Lecture 19 – Data Visualization

Learning Objectives:

6. **Learn how to document your work and prepare scientific publications.**

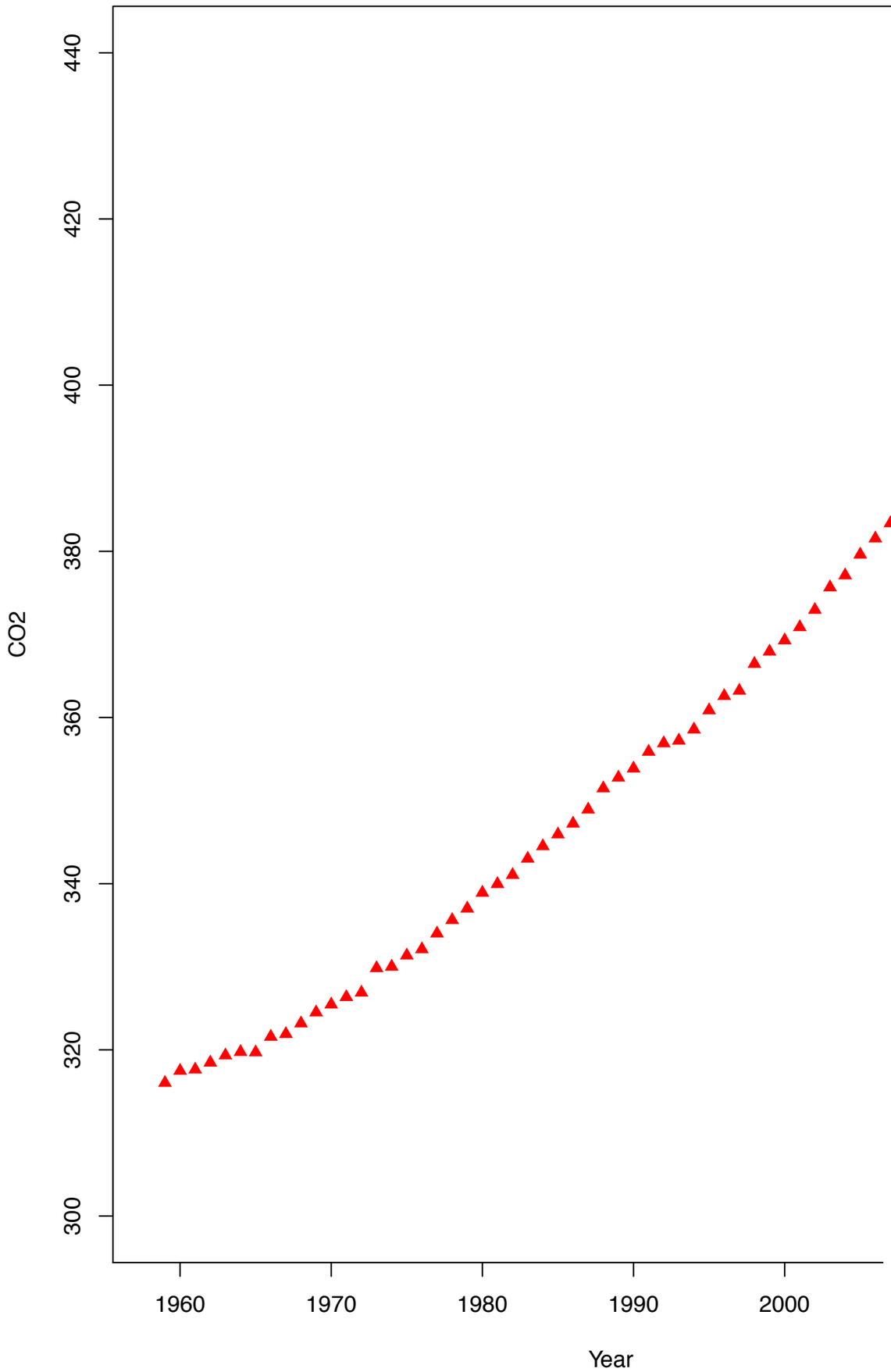
    6.1 Learn the basic principles of data visualization.

    6.2 List some things to use and things to avoid when creating visualizations.

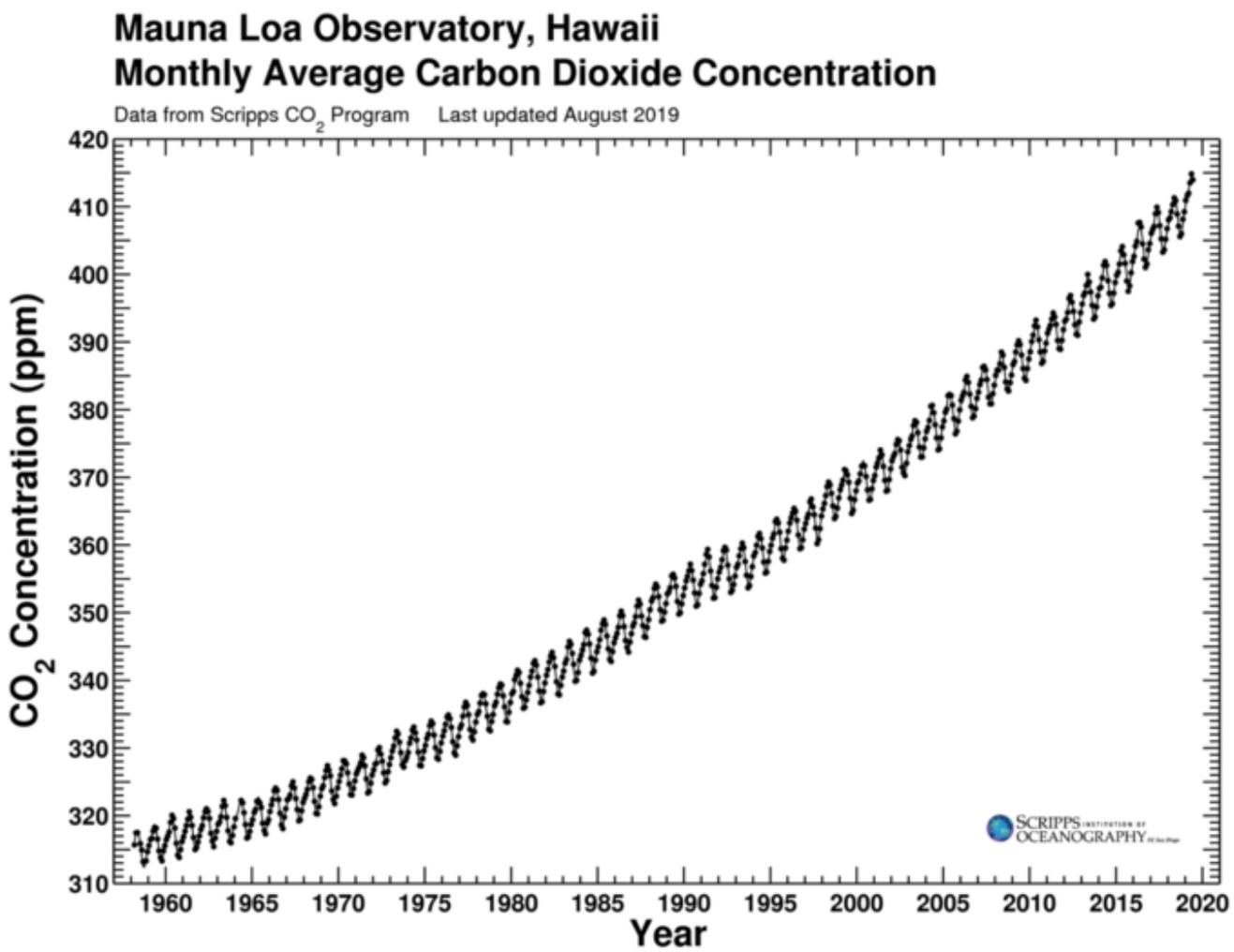
Why create data visualizations?

https://www.ted.com/talks/david_mccandless_the_beauty_of_data_visualization

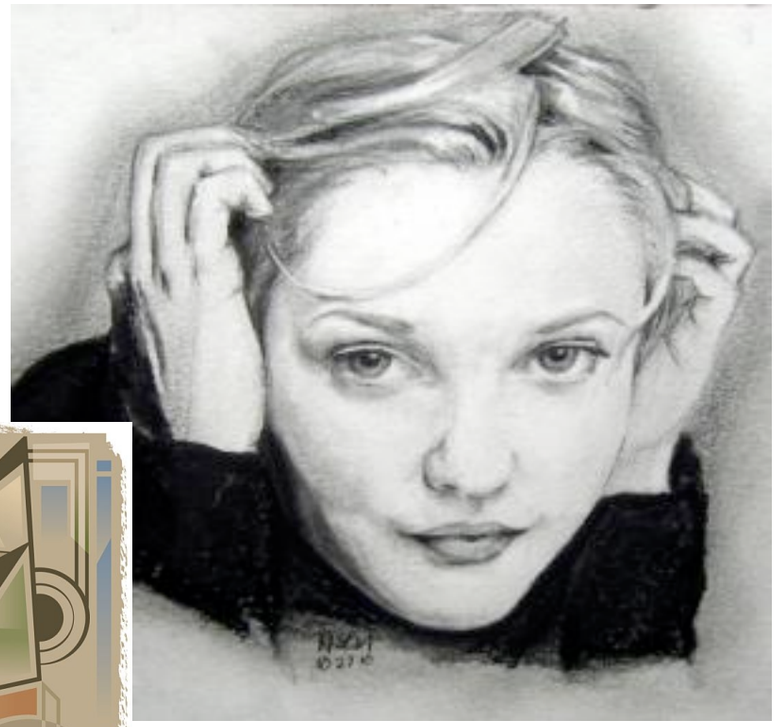
2003	4	37726	2003.2877	377.65	374.98	377.82	375.13	377.65	374.98
2003	5	37756	2003.3699	378.35	375.11	378.58	375.33	378.35	375.11
2003	6	37787	2003.4548	378.13	375.67	377.97	375.54	378.13	375.67
2003	7	37817	2003.5370	376.60	375.82	376.48	375.73	376.60	375.82
2003	8	37848	2003.6219	374.48	375.94	374.43	375.92	374.48	375.94
2003	9	37879	2003.7068	372.98	376.32	372.74	376.10	372.98	376.32
2003	10	37909	2003.7890	373.00	376.46	372.82	376.27	373.00	376.46
2003	11	37940	2003.8740	374.35	376.51	374.29	376.43	374.35	376.51
2003	12	37970	2003.9562	375.69	376.58	375.70	376.57	375.69	376.58
2004	1	38001	2004.0410	376.79	376.75	376.76	376.71	376.79	376.75
2004	2	38032	2004.1257	377.37	376.64	377.57	376.84	377.37	376.64
2004	3	38061	2004.2049	378.39	376.89	378.48	376.96	378.39	376.89
2004	4	38092	2004.2896	380.50	377.80	379.80	377.08	380.50	377.80
2004	5	38122	2004.3716	380.62	377.36	380.44	377.19	380.62	377.36
2004	6	38153	2004.4563	379.55	377.11	379.72	377.31	379.55	377.11
2004	7	38183	2004.5383	377.76	377.00	378.16	377.43	377.76	377.00
2004	8	38214	2004.6230	375.83	377.32	376.04	377.57	375.83	377.32
2004	9	38245	2004.7077	374.05	377.41	374.34	377.72	374.05	377.41
2004	10	38275	2004.7896	374.22	377.69	374.43	377.88	374.22	377.69
2004	11	38306	2004.8743	375.84	378.01	375.92	378.06	375.84	378.01
2004	12	38336	2004.9563	377.44	378.33	377.37	378.25	377.44	378.33
2005	1	38367	2005.0411	378.34	378.30	378.50	378.45	378.34	378.30
2005	2	38398	2005.1260	379.61	378.88	379.40	378.66	379.61	378.88
2005	3	38426	2005.2027	380.08	378.60	380.36	378.86	380.08	378.60
2005	4	38457	2005.2877	382.05	379.36	381.78	379.08	382.05	379.36
2005	5	38487	2005.3699	382.24	378.98	382.55	379.29	382.24	378.98
2005	6	38518	2005.4548	382.08	379.61	381.96	379.51	382.08	379.61
2005	7	38548	2005.5370	380.66	379.87	380.48	379.72	380.66	379.87
2005	8	38579	2005.6219	378.67	380.13	378.44	379.94	378.67	380.13
2005	9	38610	2005.7068	376.42	379.78	376.77	380.15	376.42	379.78
2005	10	38640	2005.7890	376.80	380.28	376.88	380.35	376.80	380.28
2005	11	38671	2005.8740	378.31	380.48	378.39	380.55	378.31	380.48
2005	12	38701	2005.9562	379.96	380.85	379.86	380.73	379.96	380.85
2006	1	38732	2006.0411	381.37	381.32	380.97	380.91	381.37	381.32
2006	2	38763	2006.1260	382.02	381.29	381.82	381.09	382.02	381.29
2006	3	38791	2006.2027	382.56	381.07	382.74	381.23	382.56	381.07
2006	4	38822	2006.2877	384.36	381.67	384.10	381.39	384.36	381.67
2006	5	38852	2006.3699	384.92	381.65	384.81	381.53	384.92	381.65

