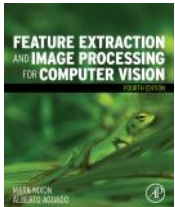
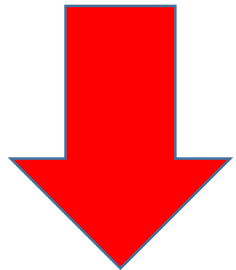
Human eye

Evolved for survival

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

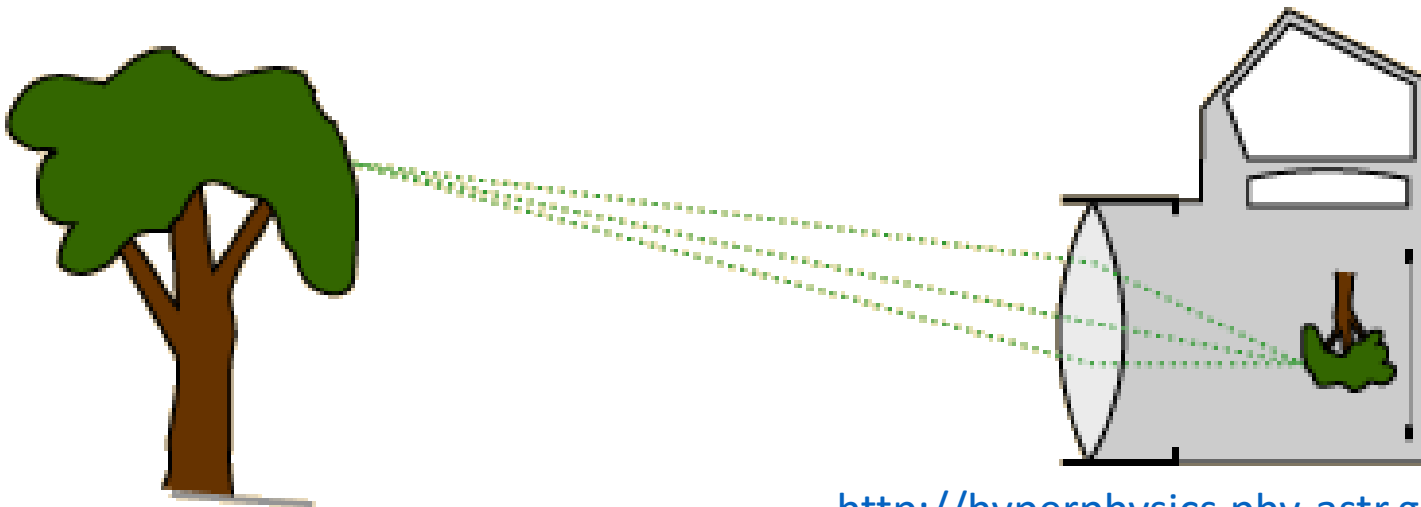
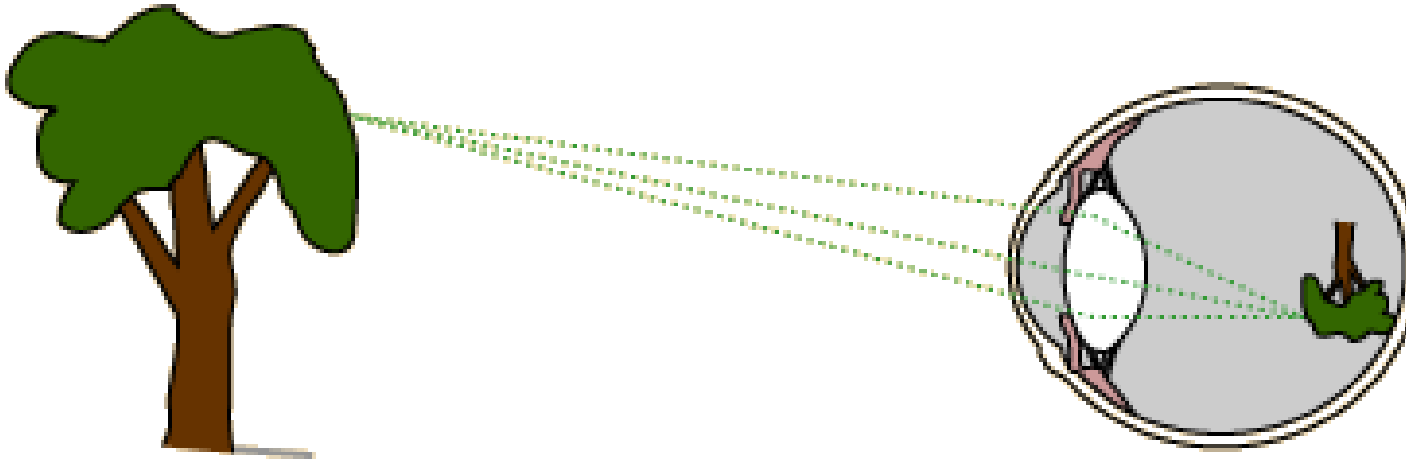
The lens is **shaped**, rather than **moved**

Image is transmitted via optic nerve



Optics

Your brain must **invert** the image



Sensors

There must be a lot!

