

Lecture 03 – Fundamentals of Data Visualization

Today's Learning Objectives:

- 6. Describe the stages of visual perception.**
- 7. Describe some of the costs and benefits of visualizations.**

Model of Visual Perception



**visual
perception**

**light hits
eyes**



**brain stuff
happens**



**meme
acquired**



Model of Visual Perception

Stage 1: Parallel

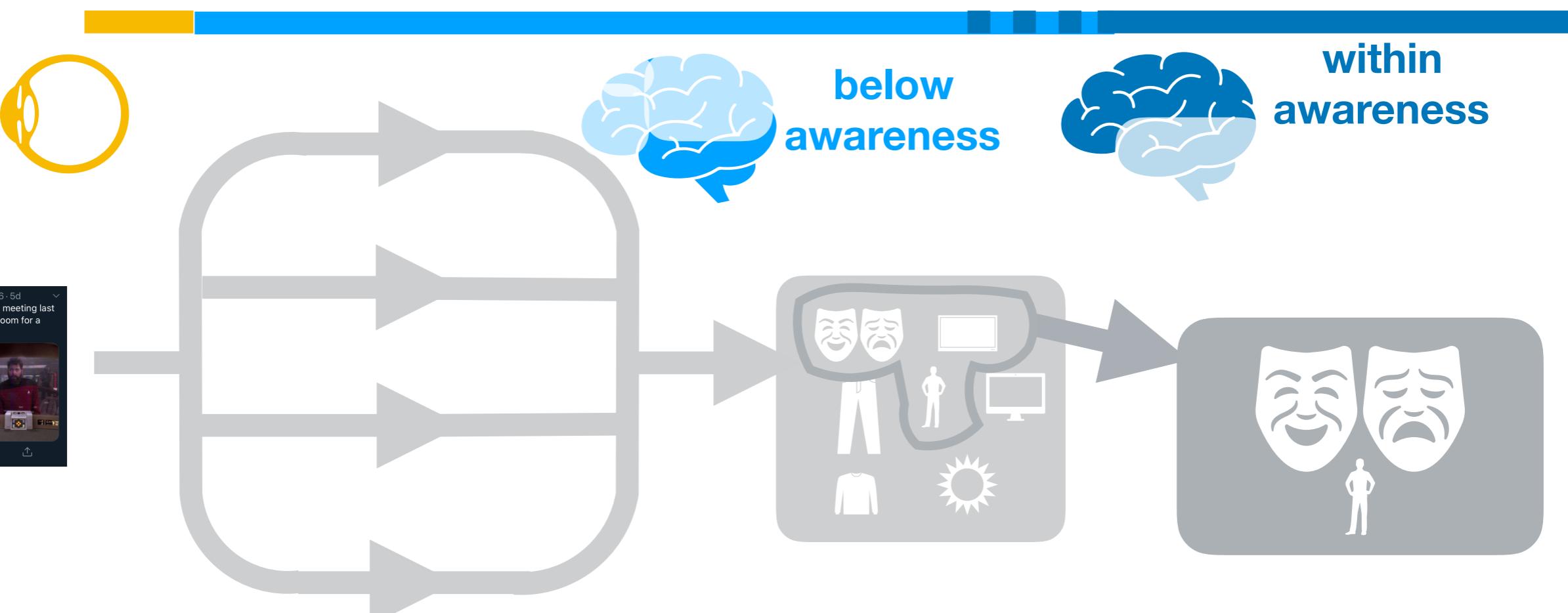
- First pass processing
- Parallel
- Transitory
- Rapid
- Extraction of features
- Bottom-up, data-driven
- Understand visual salience

Stage 2: Patterns

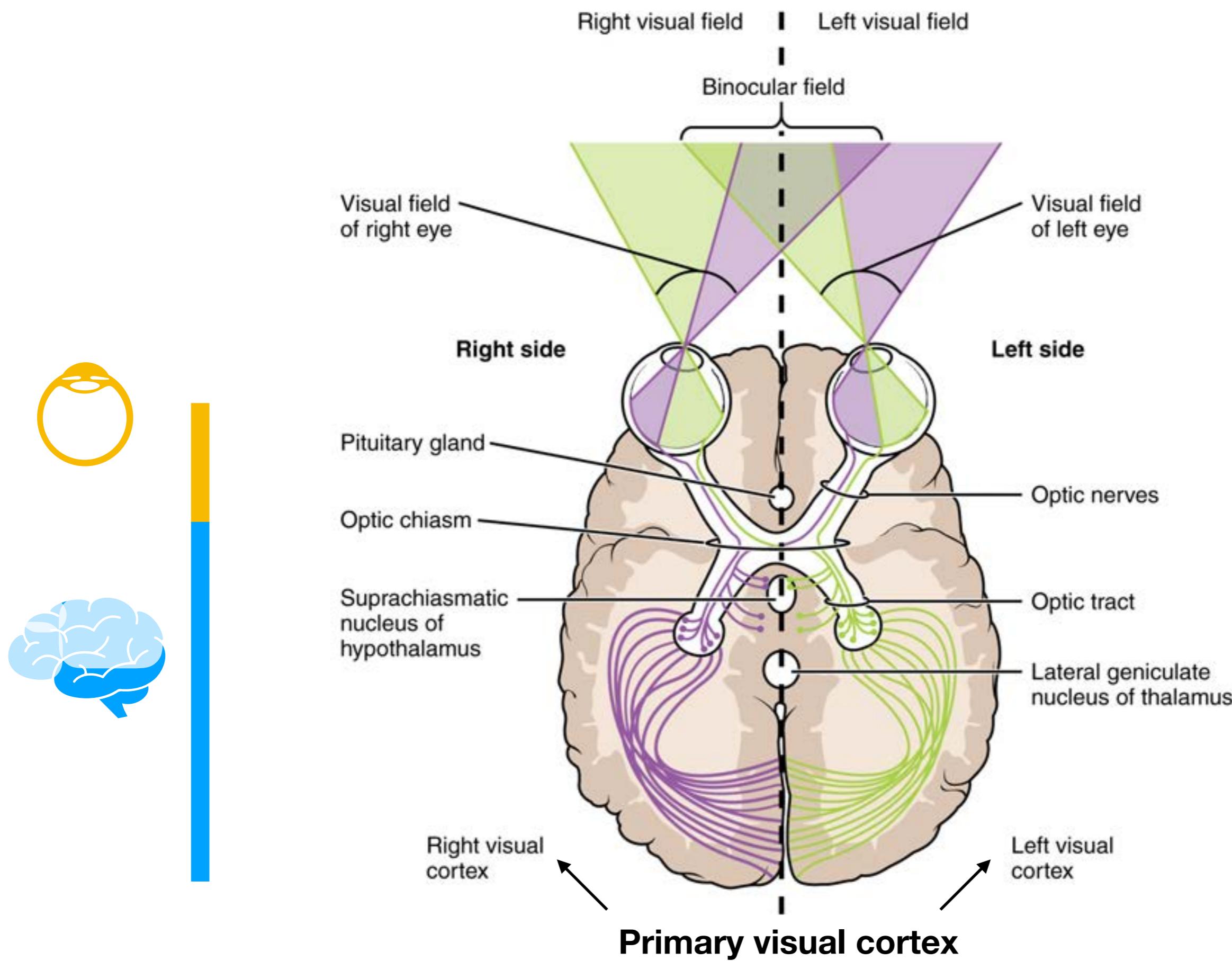
- Visual field is divided up, used for pattern finding
- Top-down attention
- Flexible
- Slower
- Serial
- Where/what split