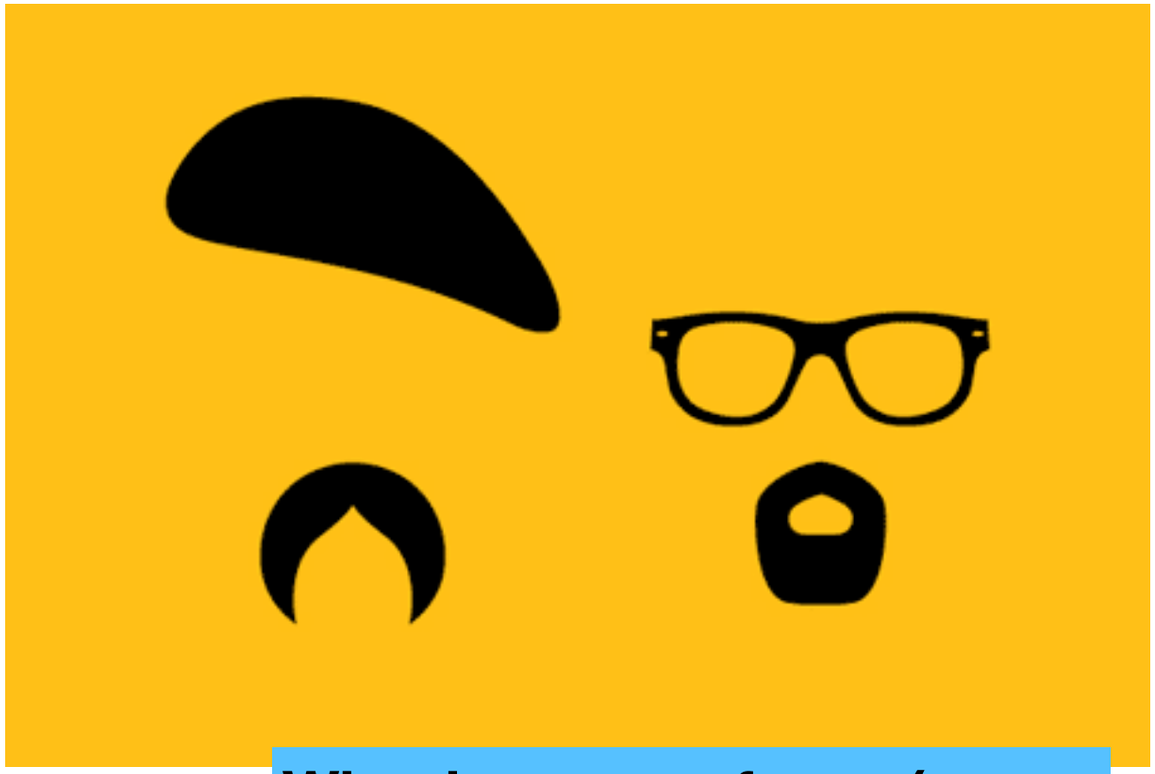


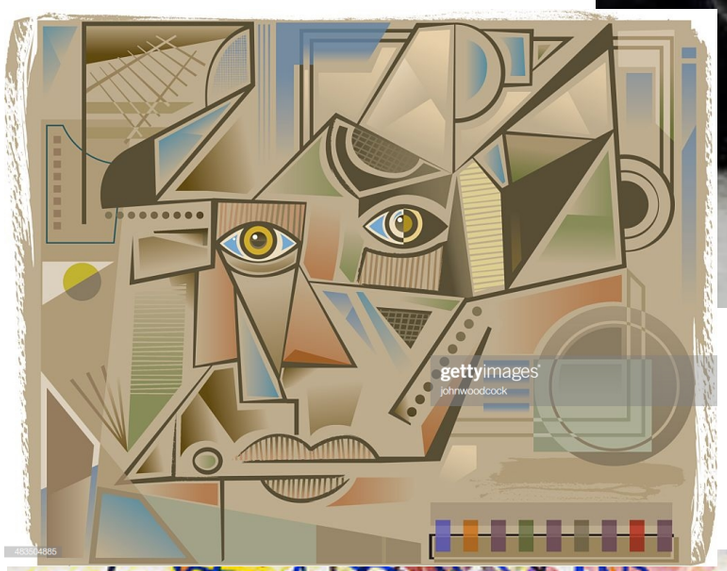
What makes some visualizations better than others?

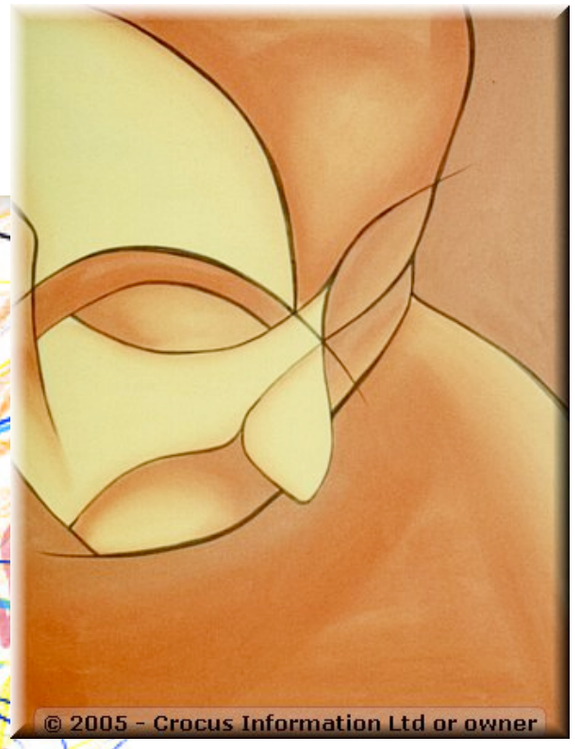


Visualization of a concept in art









Why do we see faces (even when they aren't there)?

How can we *reliably* create powerful visualizations?

Why create data visualizations?

What makes some visualizations better than others?

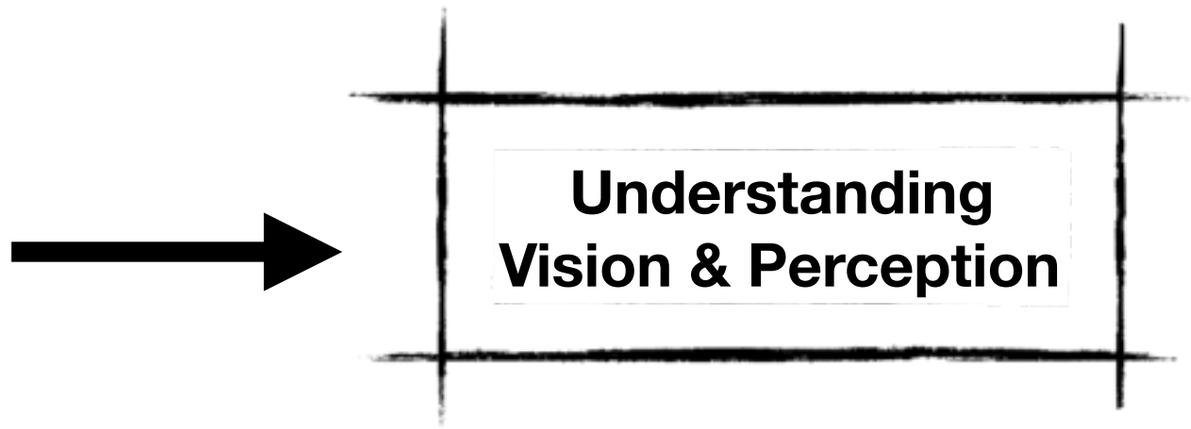
Why do we see faces (even when they aren't there)?

How can we *reliably* create powerful visualizations?

Why create data visualizations?

What makes some visualizations better than others?

Why do we see faces (even when they aren't there)?



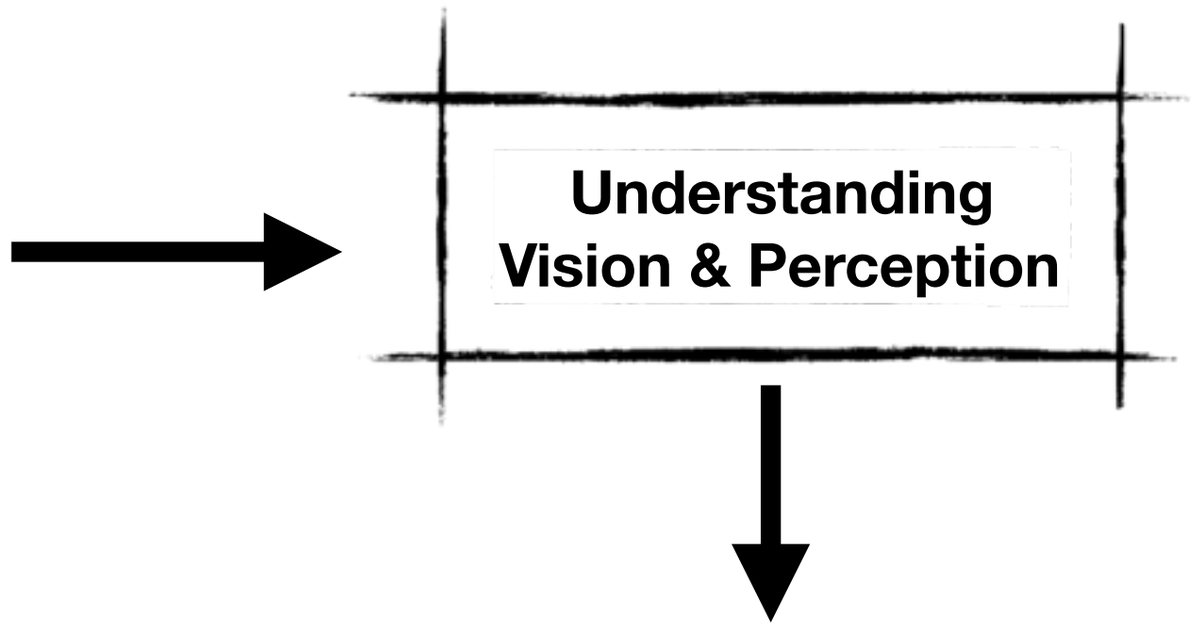
How can we *reliably* create powerful visualizations?

Why create data visualizations?

What makes some visualizations better than others?

Why do we see faces (even when they aren't there)?

How can we *reliably* create powerful visualizations?