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

Cones – colour; rods – greylevel

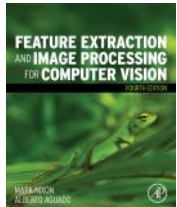
photopic

scotopic

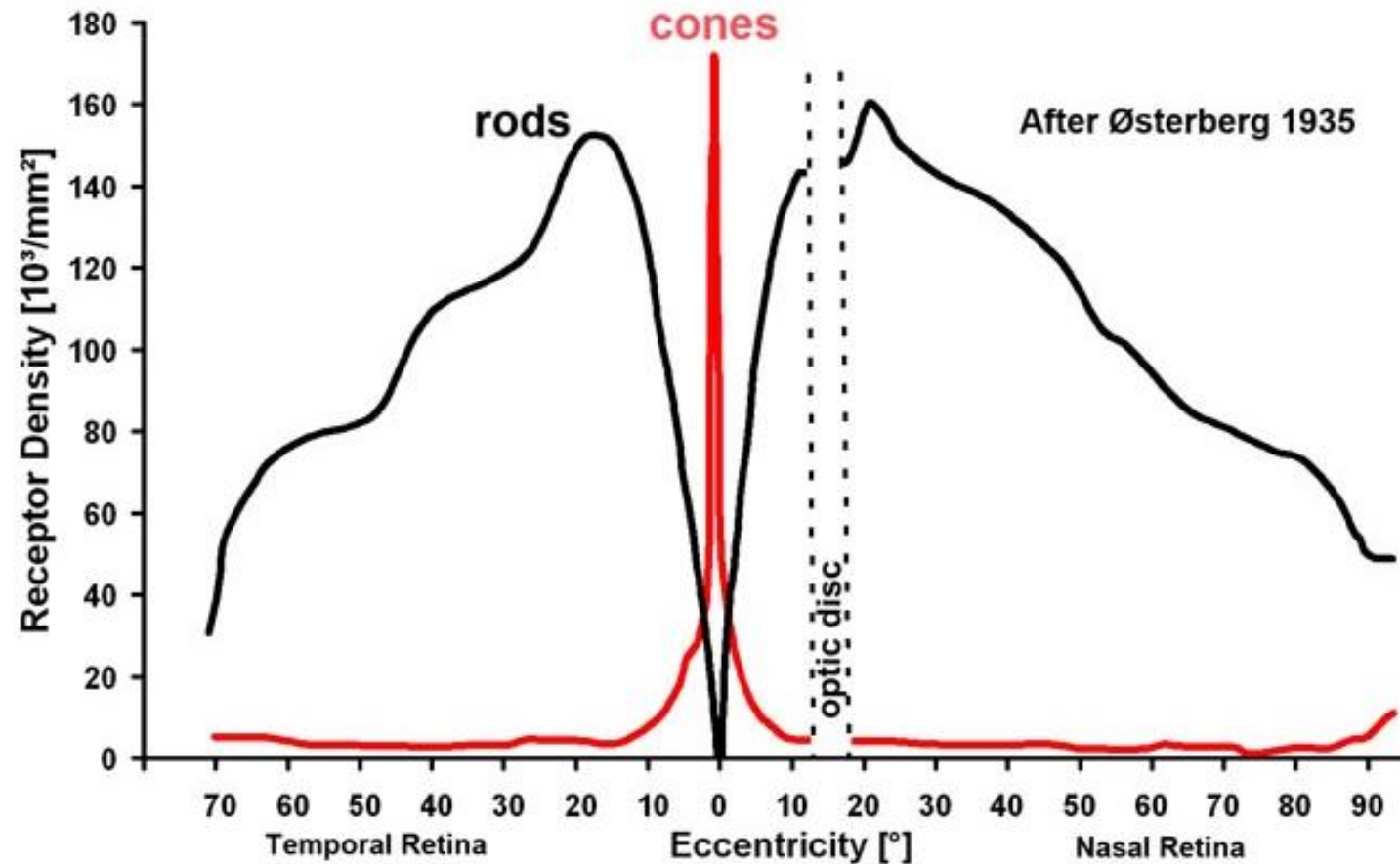
Cones come in three types

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

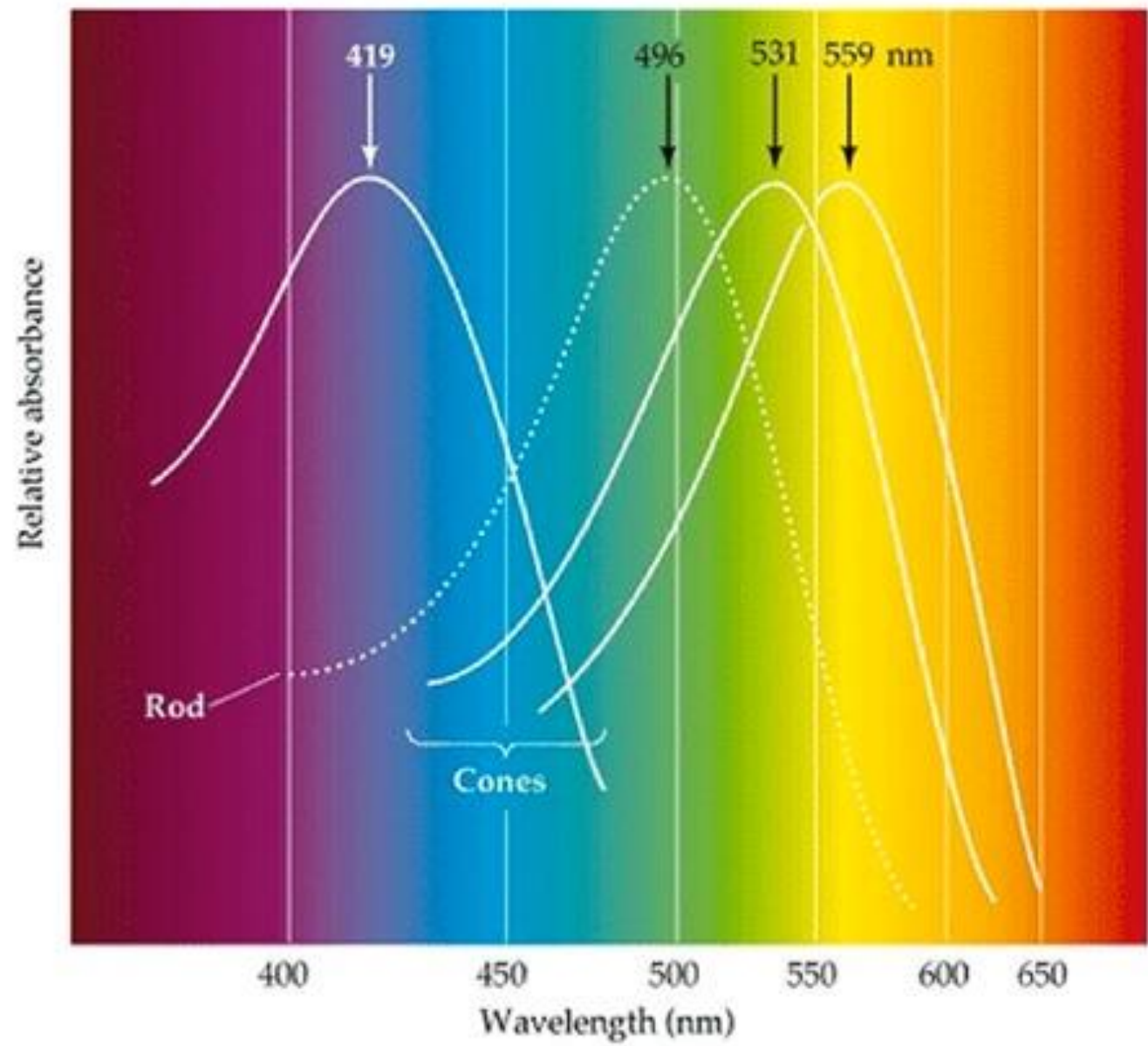
Insufficient bandwidth of **optic nerve**
implies **coding**