Stage 3: Visual Working Memory

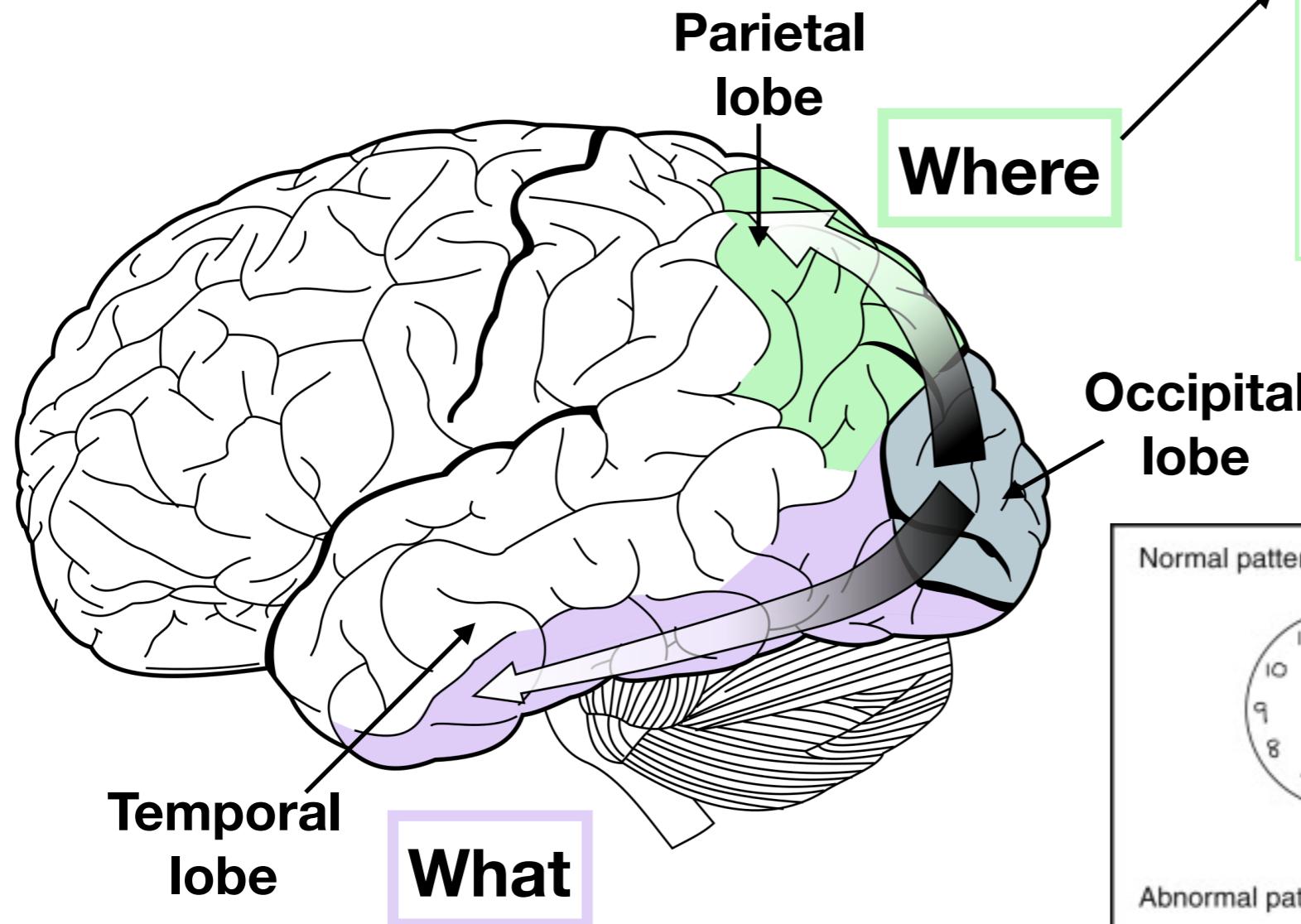
- Small no. patterns (<4) passed to VWM
- Objects held in VWM by active attention
- Limited number of WM “slots” available



Visual Field Tracts



Visual Field Processing



Where system

Visual guiding

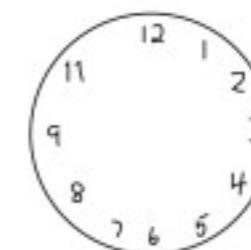
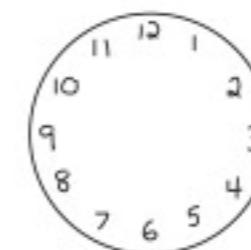
Motion