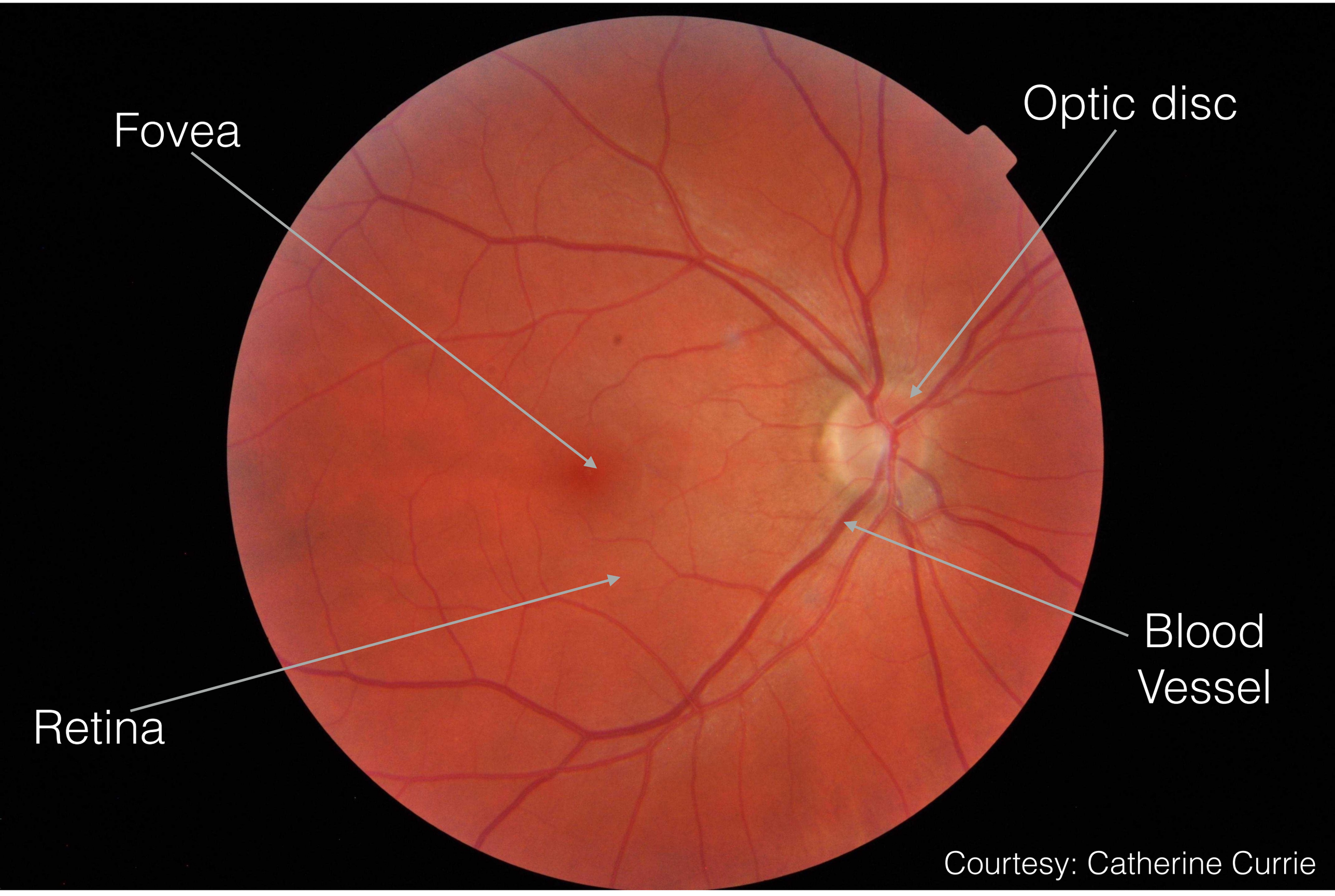


1. Contrast is Queen

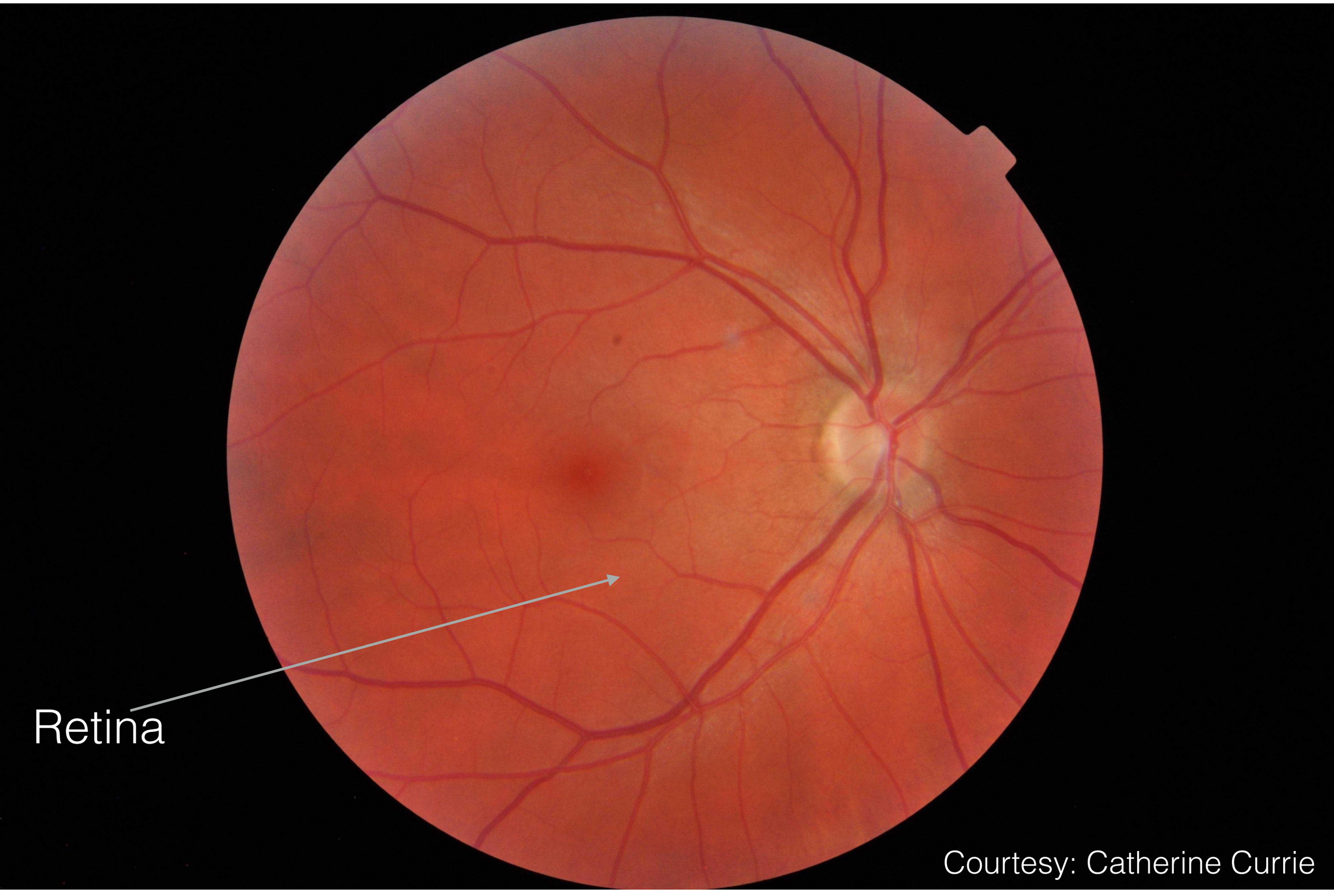
2. You don't see by transmitting images

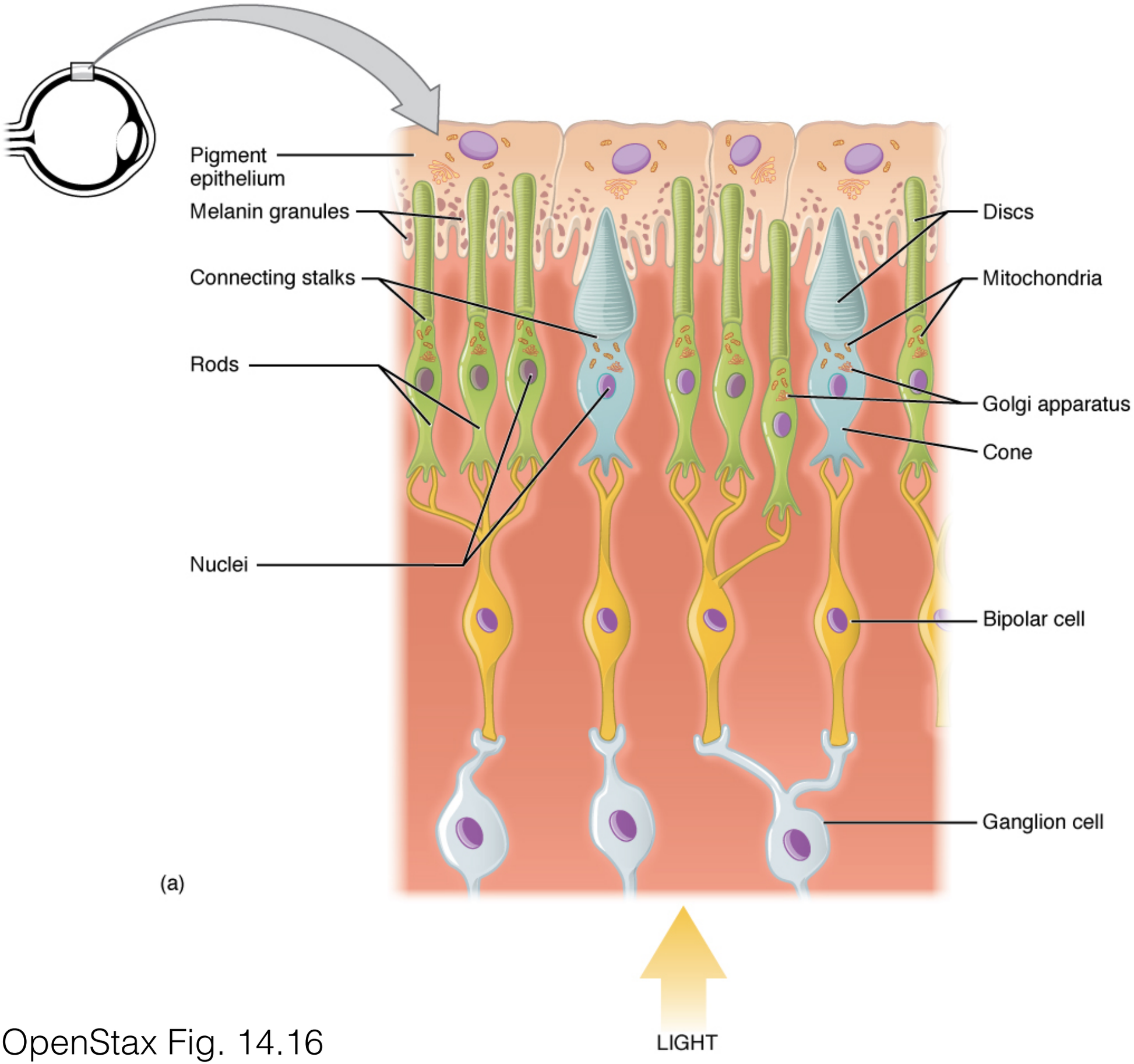
3. Acuity drops from the center of vision

1. Contrast is Queen – This is My Eyeball.



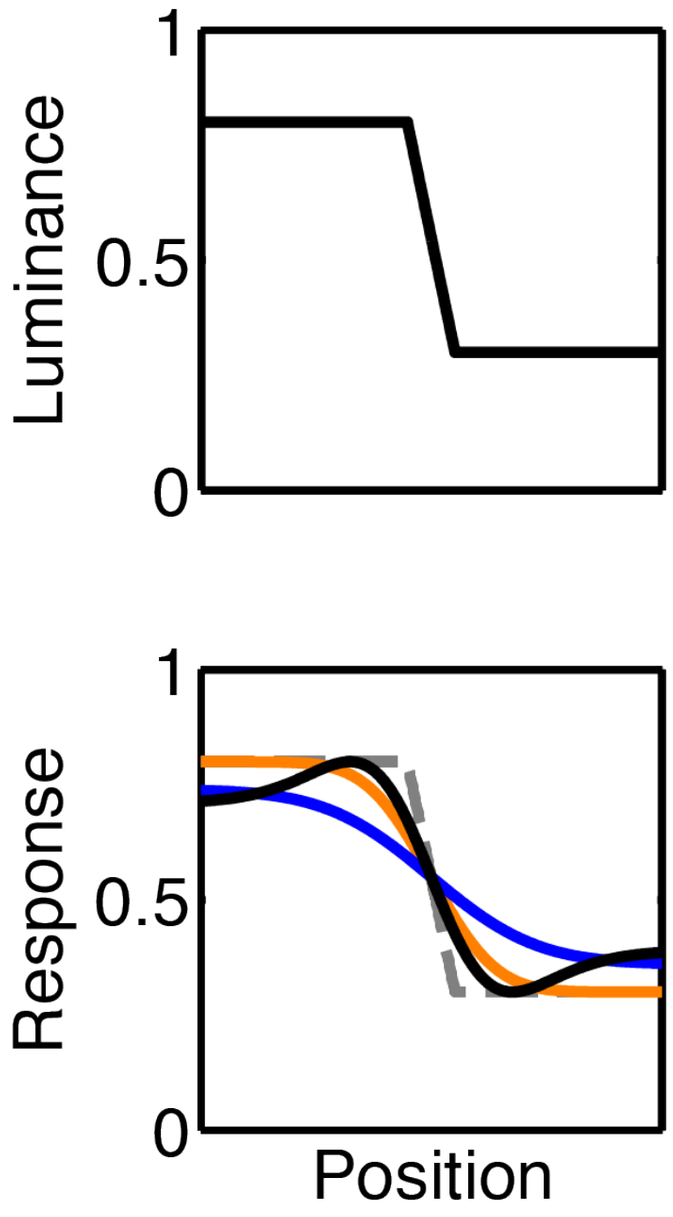
1. Contrast is Queen – This is My Eyeball.