Rod and cone densities



No sensors on blind spot
Most **cones** on fovea
Rods elsewhere

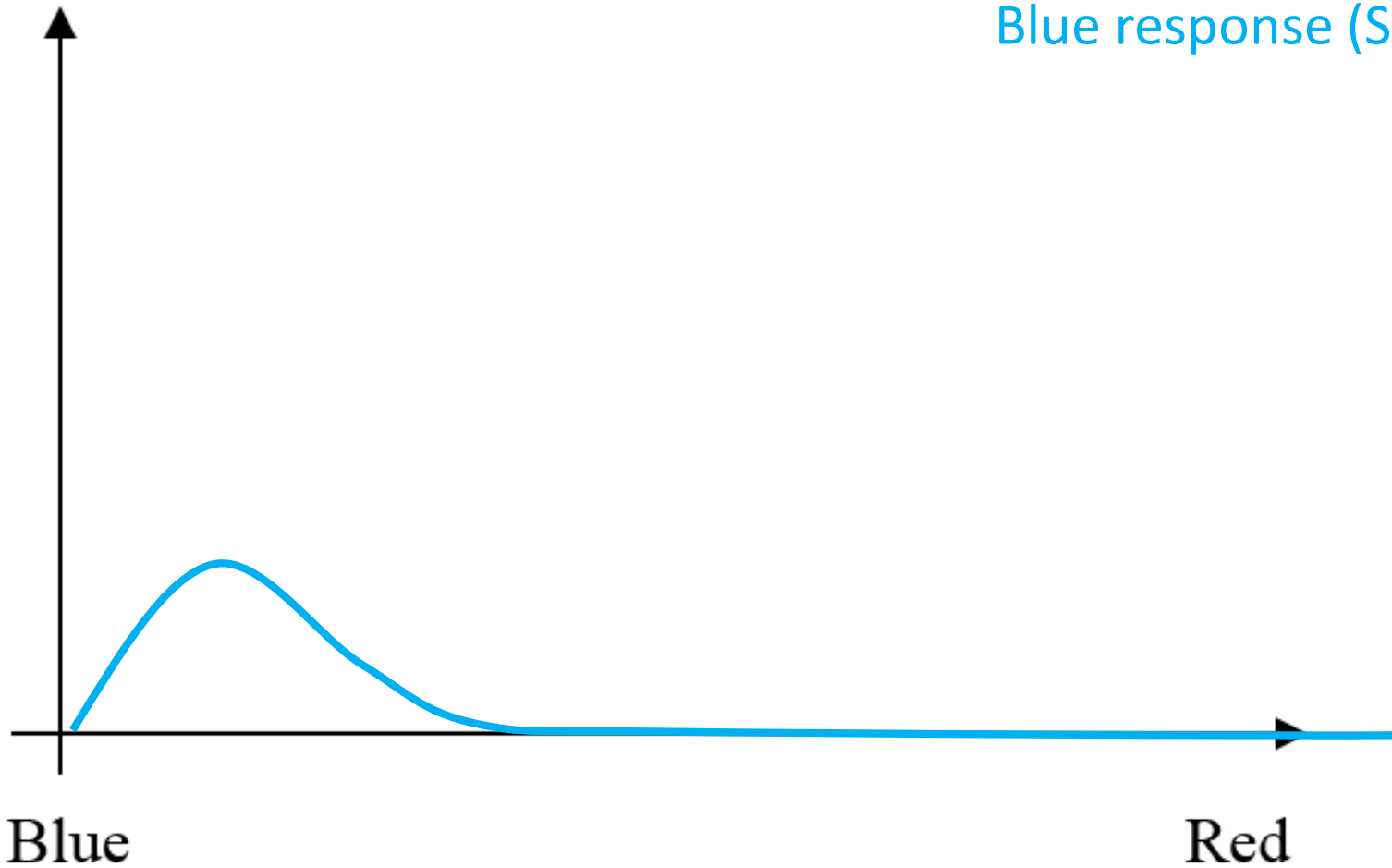


<http://webvision.med.utah.edu/wp-content/uploads/2011/03/Spectrum.jpeg>

Spectral responses

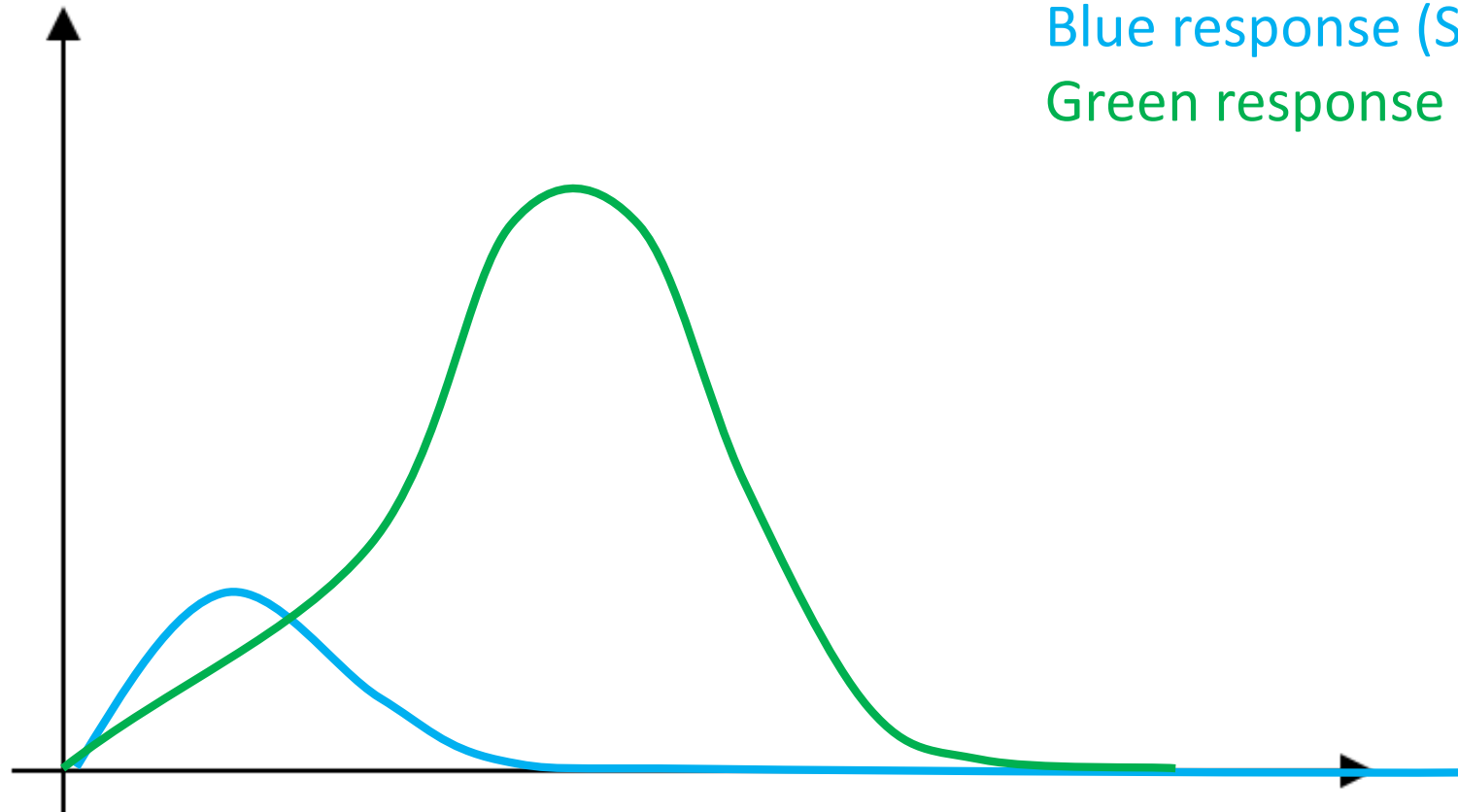
Spectral response

Blue response (S sensors) is poor



Spectral responses

Spectral response



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

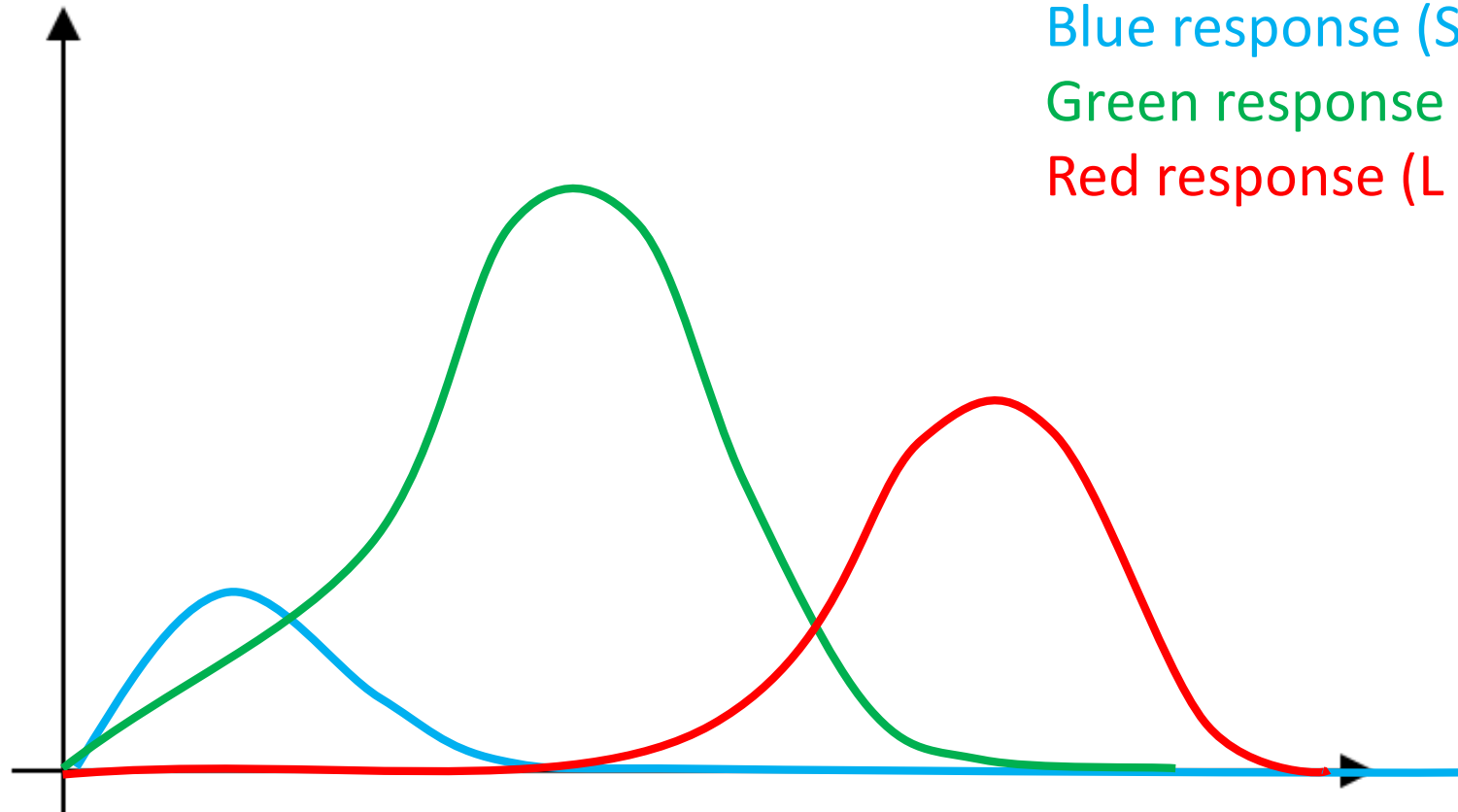
Blue

Red



Spectral responses

Spectral response



Blue response (S sensors) is poor
Green response (M sensors) dominates
Red response (L sensors) close to heat