Colorblind

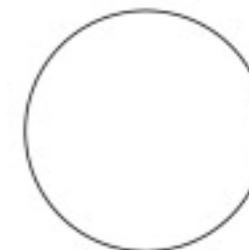
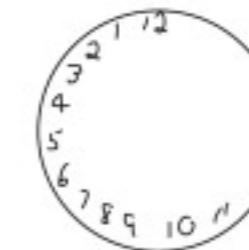
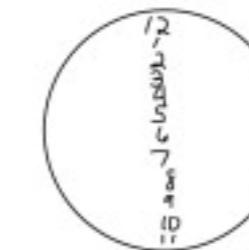
Calculated across retina

Breaks

Normal patterns:



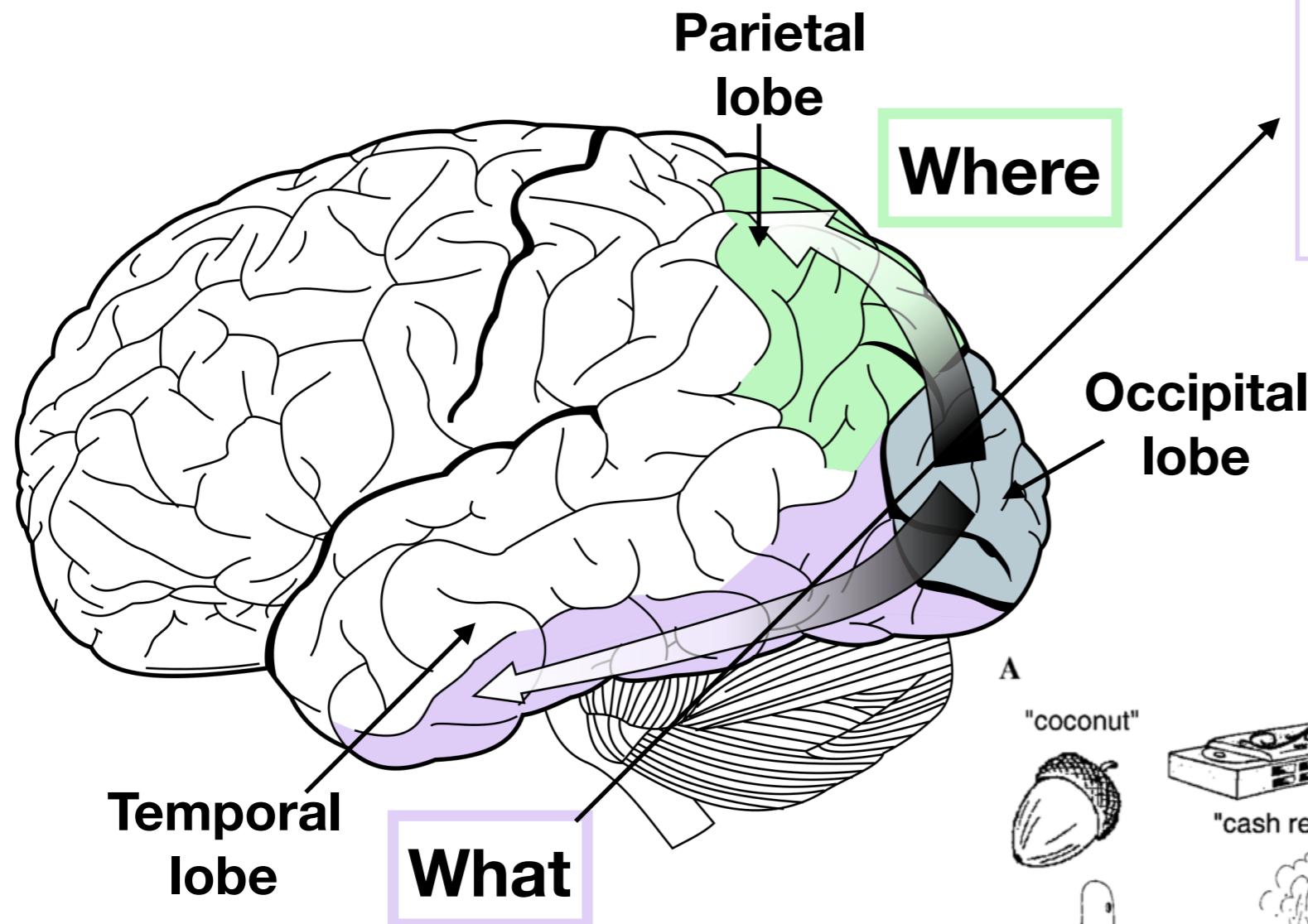
Abnormal patterns:



Note: colors do not correspond to visual tracts slide!

McGee, Mental Status exam, 2012

Visual Field Processing

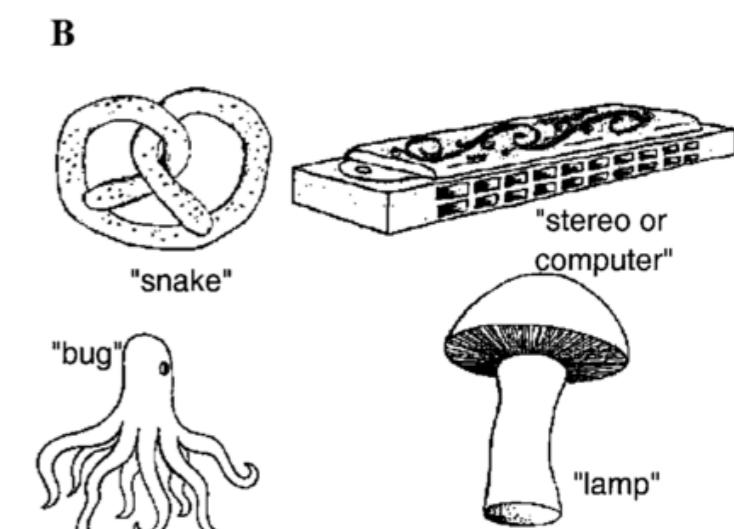
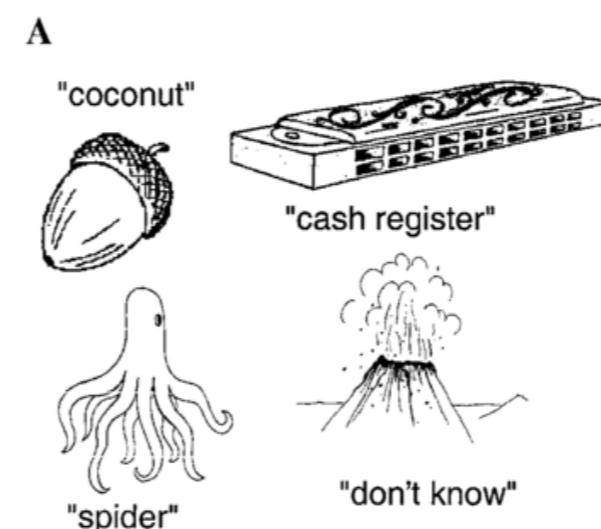