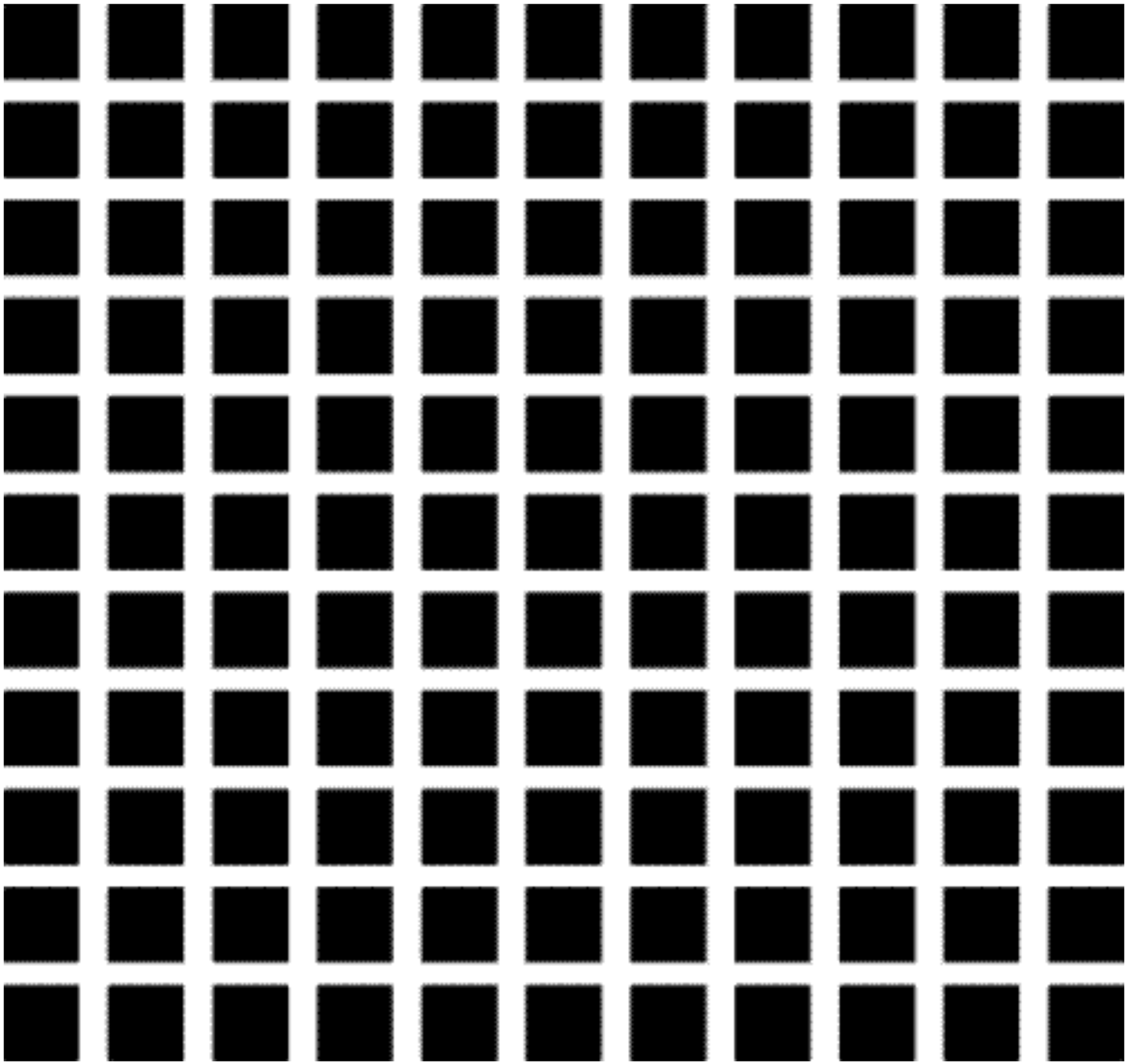


OpenStax Fig. 14.16

How Contrast Works

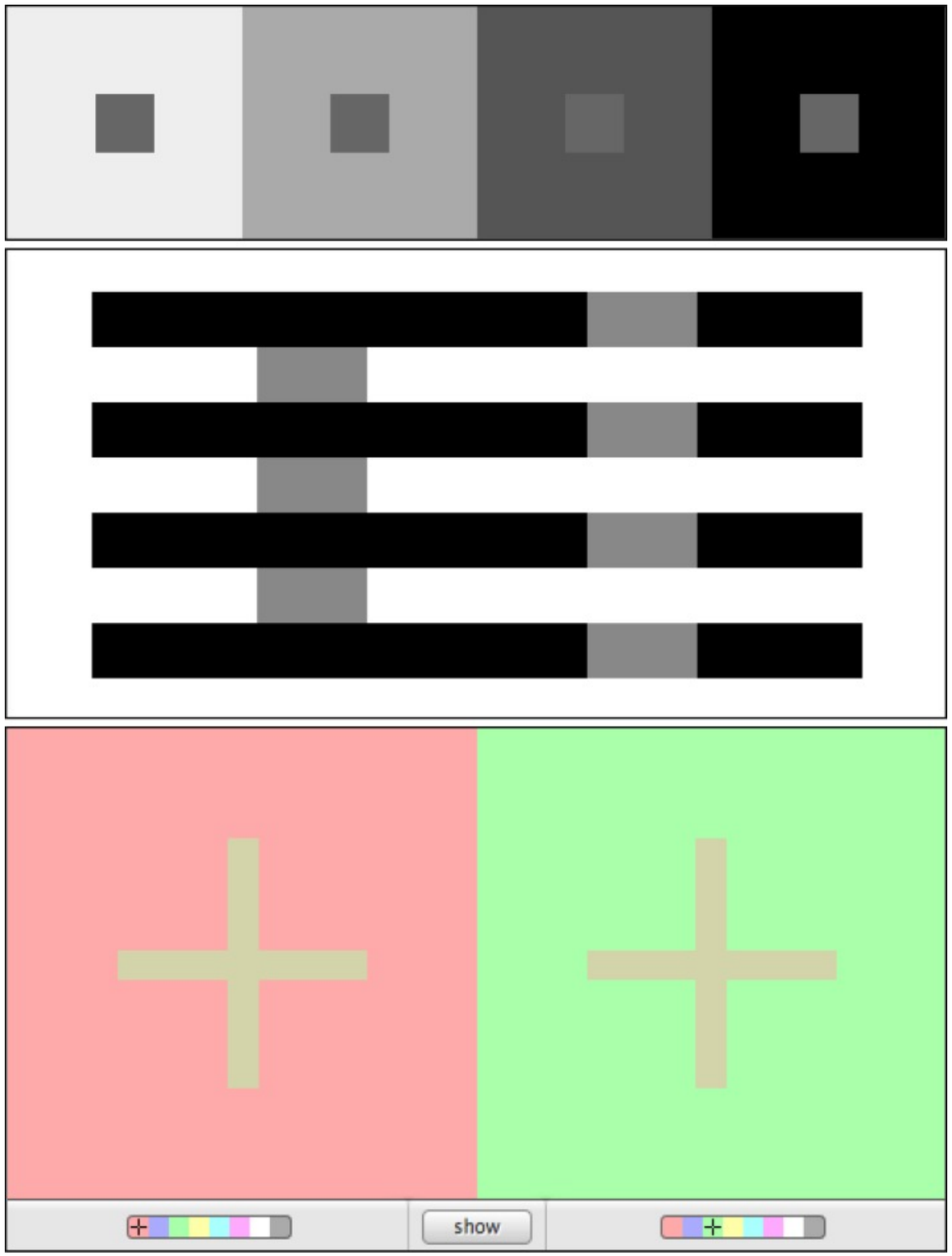


Mach band illusion
Hartline and Ratliff 1957
Dylan Muir



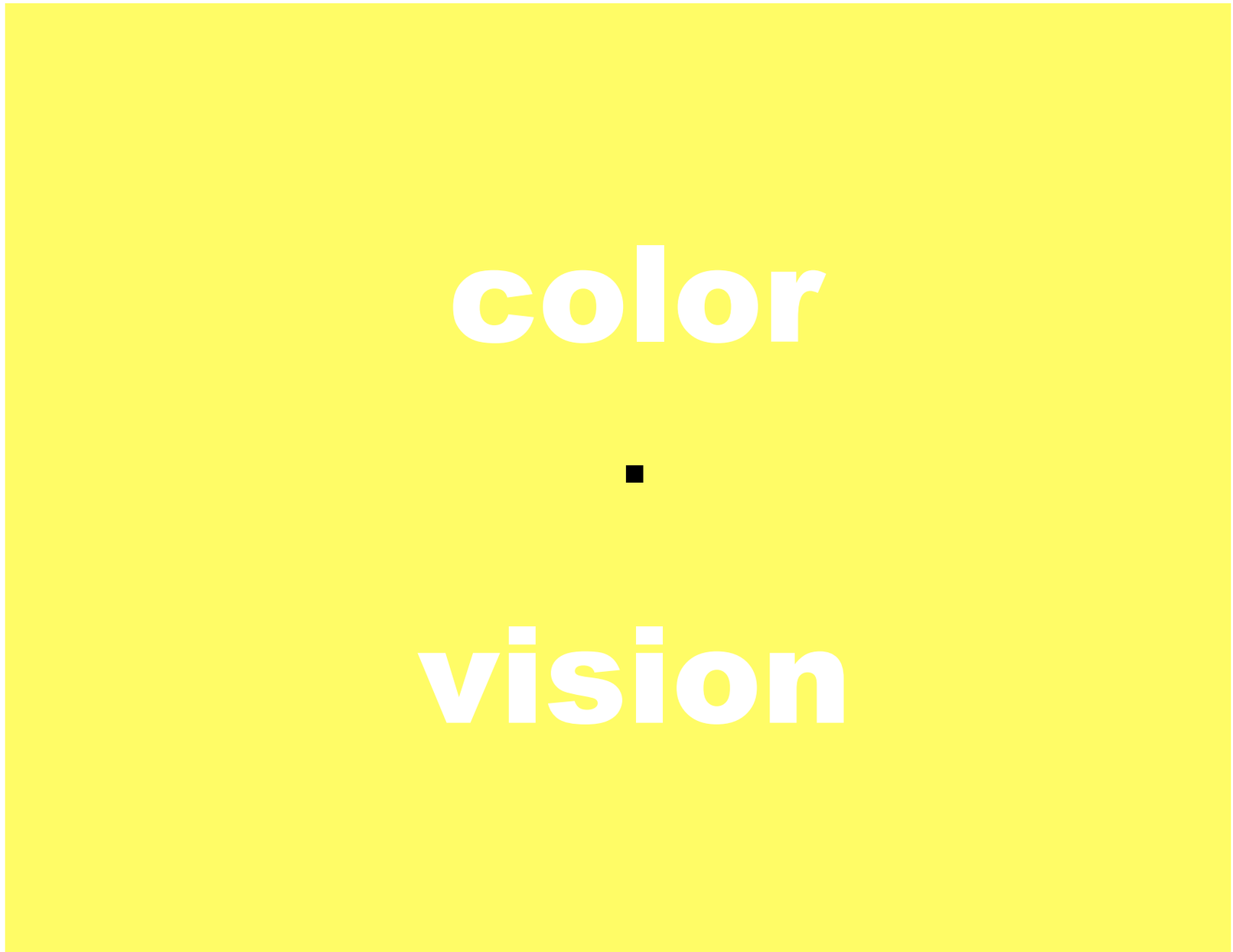
Contrast makes luminance tricky!

This text is white.



Wyttenbach 2012 J Under Neuro Ed

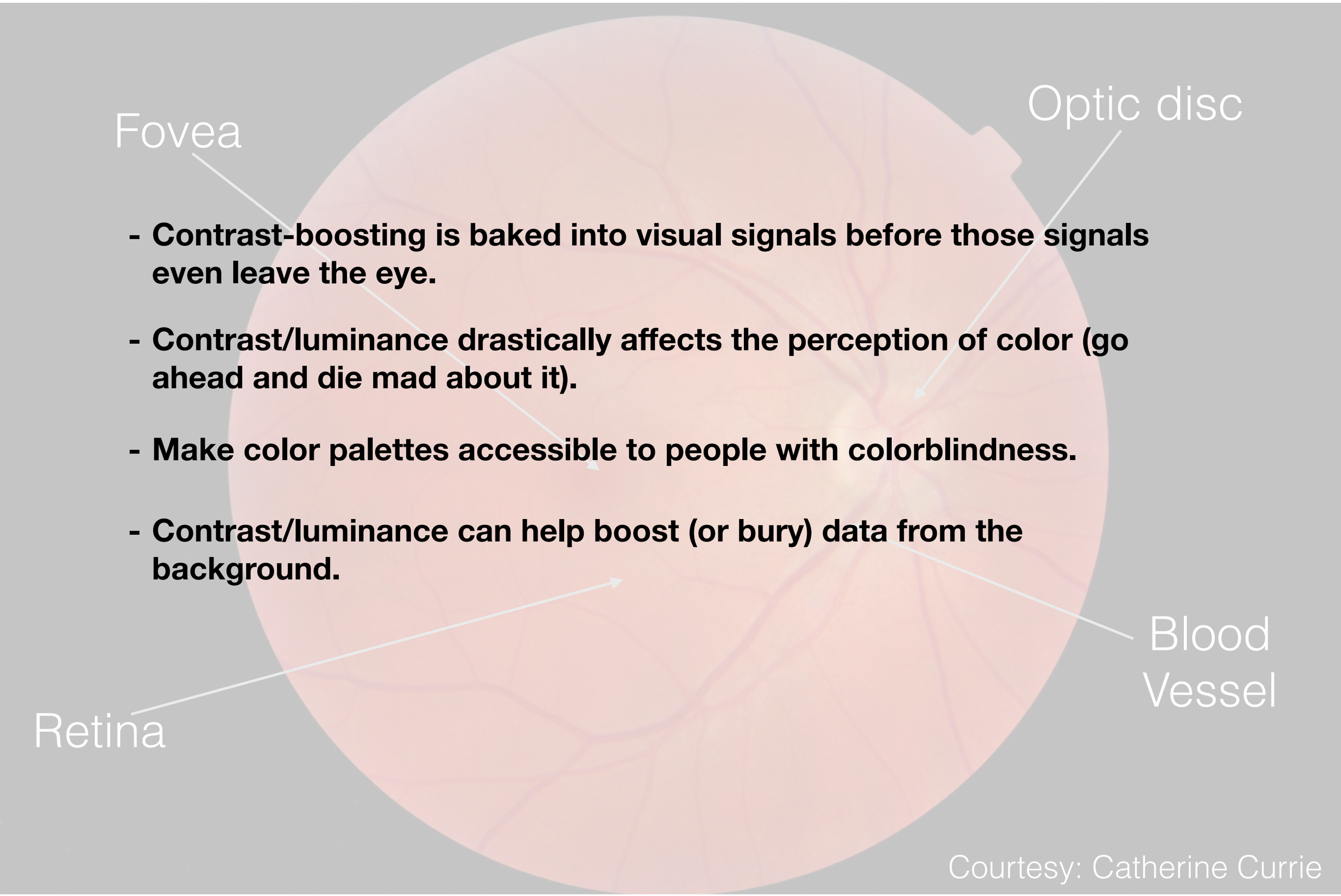
Contrast makes luminance tricky!



Livingstone 2014 reproduction

Contrast makes luminance tricky!