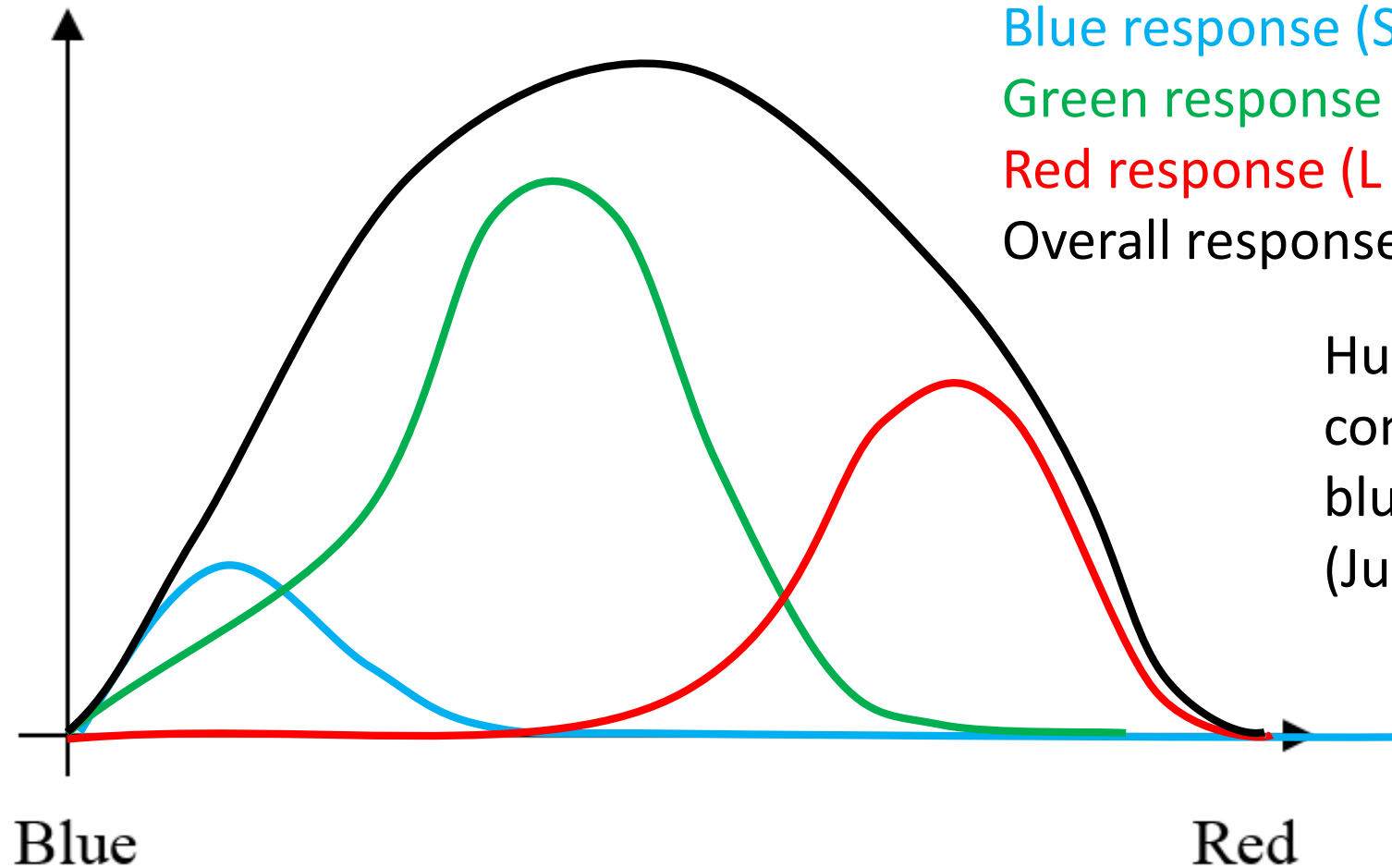
Blue

Red



Spectral responses

Spectral response



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)



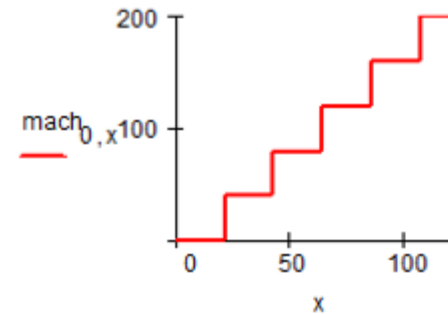
Mach bands

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

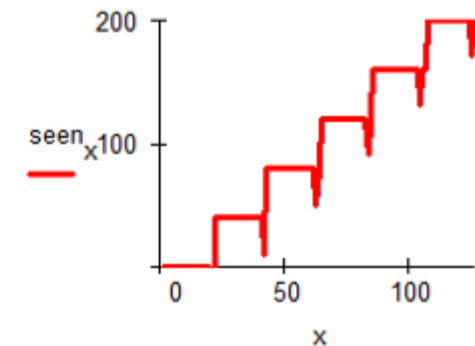
Result of **brightness adaption**



(a) image showing the Mach band effect



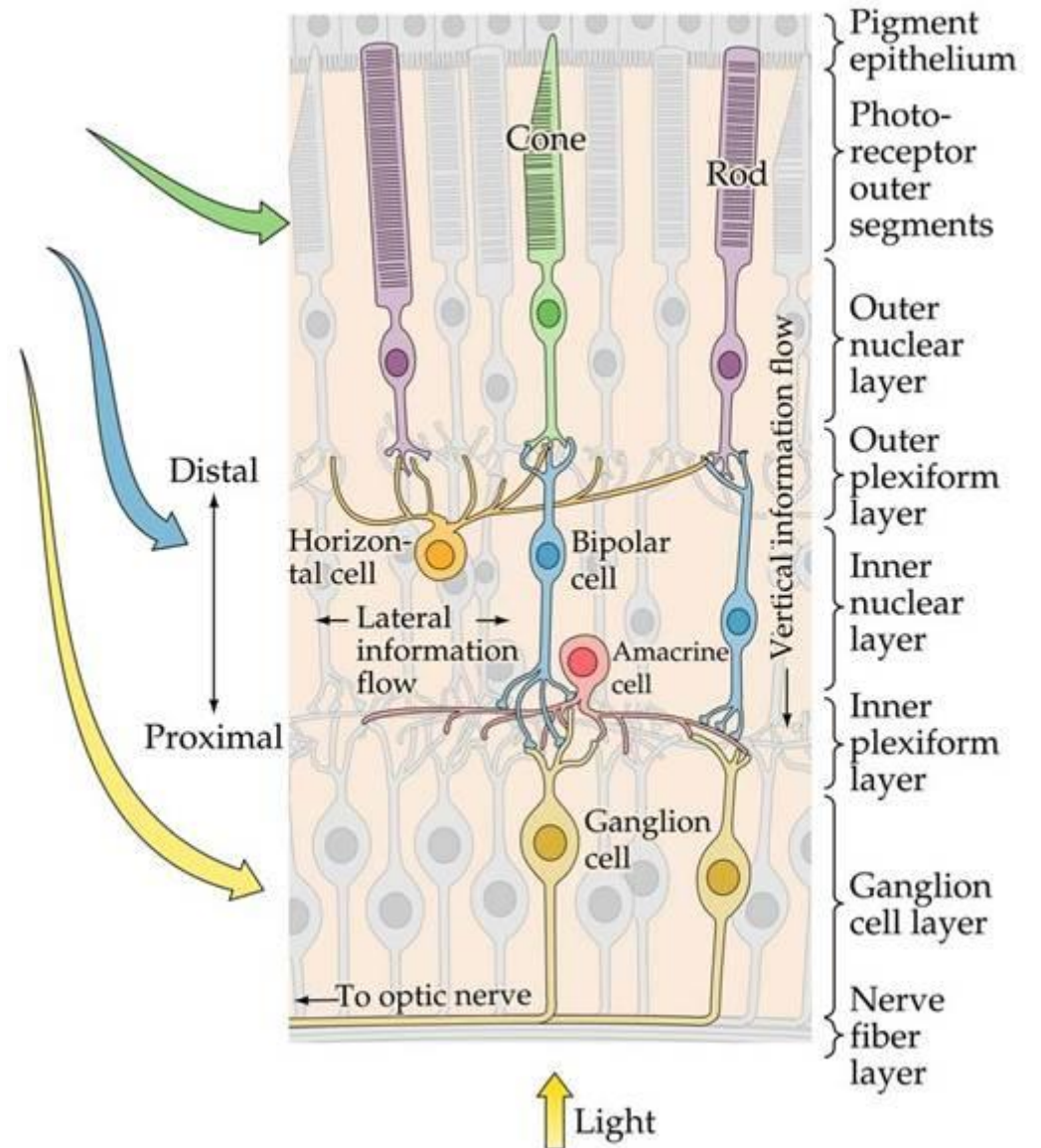
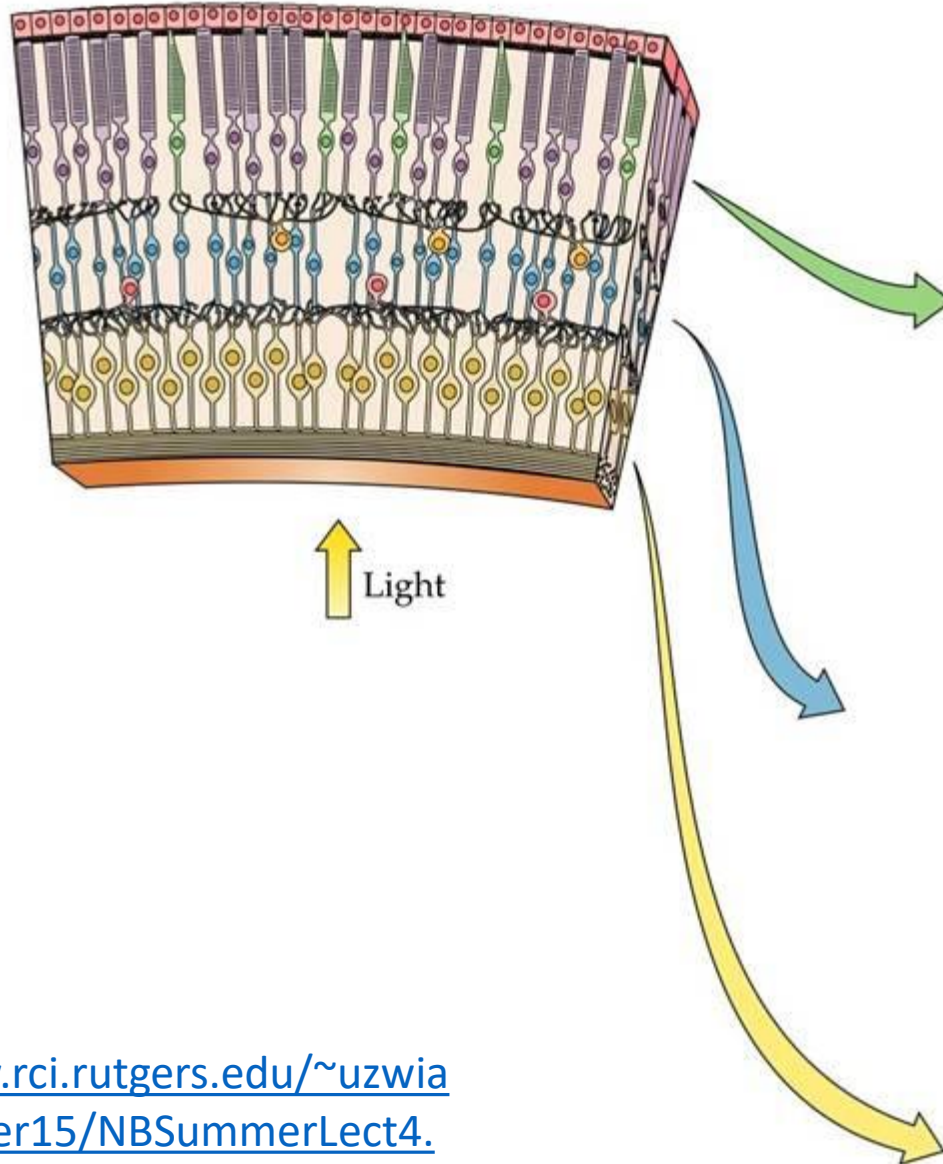
(b) cross-section
through (a)