What system

Object recognition
Detailed but slow
Color recognition
Fovea (local)

Breaks

"visual agnosias"



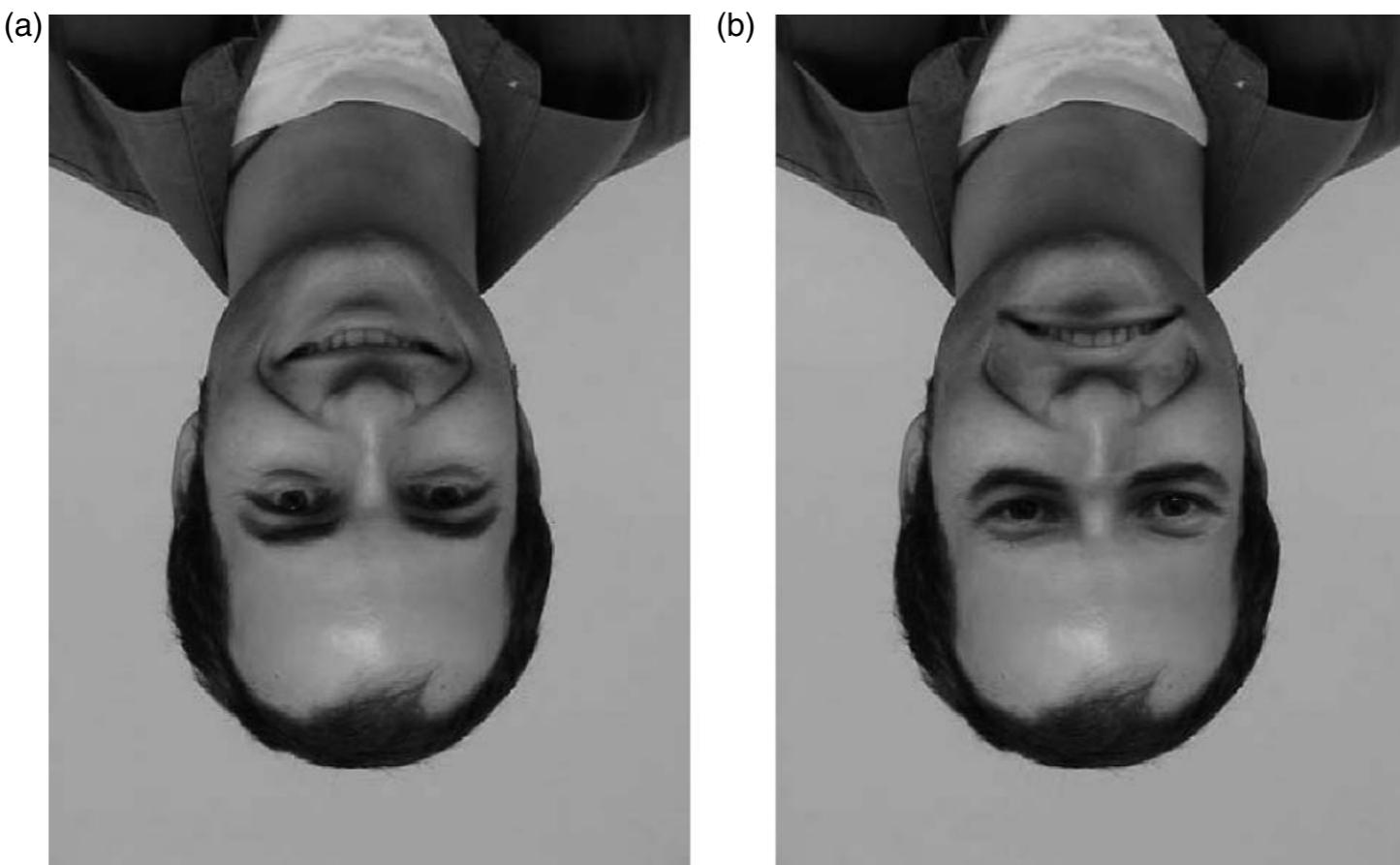
Responses of "S.M." and "R.N.", Behrman 2003

Note: colors do not correspond
to visual tracts slide!

Face blindness

**Object
Recognition
is local**

**Face
Recognition
is special!**



Demonstration of Selective Attention:

<https://www.youtube.com/watch?v=vJG698U2Mvo>



Discussion:

What are the costs and benefits of visualization for the creator? user?

Lecture 04 – The Eye

Today's Learning Objectives:

- 1. Describe the most important functional parts of the eye.**
- 2. Describe the functionally important parts of the retina.**
- 3. Discuss how the anatomy of the retina impacts vision.**
- 4. Describe the roles of spatial frequency and contrast in pattern recognition.**
- 5. Define five types of visual acuity.**
- 6. Define aliasing and discuss how to avoid it.**
- 7. Describe the effects of chromatic aberration on vision.**

Diagram of the Eye in cross section:

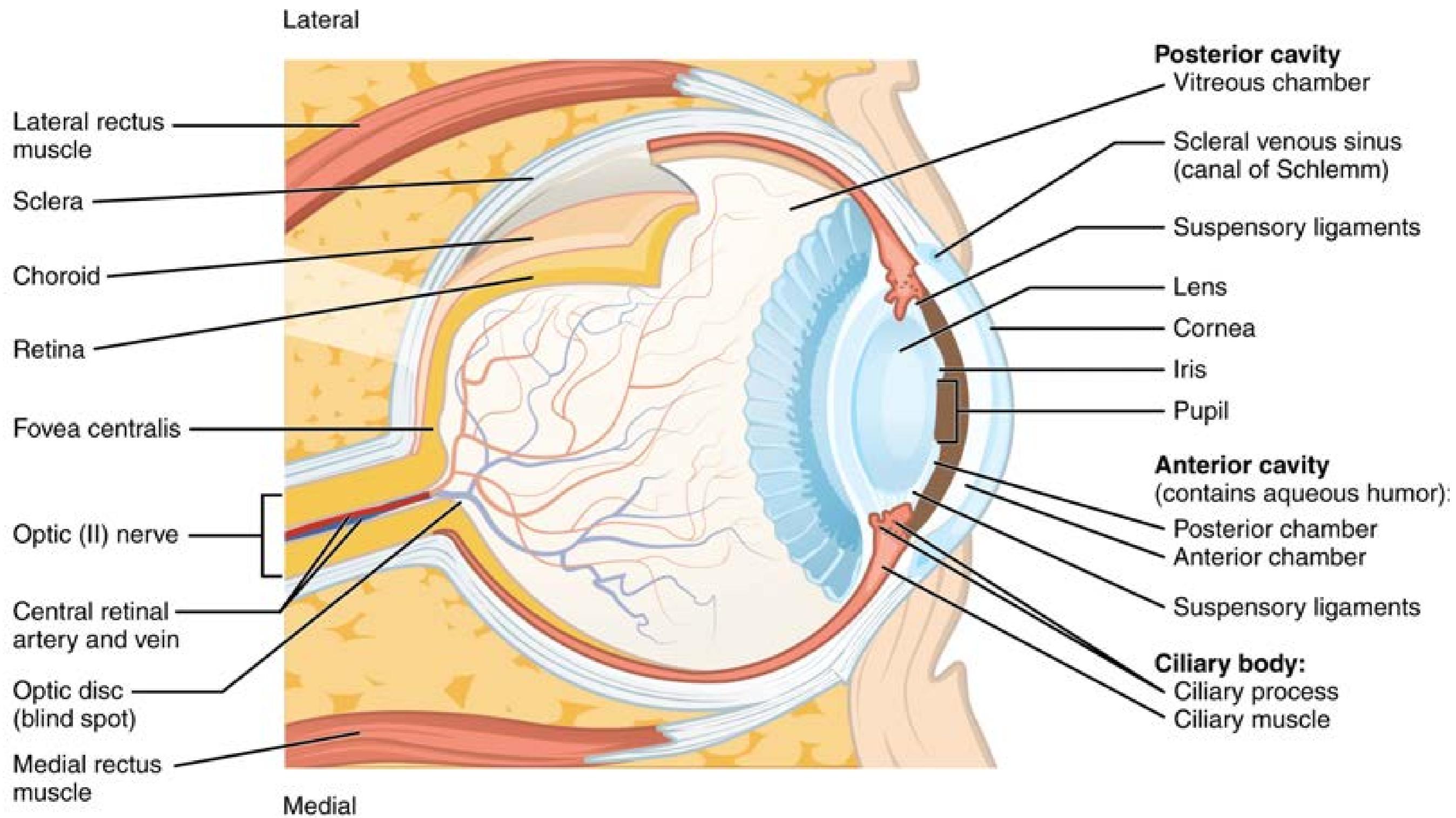
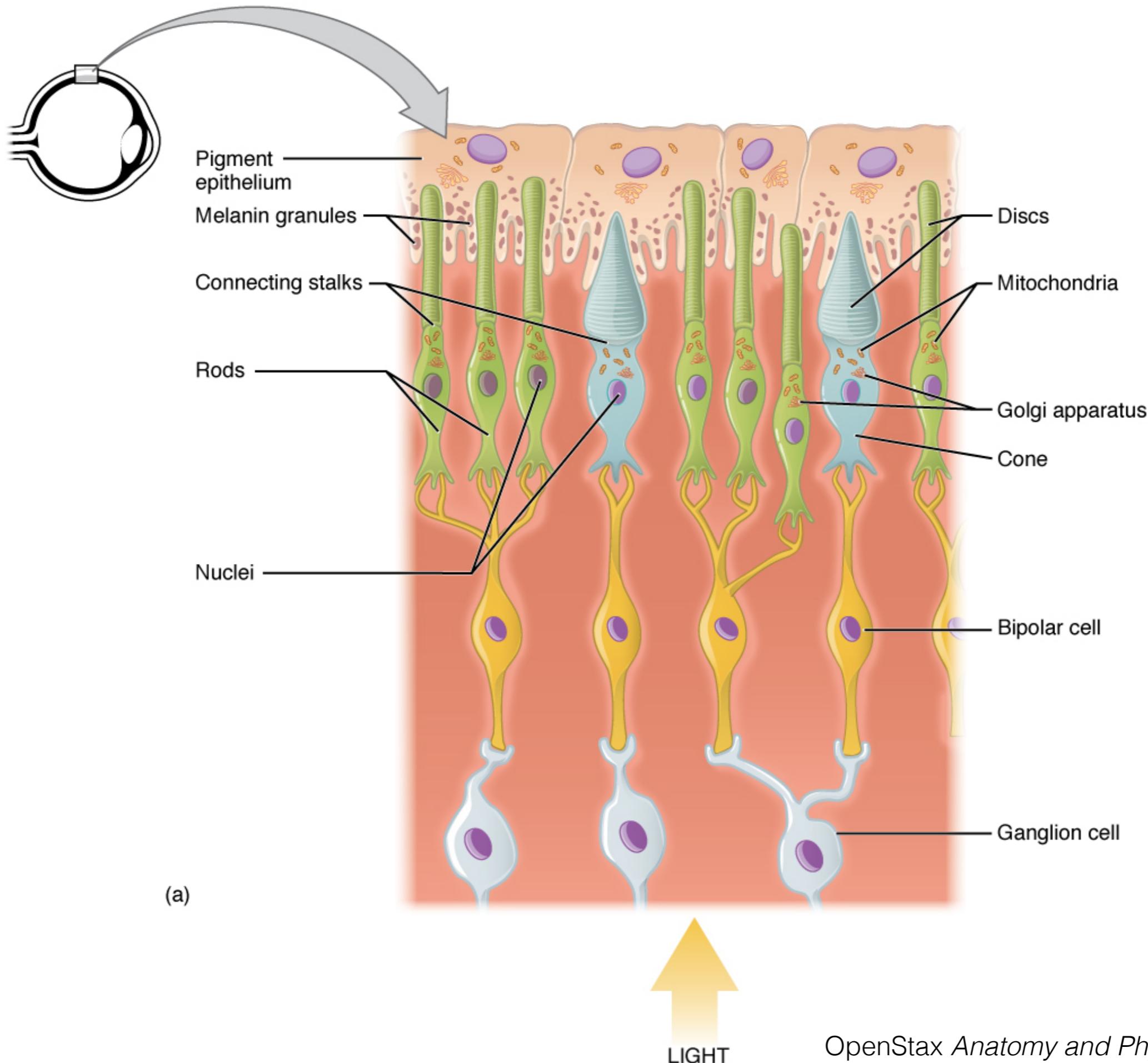