1. Contrast is Queen



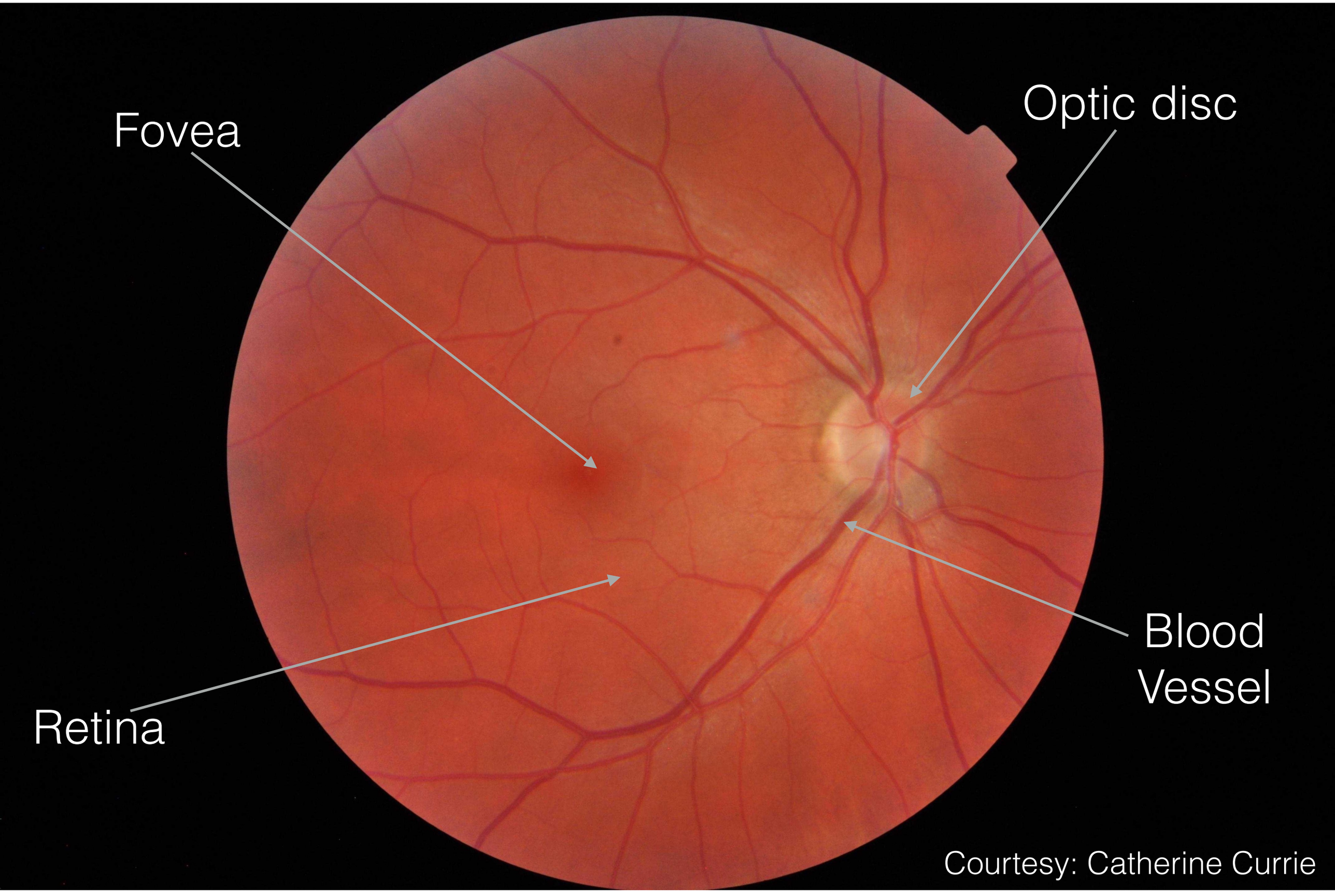
- **Contrast-boosting is baked into visual signals before those signals even leave the eye.**

- **Contrast/luminance drastically affects the perception of color (go ahead and die mad about it).**

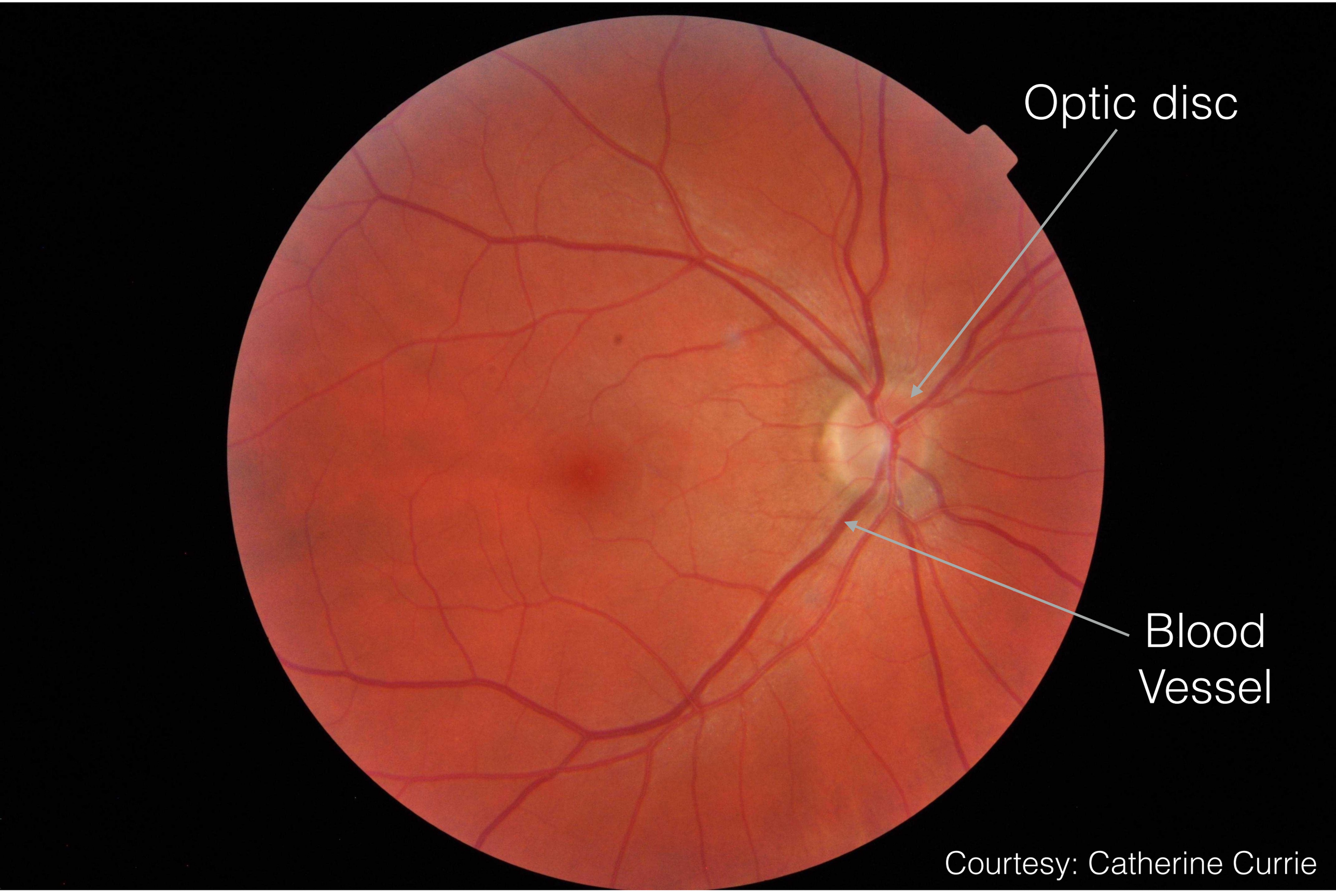
- **Make color palettes accessible to people with colorblindness.**