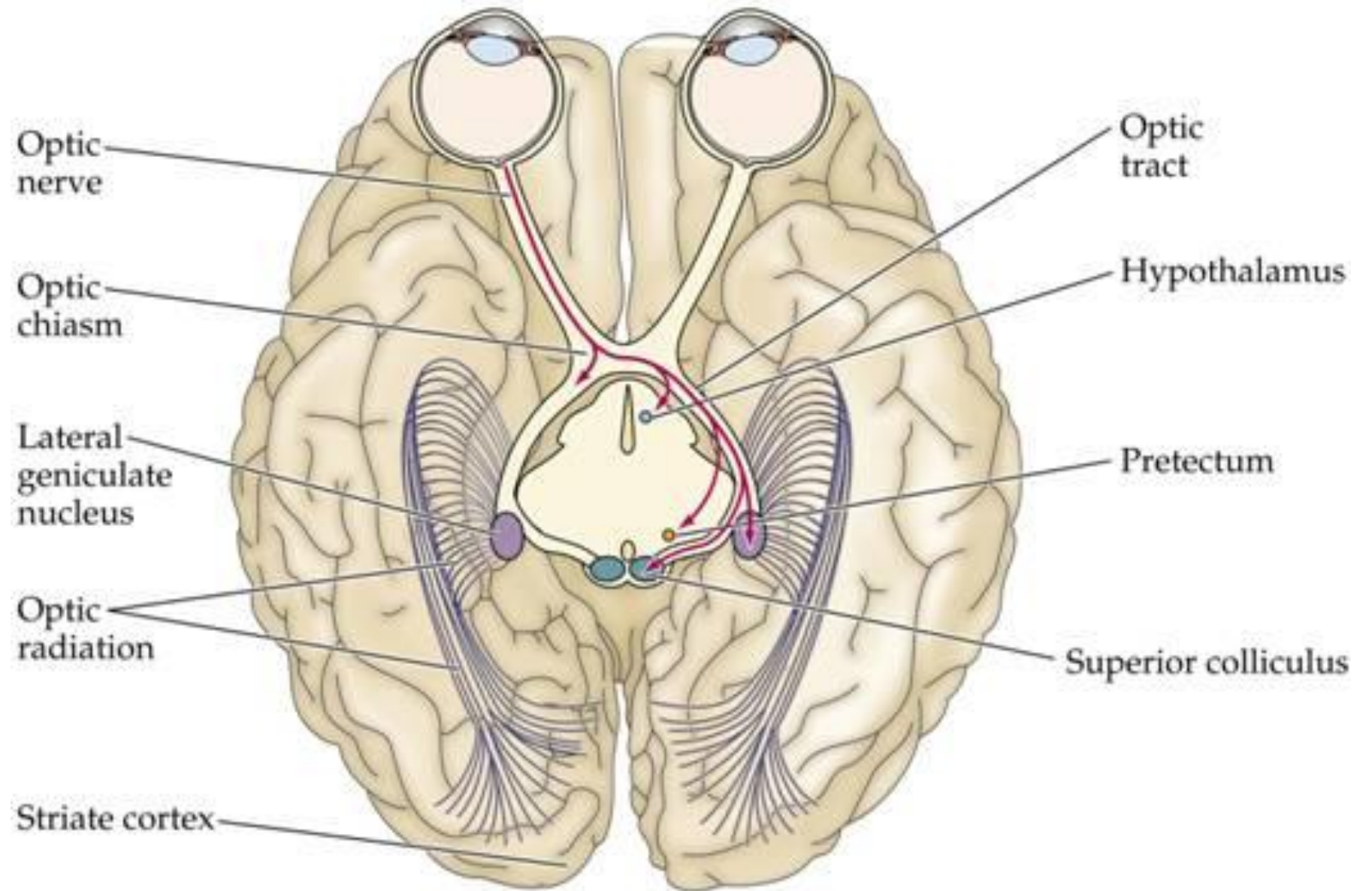
(c) perceived cross-
section through (a)



Section of retina



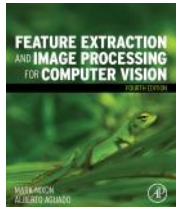
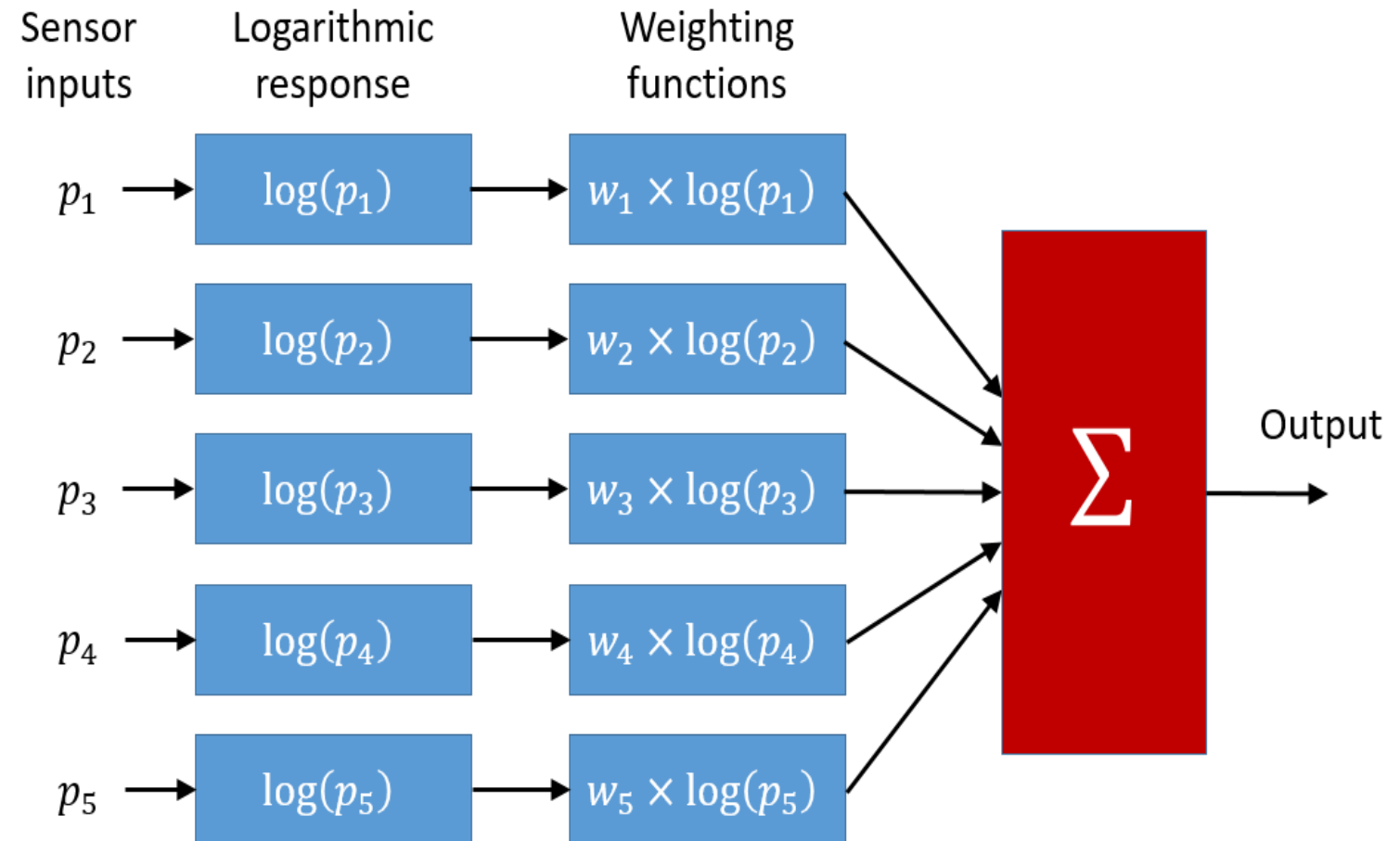
Cortices