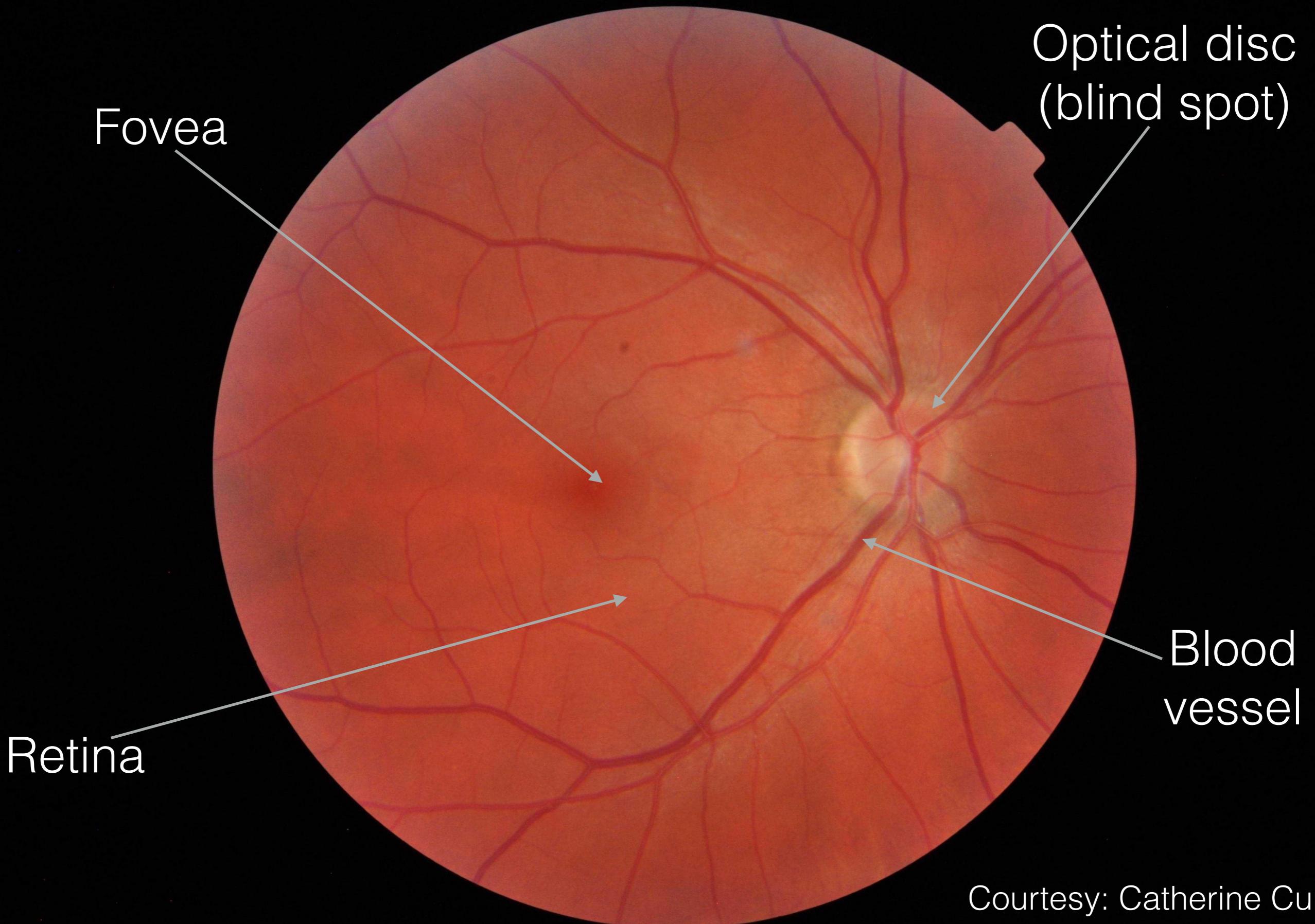