- **Contrast/luminance can help boost (or bury) data from the background.**

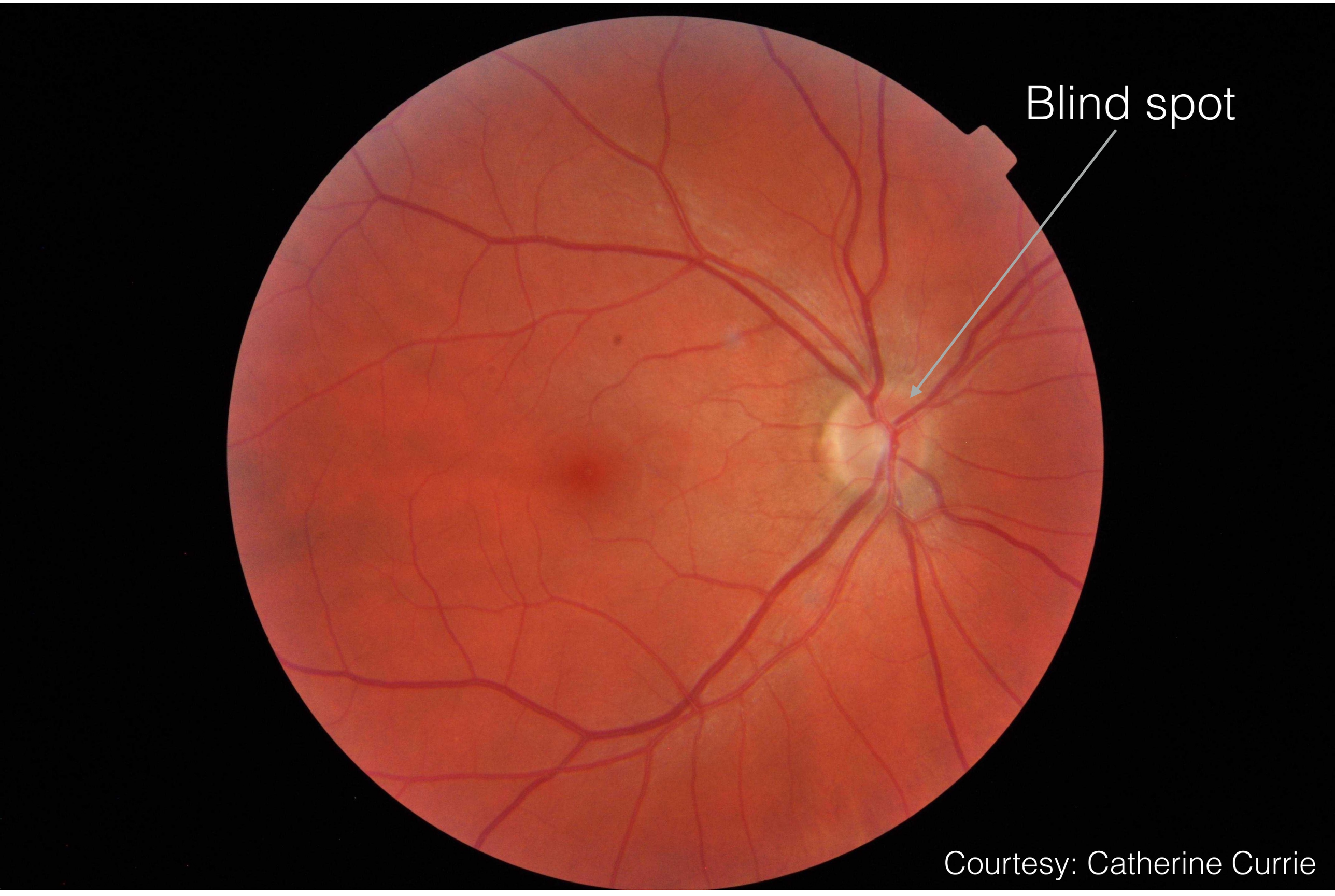
2. You don’t see by transmitting images



2. You don’t see by transmitting images



2. You don’t see by transmitting images

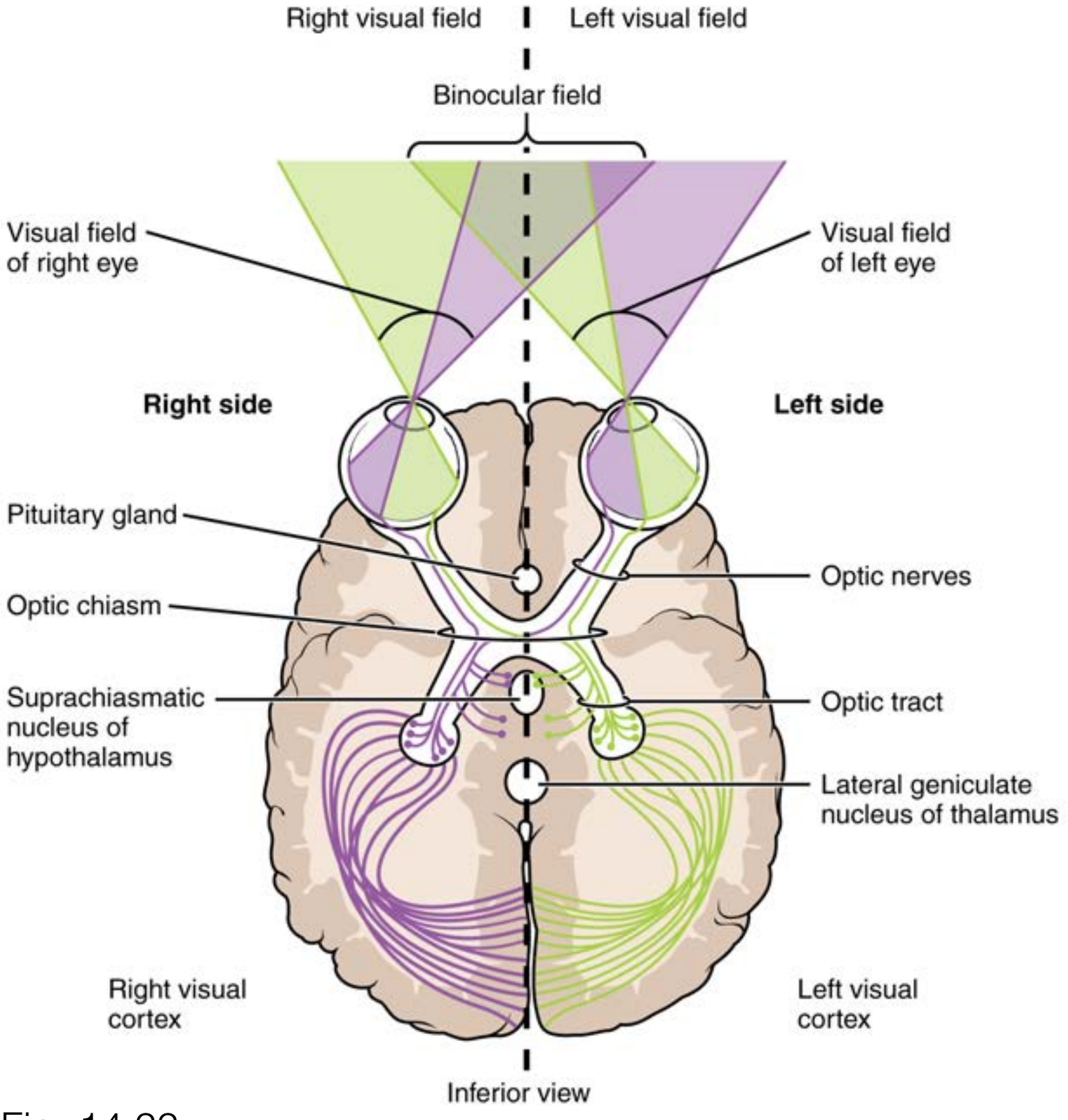


Find Your Blind Spot

O

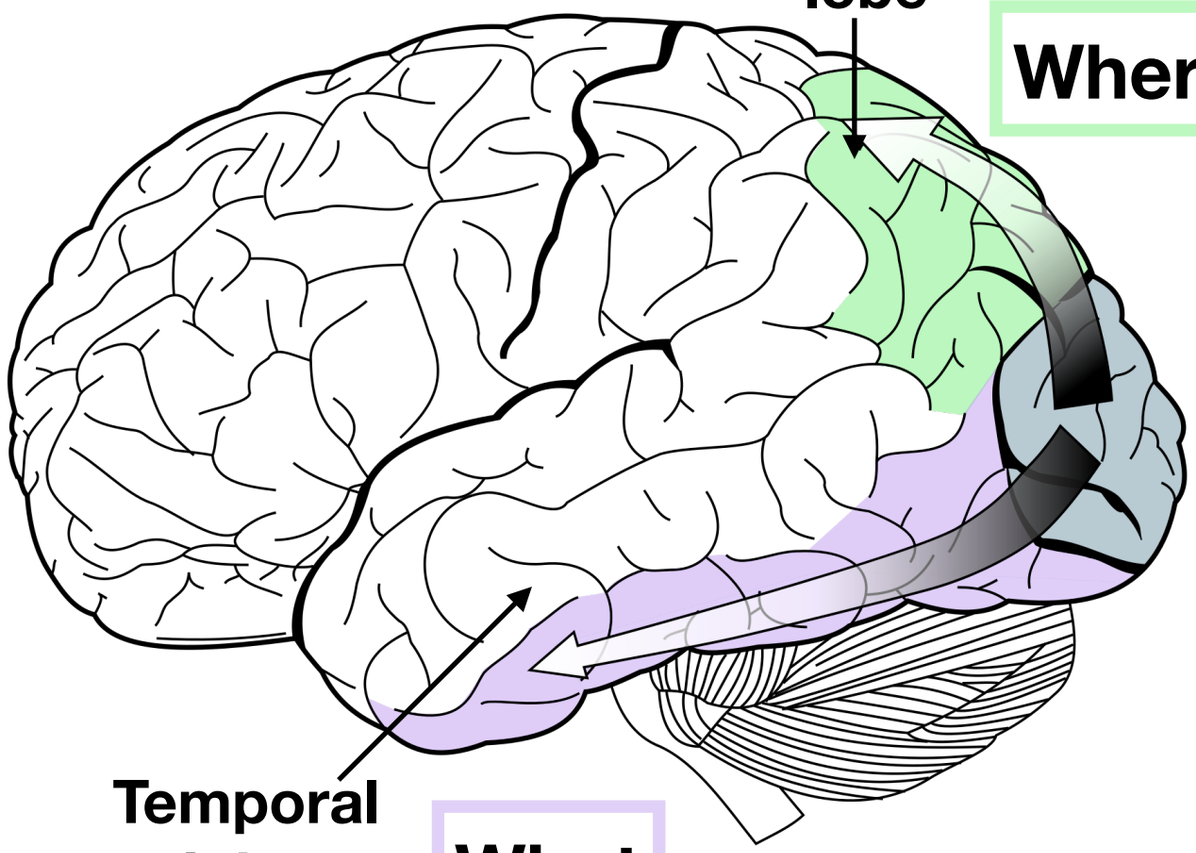
X

Visual Field Tracts



OpenStax Fig. 14.22

Visual Field Processing



Where system

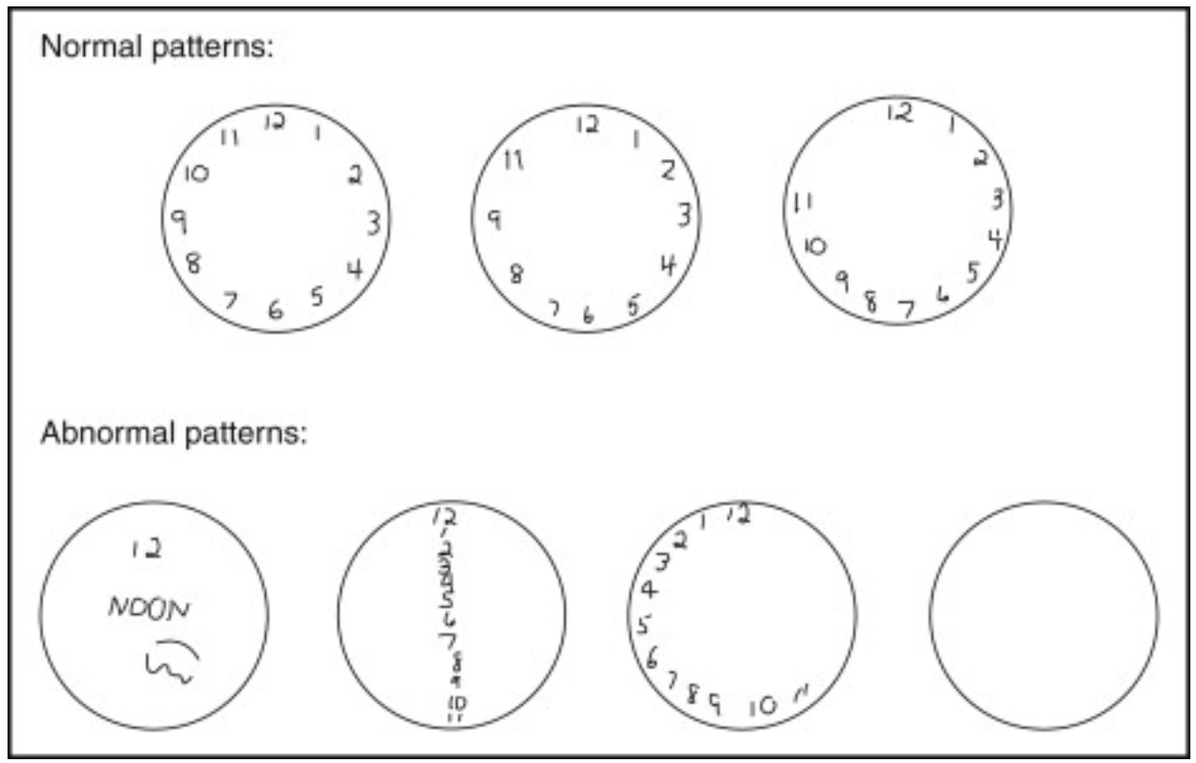
Visual guiding

Motion

Colorblind

Calculated across retina

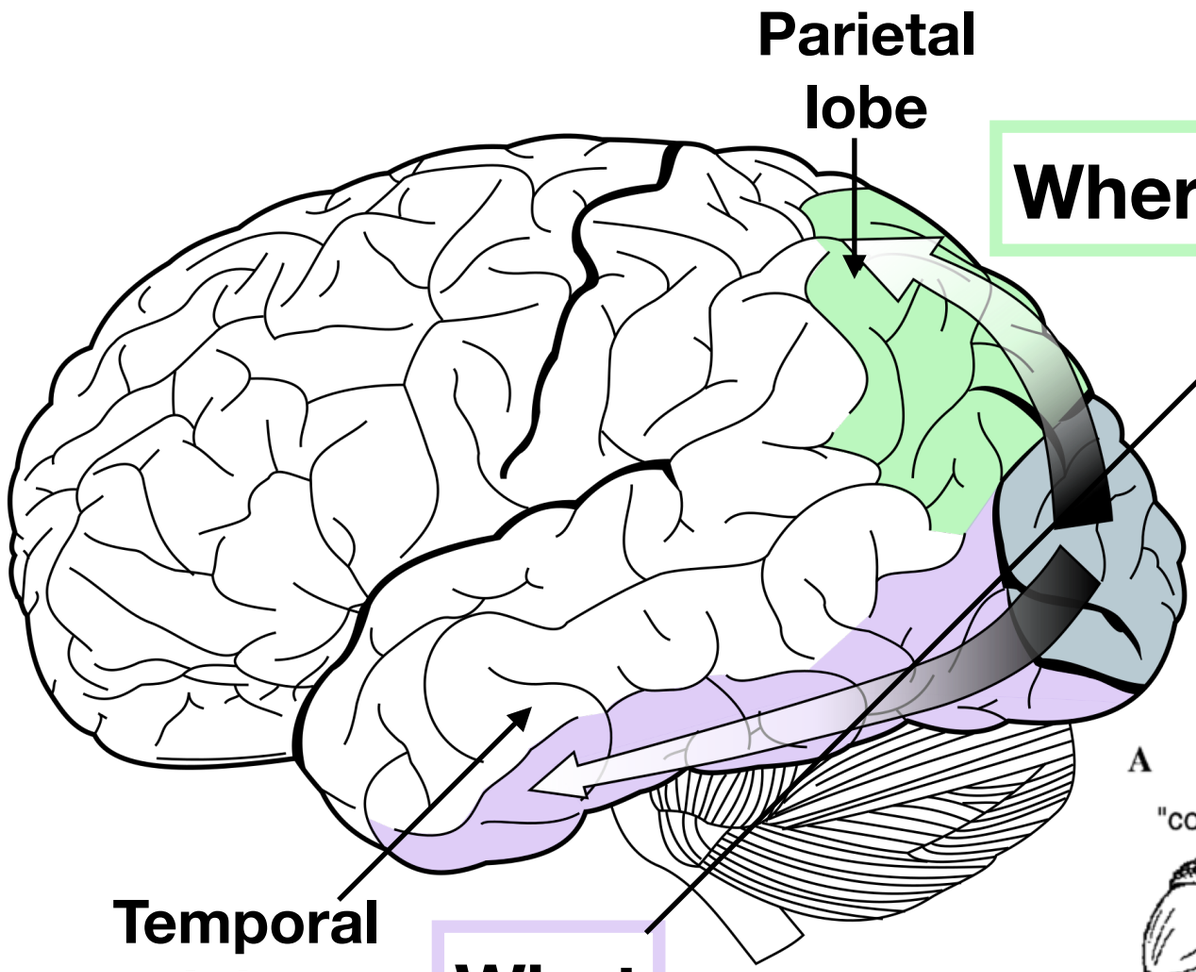
Breaks



McGee, Mental Status exam, 2012

Note: colors do not correspond to visual tracts slide!

Visual Field Processing



What system

Object recognition

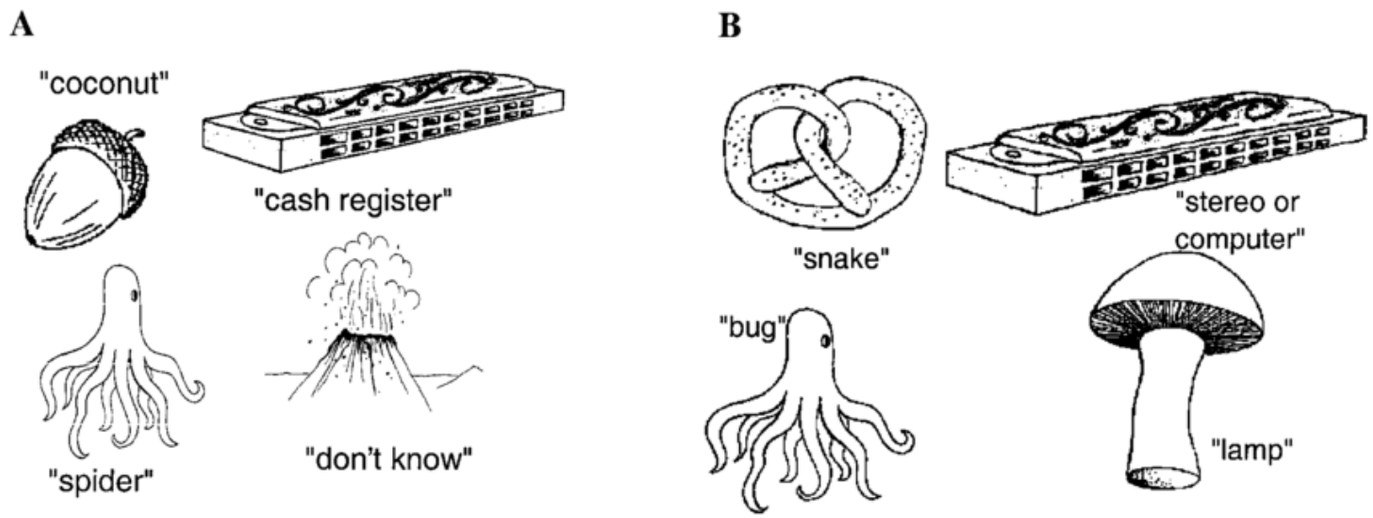
Detailed but slow

Color recognition

Fovea (local)

Breaks

“visual agnosias”