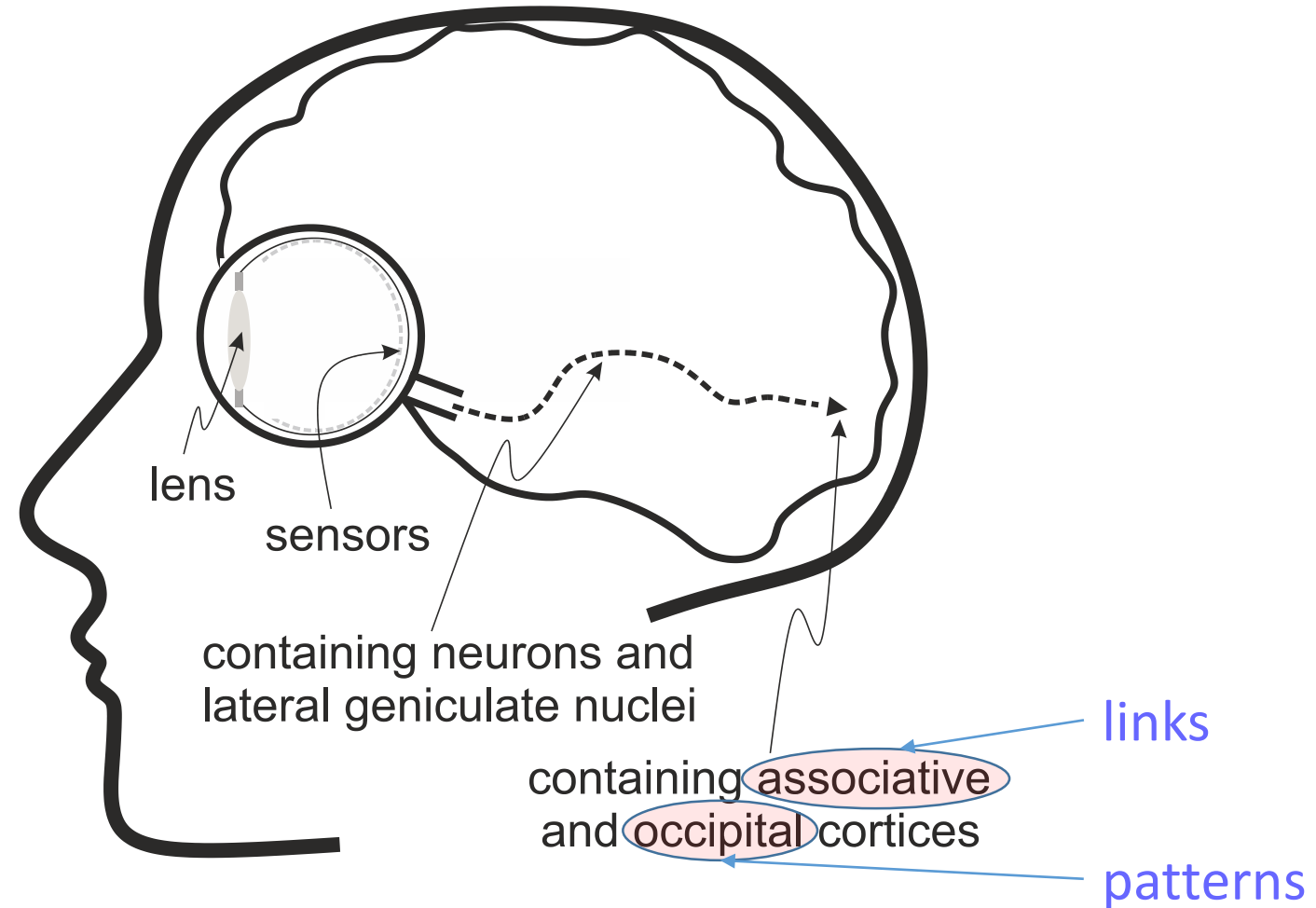
Neural processing

Sensor information must be **combined**

Note **Weber's law**



Where are we?

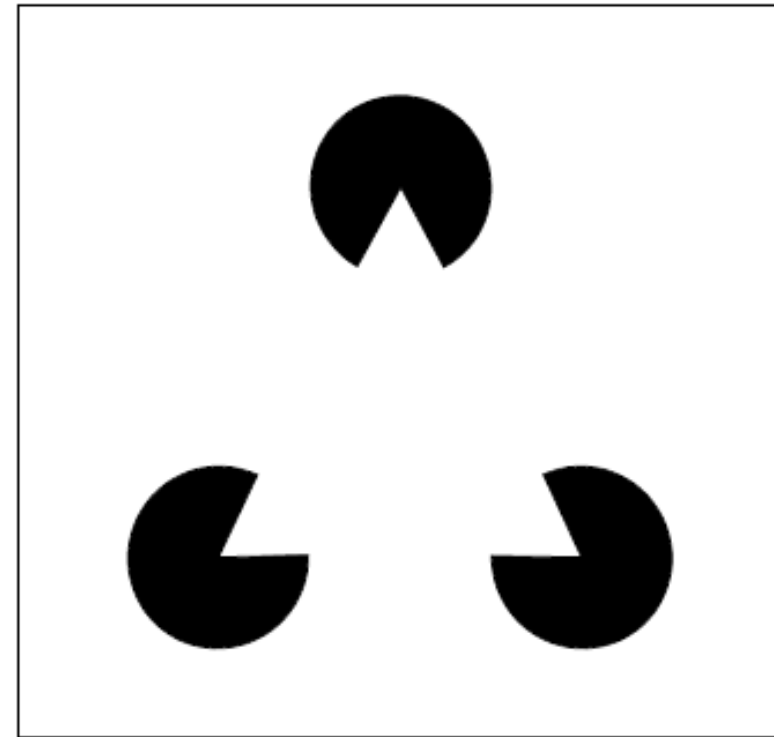


How human vision uses edges

The human eye needs **training** and can be **deceived**



(a) word?

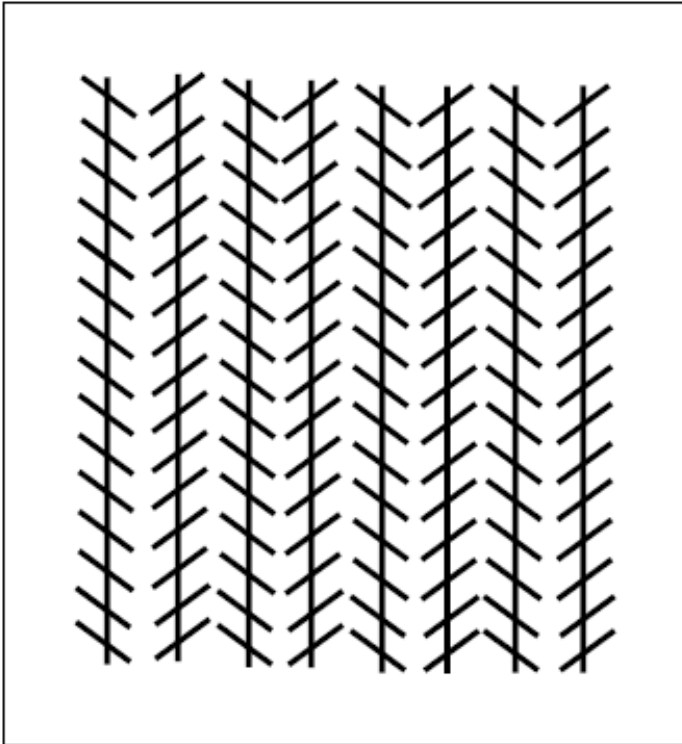


(b) Pacmen?