Diagram of retinal tissue:



This is my eyeball.



Find Your Blind Spot

O

X

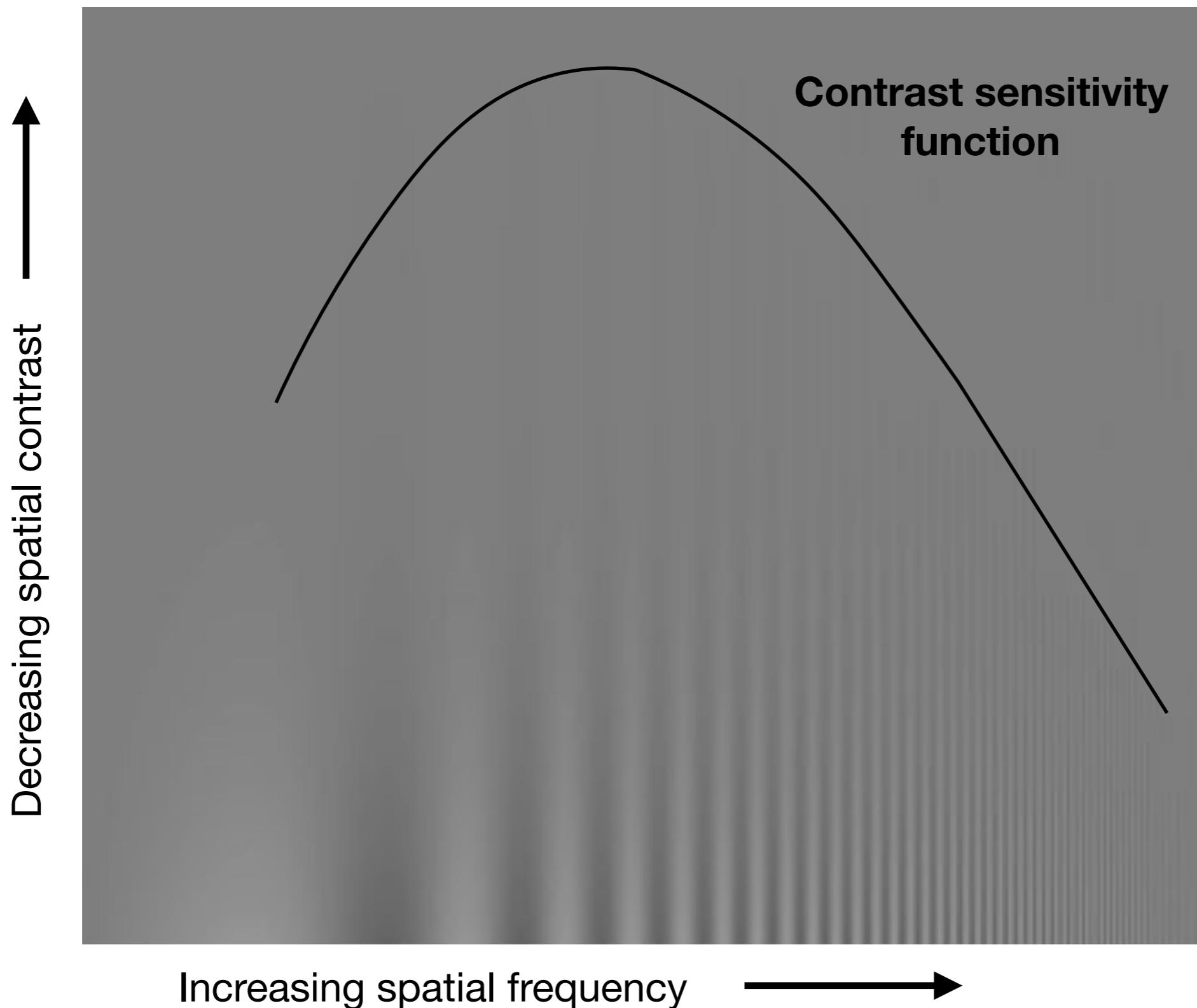
Defining Acuity

<u>Acuity type</u>	<u>Demonstration</u>	<u>Human limit</u>
Point acuity	● ●	1 minute of arc
Grating acuity		1-2 minutes of arc
Letter acuity	E	5 minutes of arc
Vernier acuity	— —	10 seconds of arc

Acuity is high centrally and drops off peripherally.



Spatial and Contrast Acuity (Ware Fig 2.25)



Spatial Frequency Channels

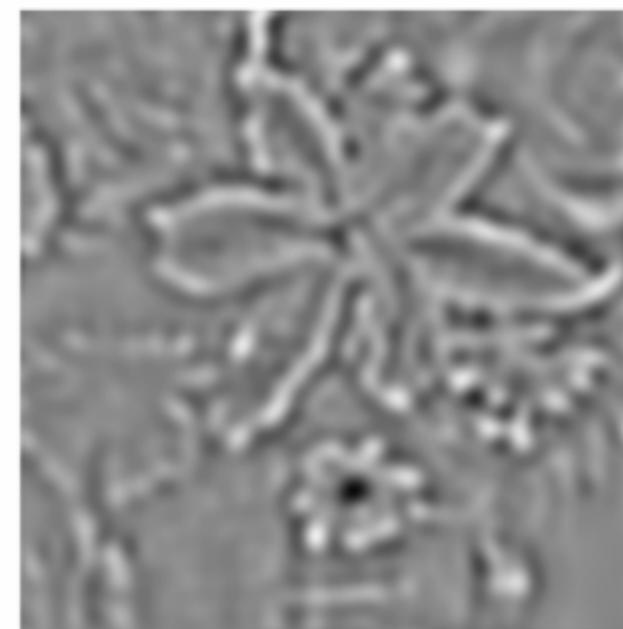
'Low' spatial frequency filters encode coarse luminance variations in the world (e.g. large objects, overall shape)



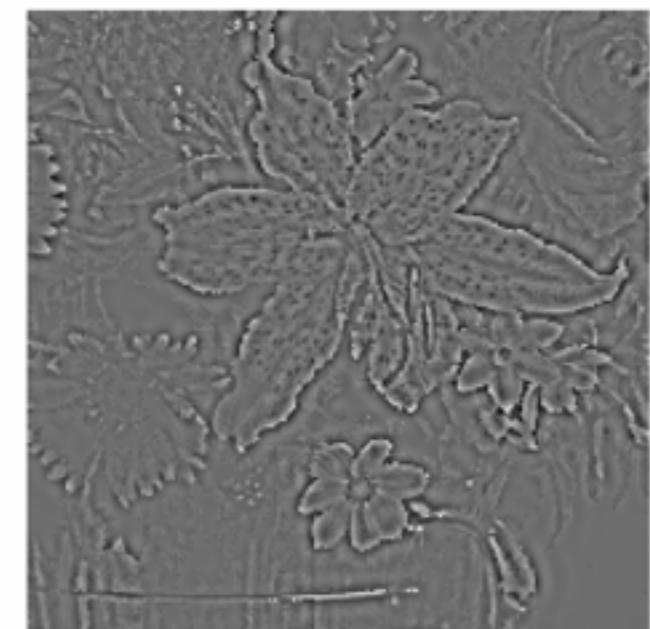
Coarse



'High' spatial frequency filters respond to the fine spatial structure of the world (e.g. small objects, detail)