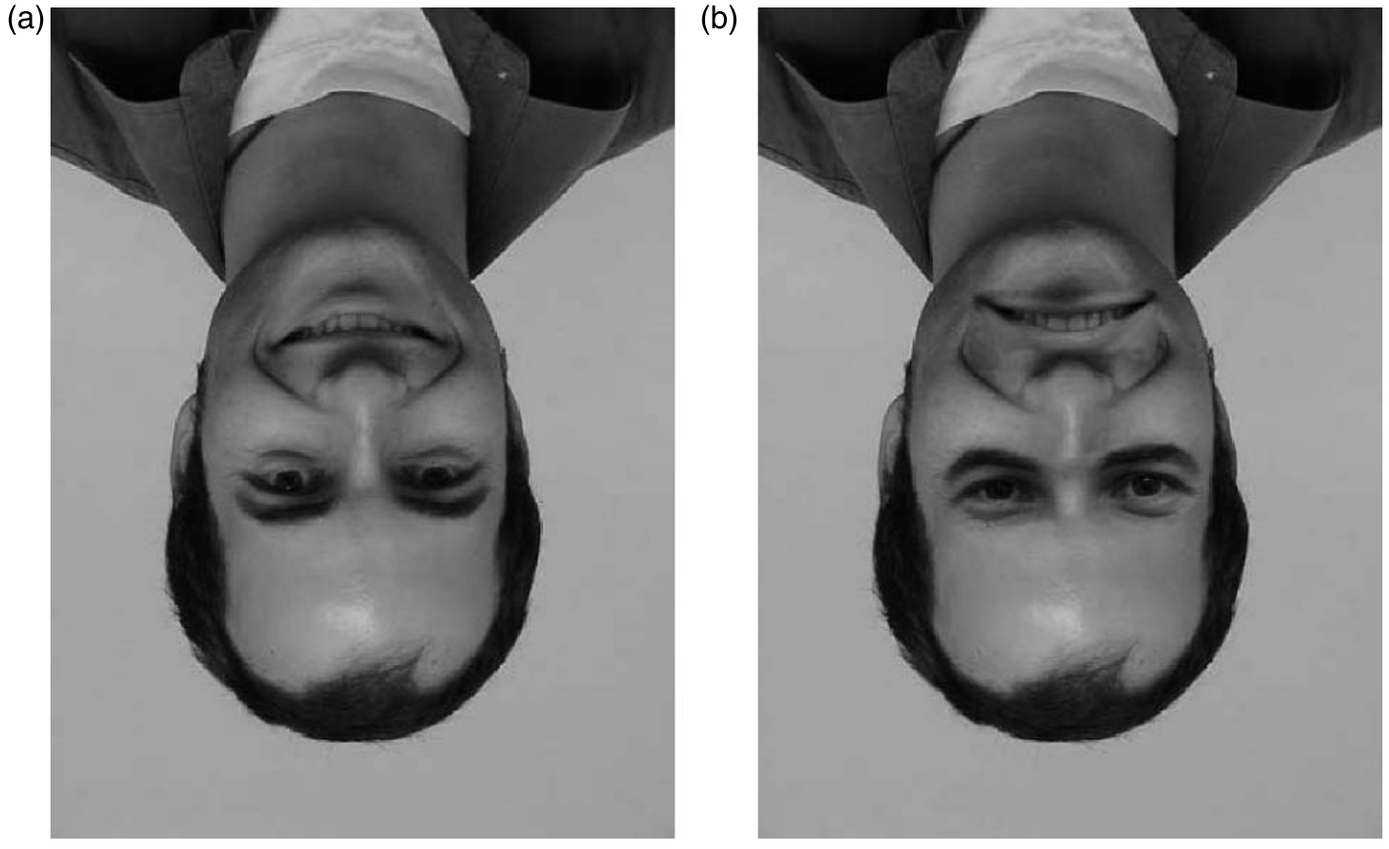
Responses of “S.M.” and “R.N.”, Behrmann 2003

Face blindness

Note: colors do not correspond to visual tracts slide!

Object Recognition is local

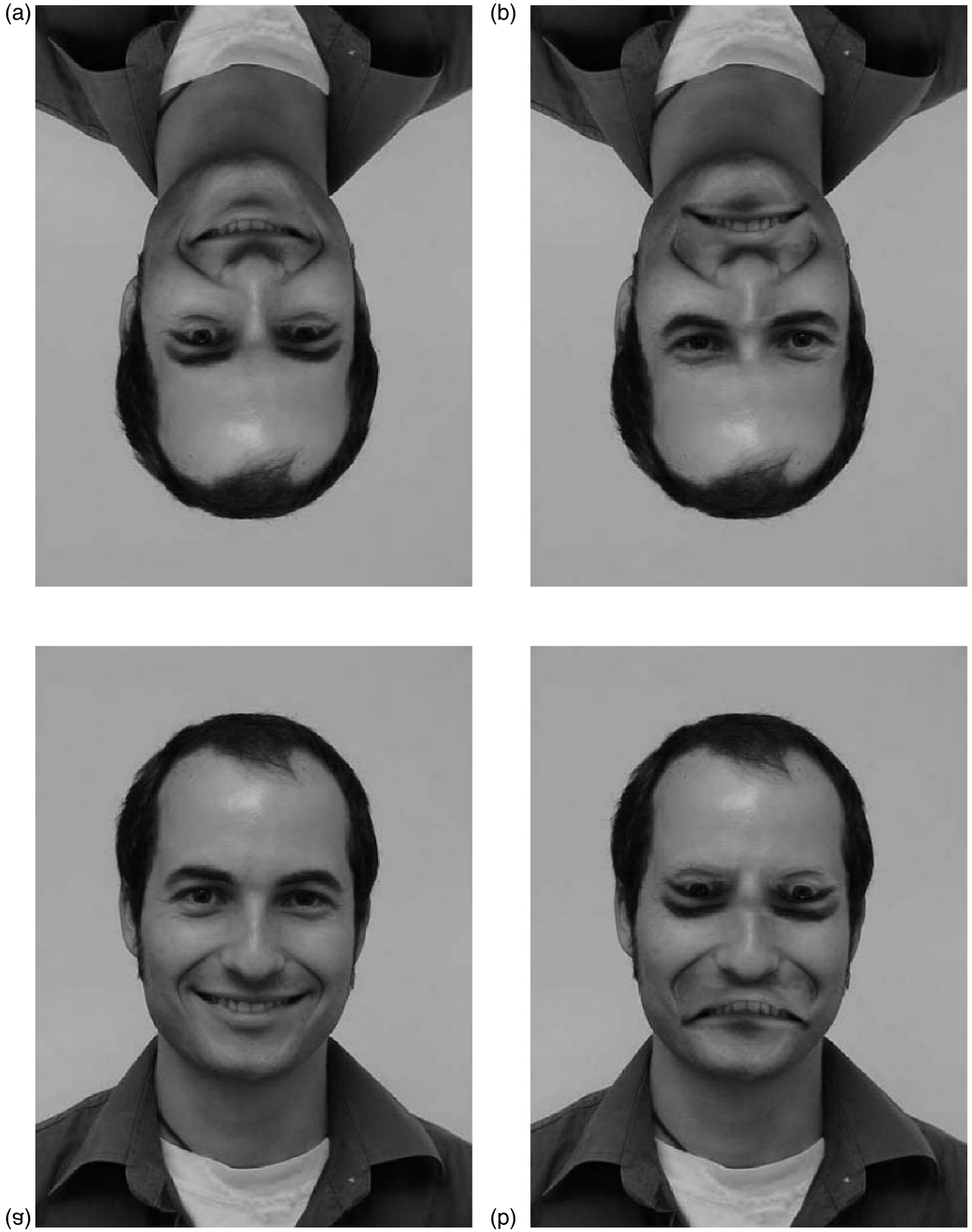
Face Recognition is special!



Grüter et al. 2008 *J Neuropsychology*

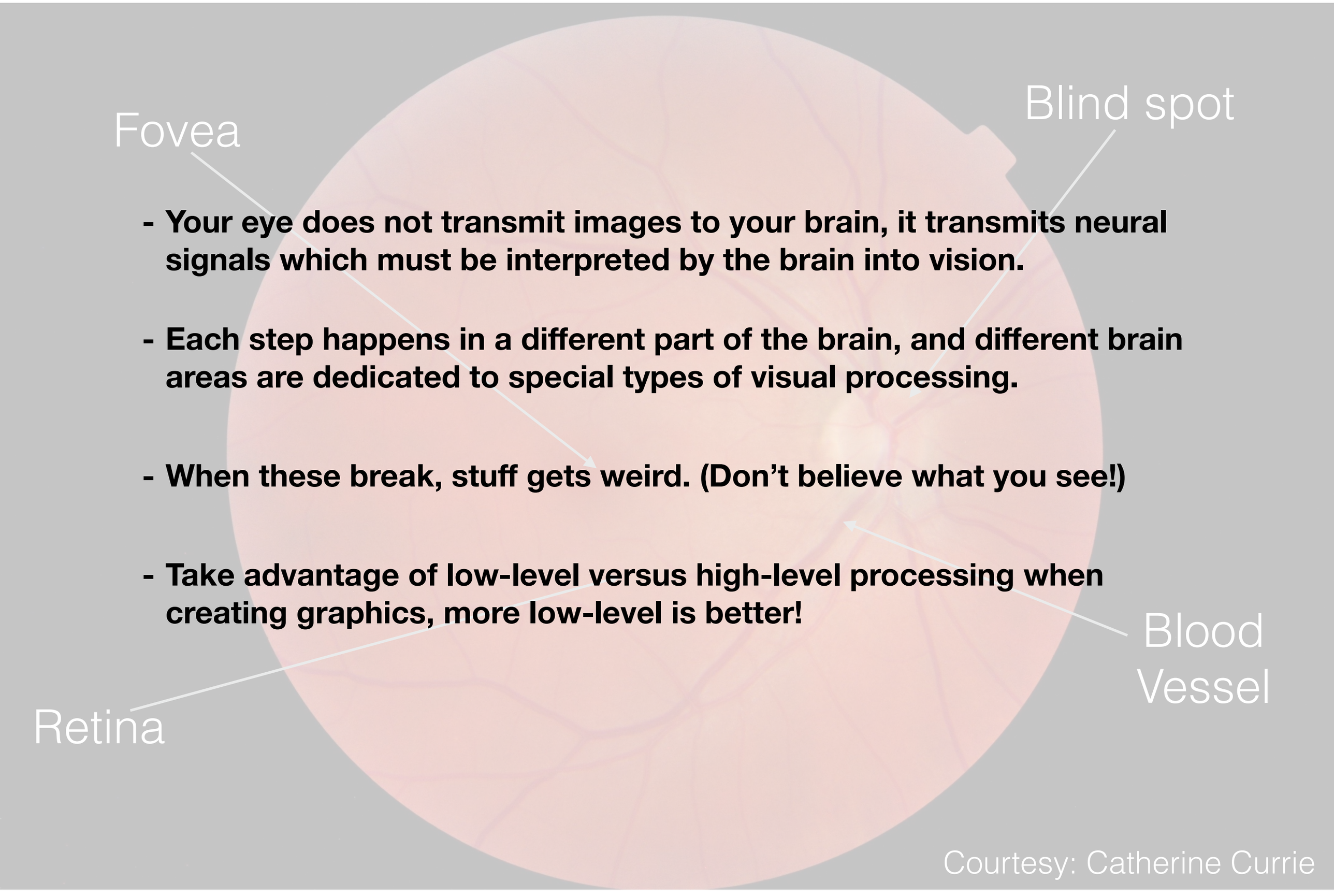
Object Recognition is local

Face Recognition is special!



Grüter et al. 2008 *J Neuropsychology*

2. You don’t see by transmitting images



- **Your eye does not transmit images to your brain, it transmits neural signals which must be interpreted by the brain into vision.**

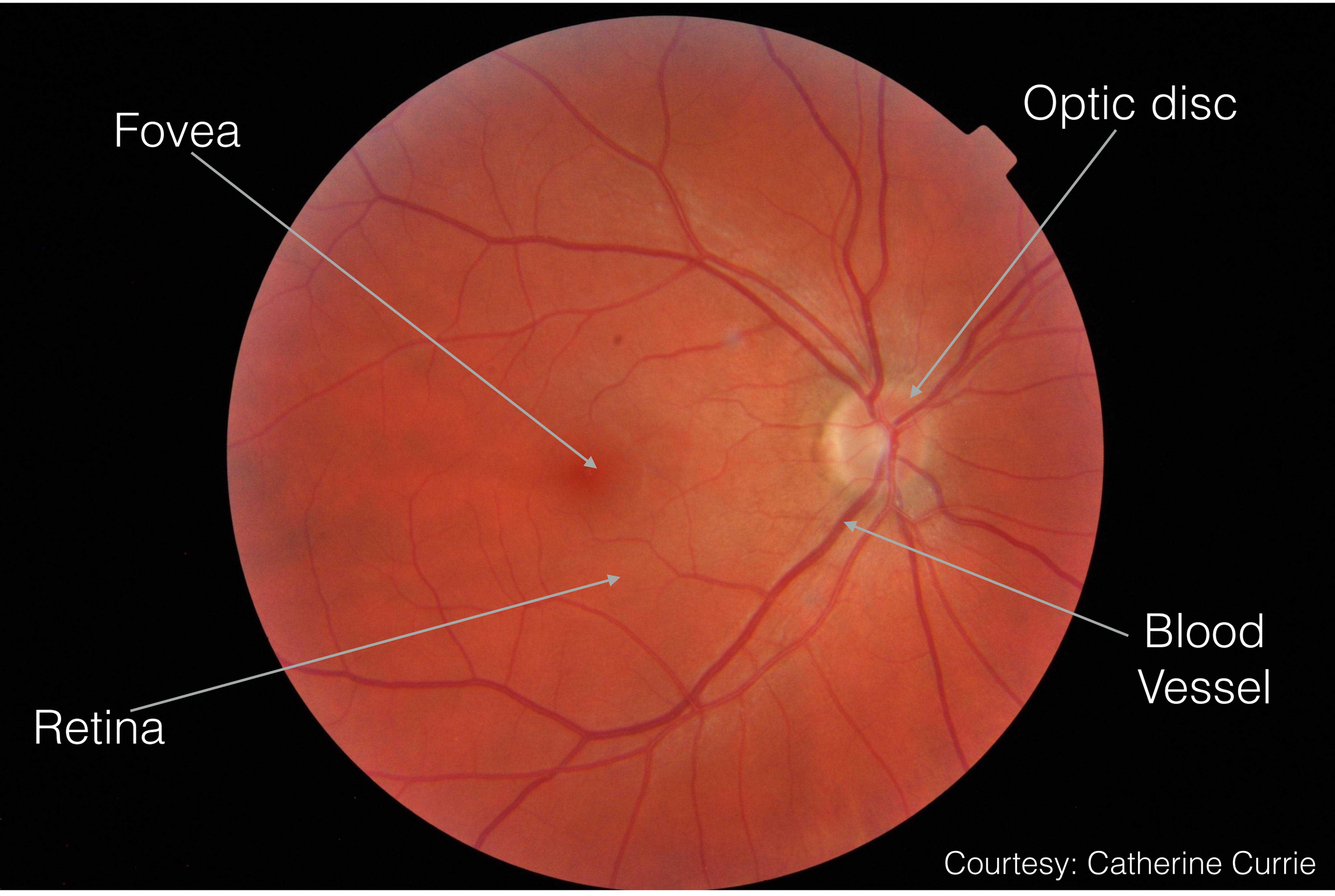
- **Each step happens in a different part of the brain, and different brain areas are dedicated to special types of visual processing.**