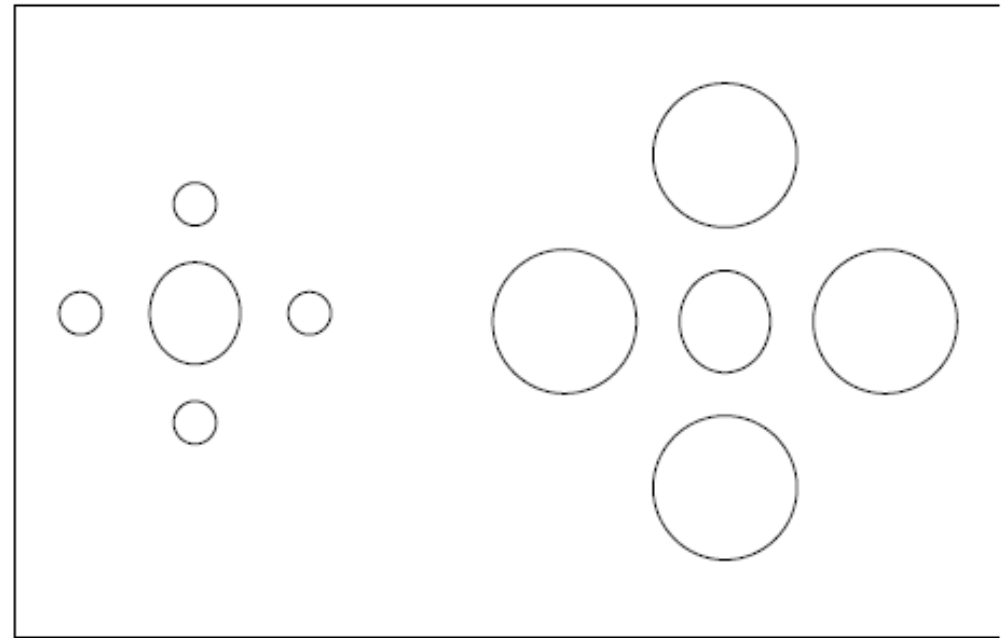


Static illusions

Measurement needs comparison

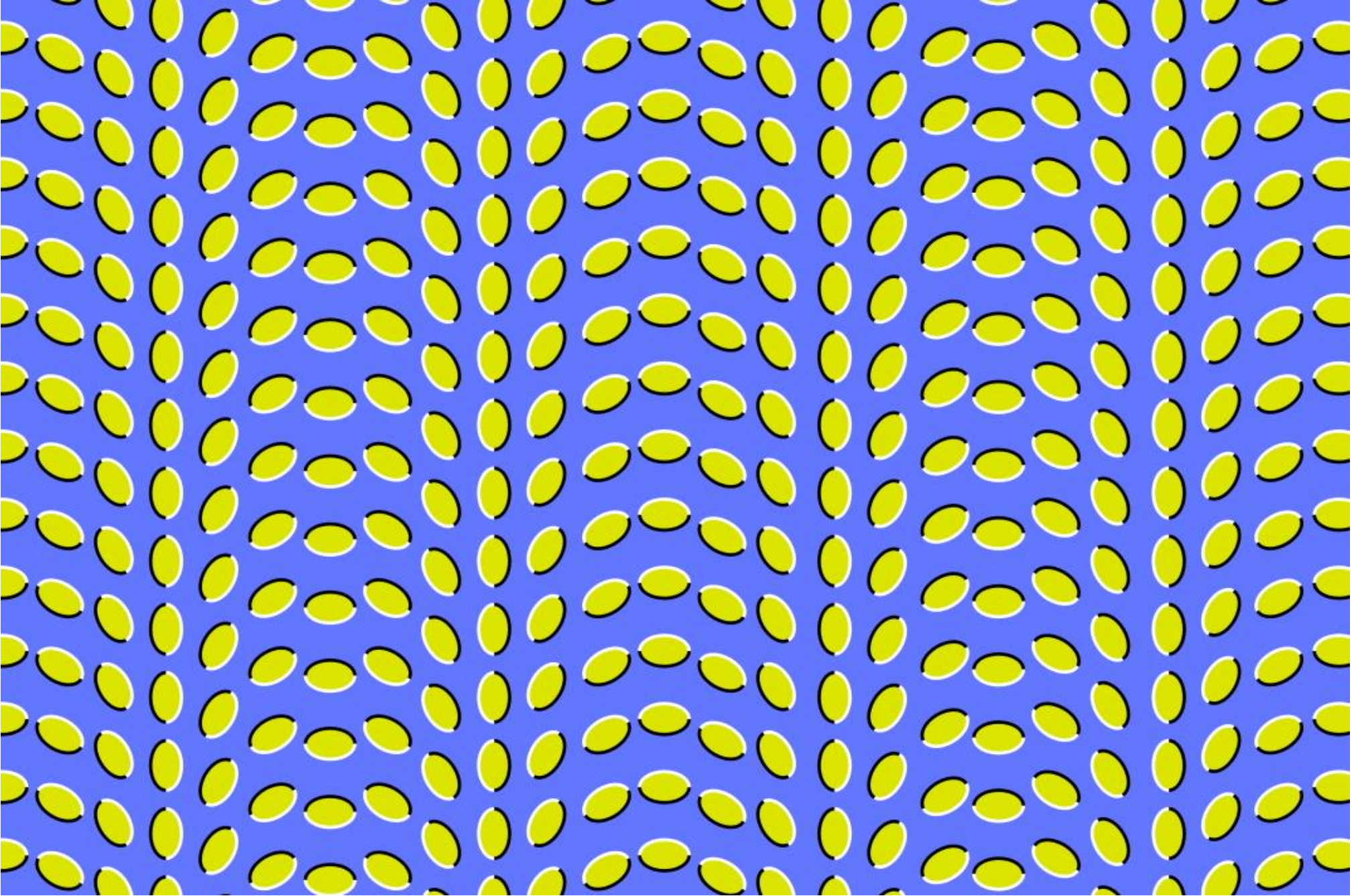


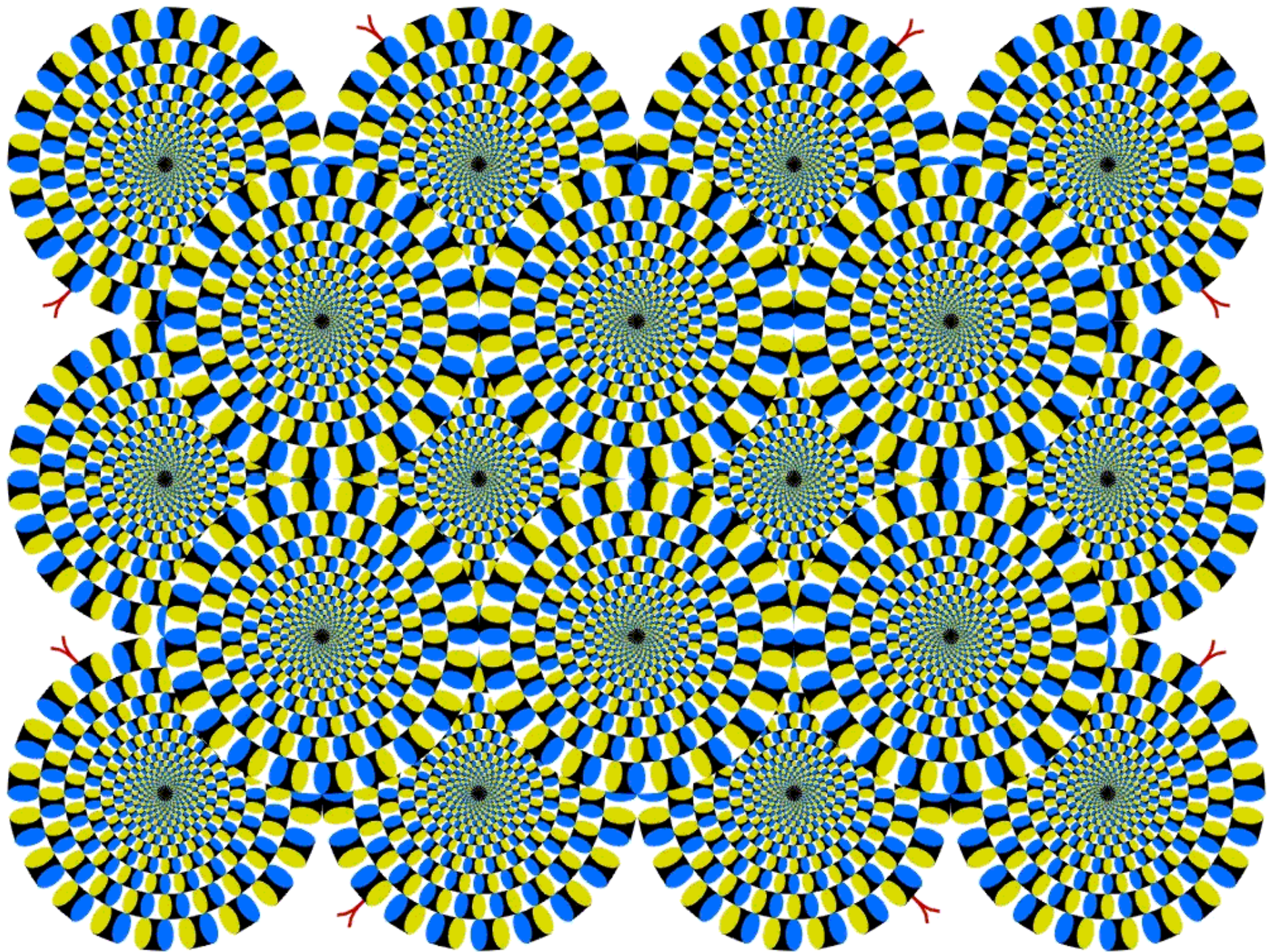
(a) Zollner



(b) Ebbinghaus

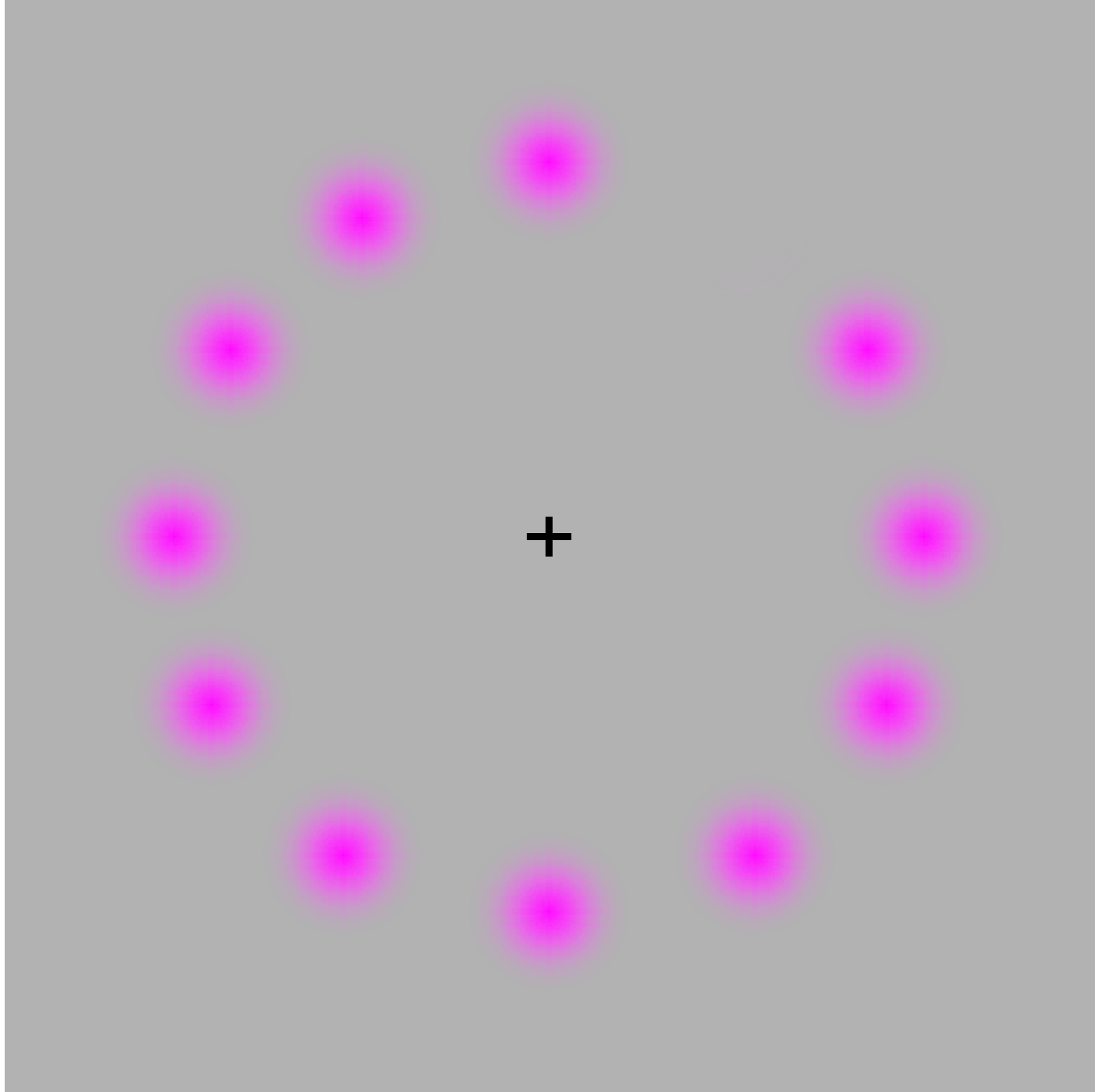






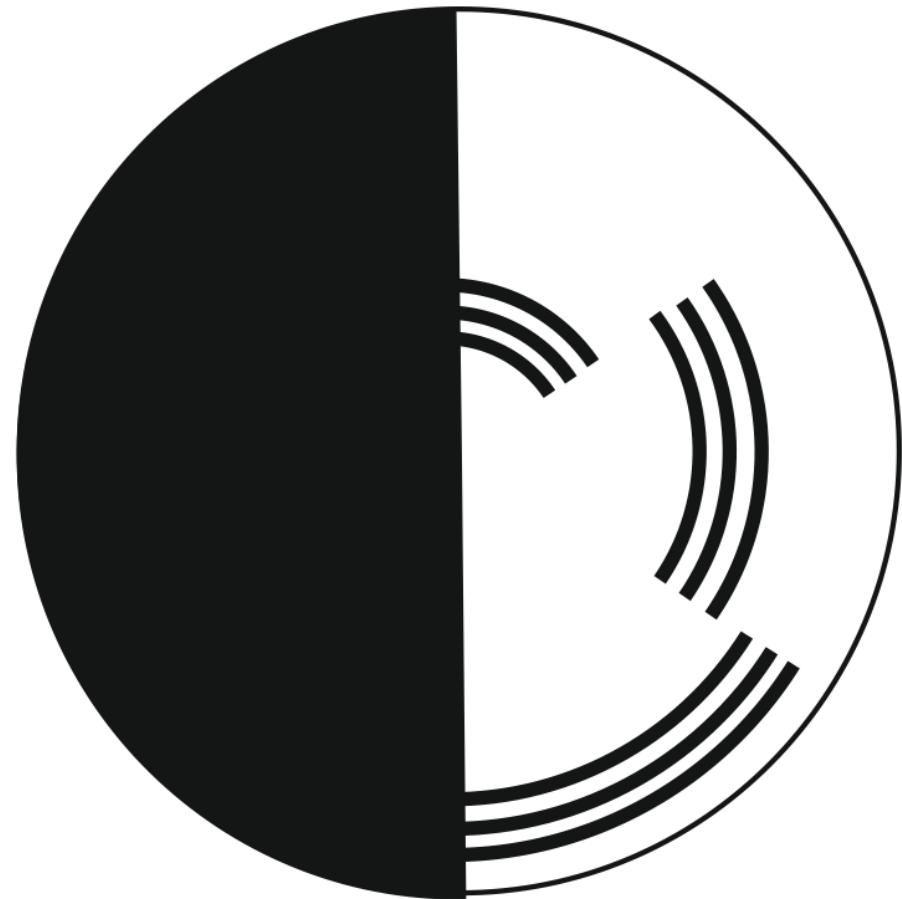