Medium

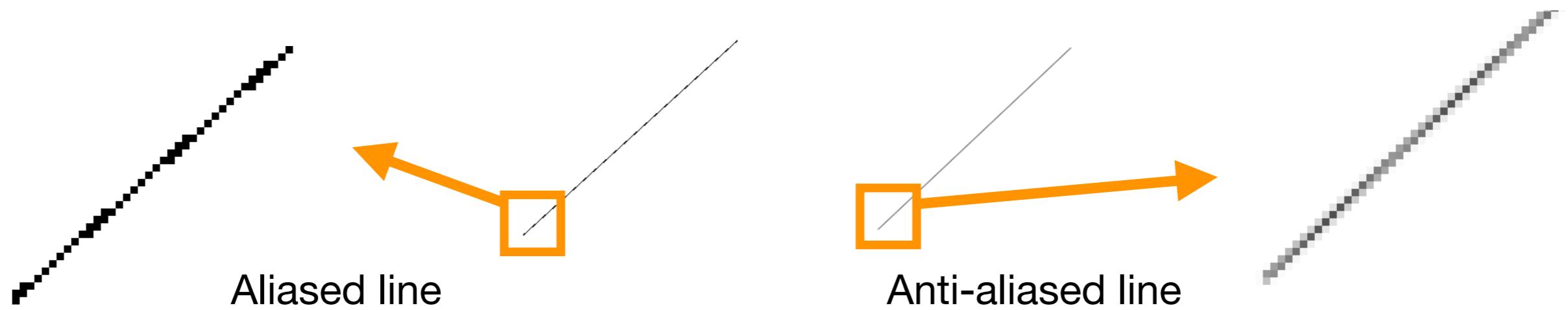
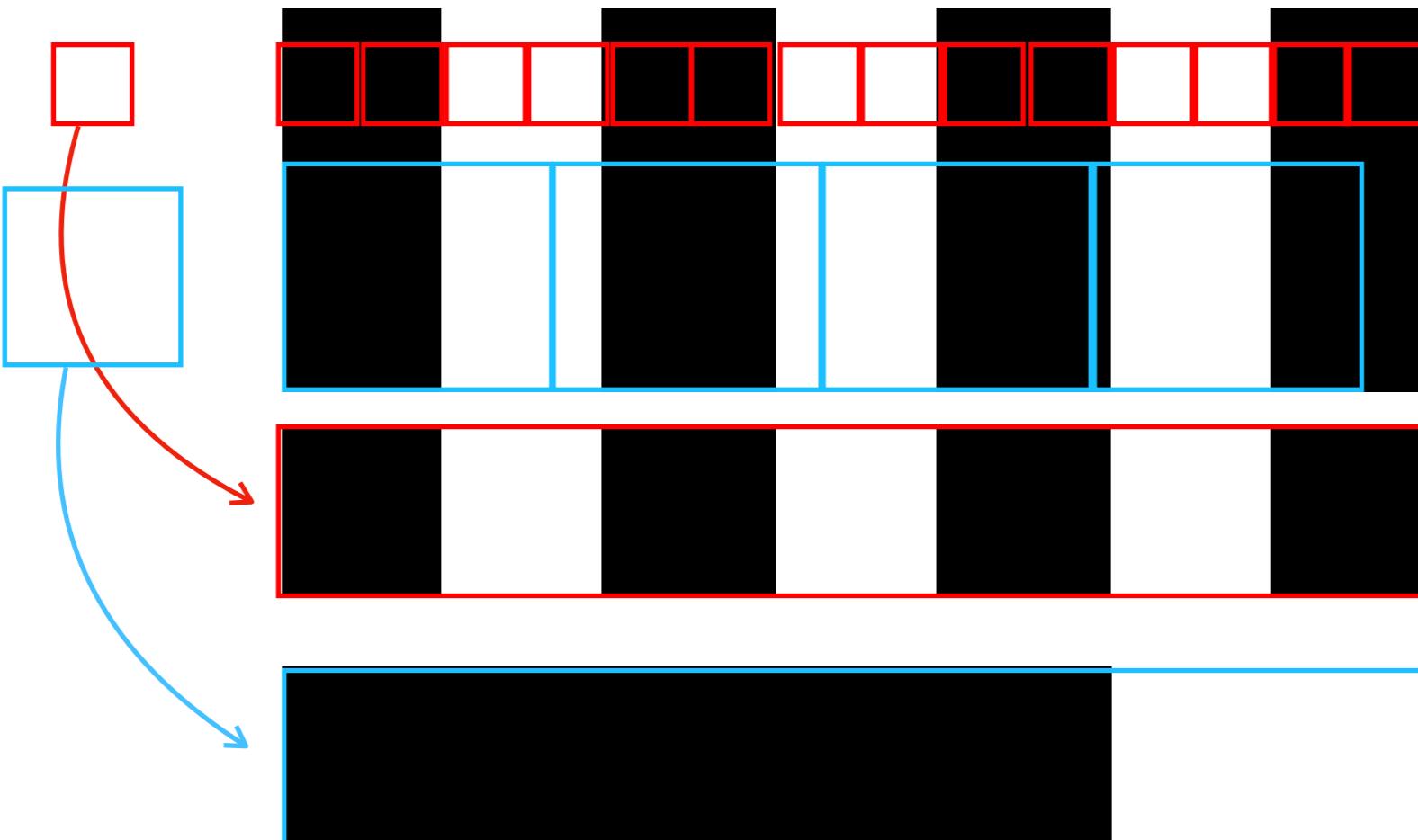


Fine

Image: M. Landy

Sampling Frequencies and Aliasing

Nyquist limit - signal can be reconstructed only if sampling is twice the highest frequency of the source.



Chromatic Aberration (reproduced from Ware Fig 2.15)

**Most people see the red
closer than the blue,
but some see the
opposite effect.**

References:

OpenStax. 2017. *Anatomy and Physiology*. OpenStax Publishing. ISBN-10: 1-947172-04-2

Behrman M, Kimchi R. 2003. What does visual agnosia tell us about perceptual organization and its relationship to object perception? *J Exp Psych Human Perception Performance*. 29(1): 19-42.

Grüter T, Grüner M, Carbon C-C. 2008 Neural and genetic foundations of face recognition and prosopagnosia. *J Neuropsychology* 2: 79-97.

McGee S. 2012. *Evidence-Based Physical Diagnosis*. 3rd ed. Elsevier Saunders Publishing.

M Landy. Perception Lecture Notes: Spatial Frequency Channels. <https://www.cns.nyu.edu/~david/courses/perception/lecturenotes/channels/channels.html>