- **When these break, stuff gets weird. (Don’t believe what you see!)**

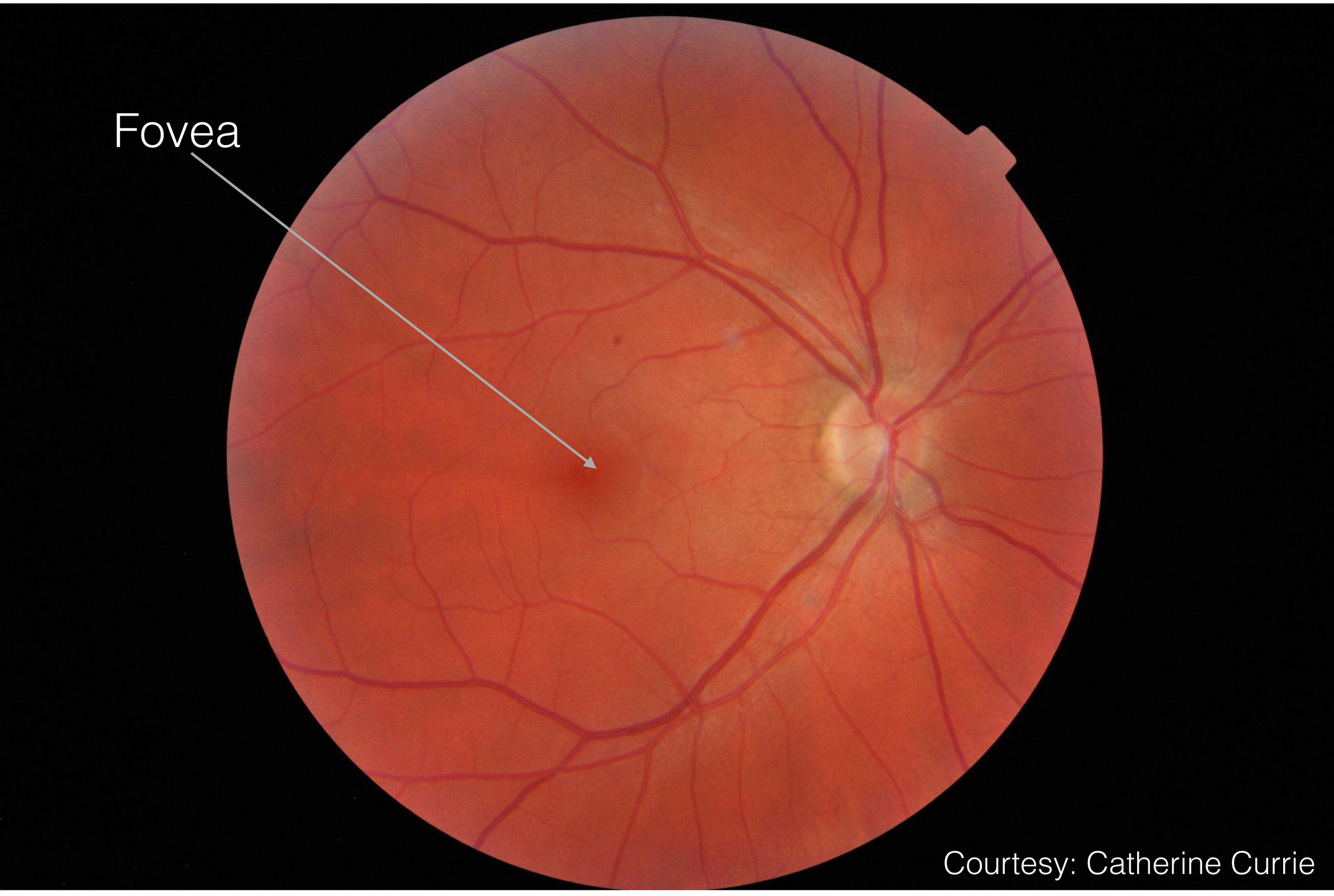
- **Take advantage of low-level versus high-level processing when creating graphics, more low-level is better!**

Courtesy: Catherine Currie

3. Acuity drops from the center of vision

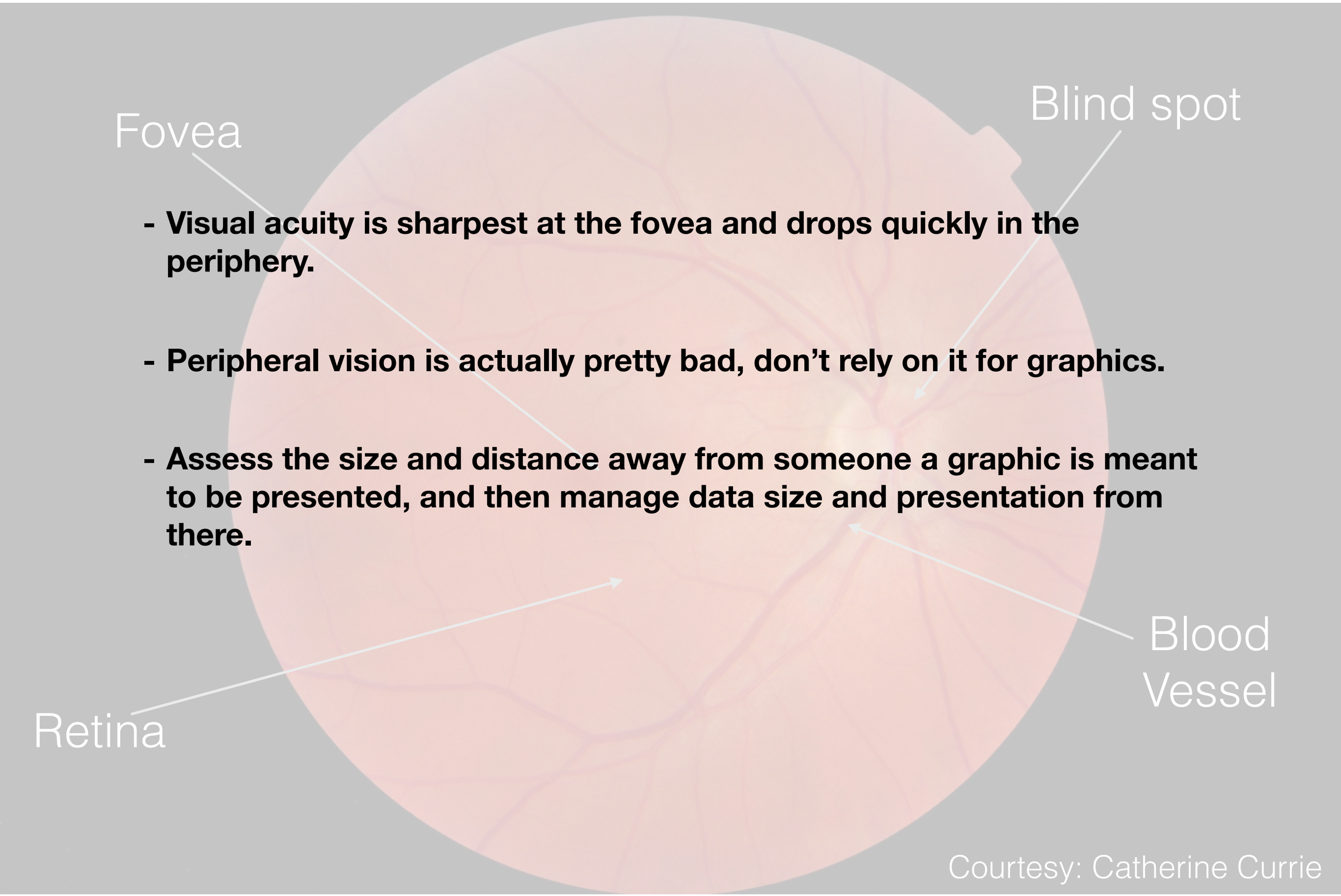


3. Acuity drops from the center of vision



Acuity is high centrally and drops of peripherally.

3. Acuity drops from the center of vision



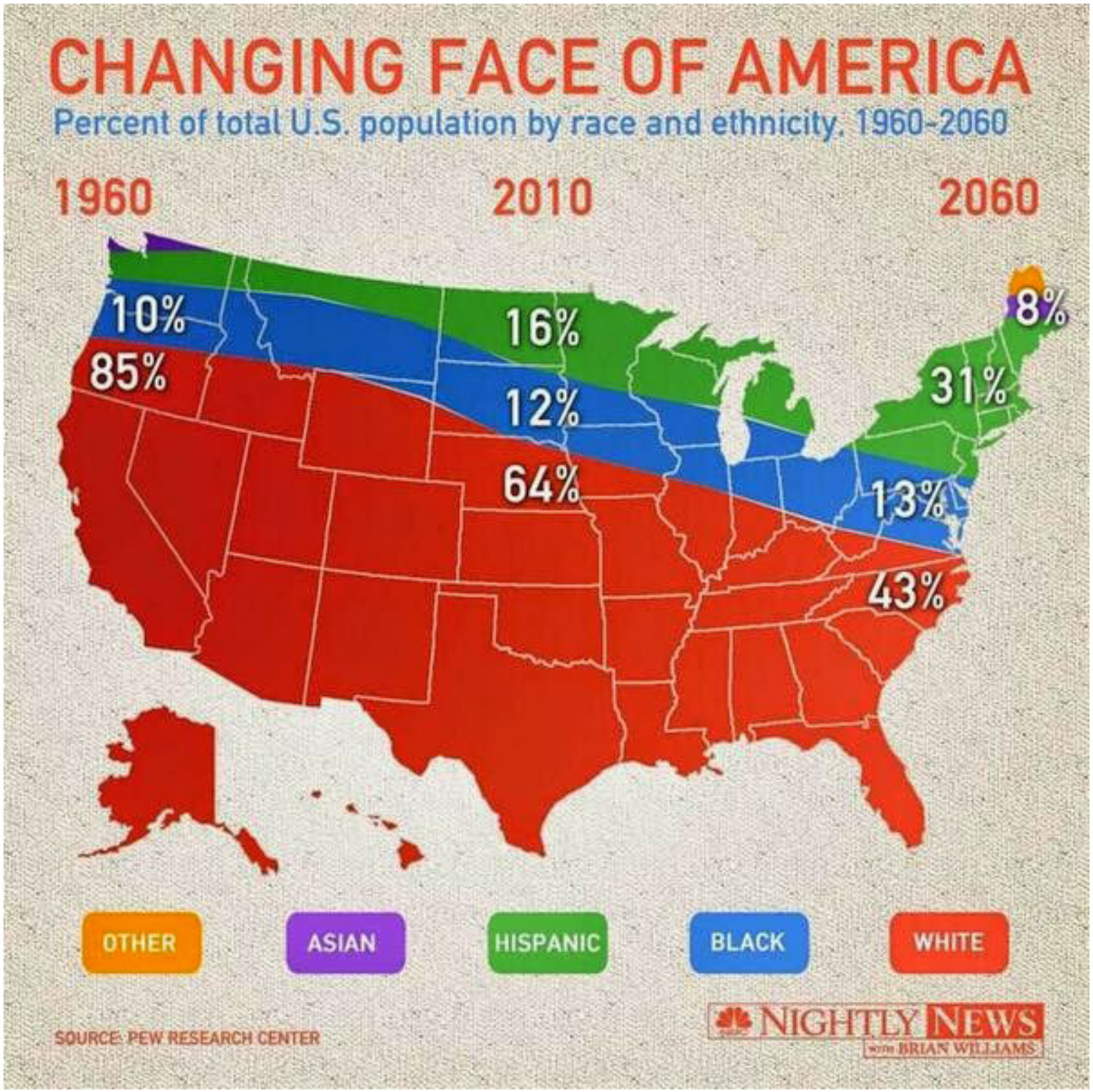
- **Visual acuity is sharpest at the fovea and drops quickly in the periphery.**

- **Peripheral vision is actually pretty bad, don’t rely on it for graphics.**

- **Assess the size and distance away from someone a graphic is meant to be presented, and then manage data size and presentation from there.**

Courtesy: Catherine Currie

How can we make this visualization better?



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.

Kuffler SW. 1953. Discharge patterns and functional organization of mammalian retina. J Neurophysiol 16: 37-68.

Livingstone M. 2014. “What Can Art Tell Us about the Human Brain?” UC Irvine Lecture, Youtube: https://www.youtube.com/watch?v=fwPqSxR-Z5E

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

Muir D. 2012. H. Keffer Hartline and lateral inhibition: a brief biography of an influential idea. 30th Oct. dylan-muir.com.

Wyttenbach RA. 2012. Exploring sensory neuroscience through experience and experiment. J Under Neuro Ed 11(1): A126-A131.

Additional Resources

http://adv-r.had.co.nz/Profiling.html#parallelise –
Optimization: parallelise, in *Advanced R*

https://cran.r-project.org/web/packages/foreach/vignettes/foreach.html –
foreach package vignette

https://citeseerx.ist.psu.edu/viewdoc/download?
doi=10.1.1.467.9918&rep=rep1&type=pdf –
***Parallel Computing for Data Science*, by Norman Matloff**