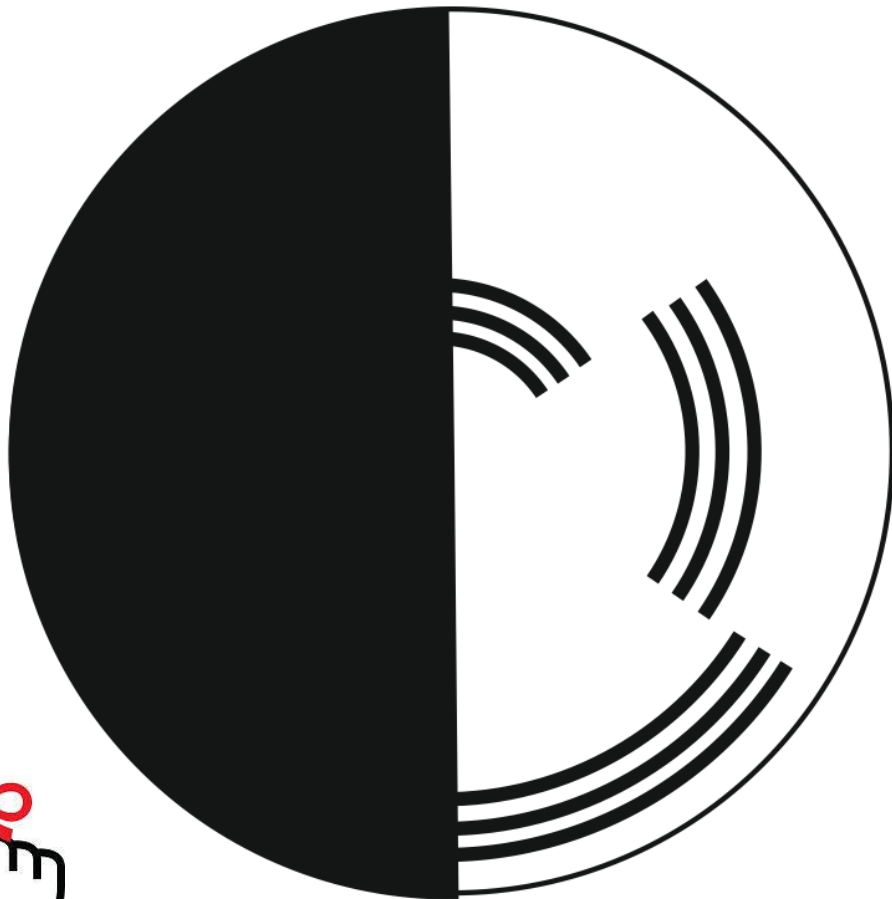
Animations

[http://comp3204.ecs.soton.ac.uk/mark/Lecture 1 animations 2020.pptx](http://comp3204.ecs.soton.ac.uk/mark/Lecture_1_animations_2020.pptx)



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**

Takeaway time –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

