Perception Week 2

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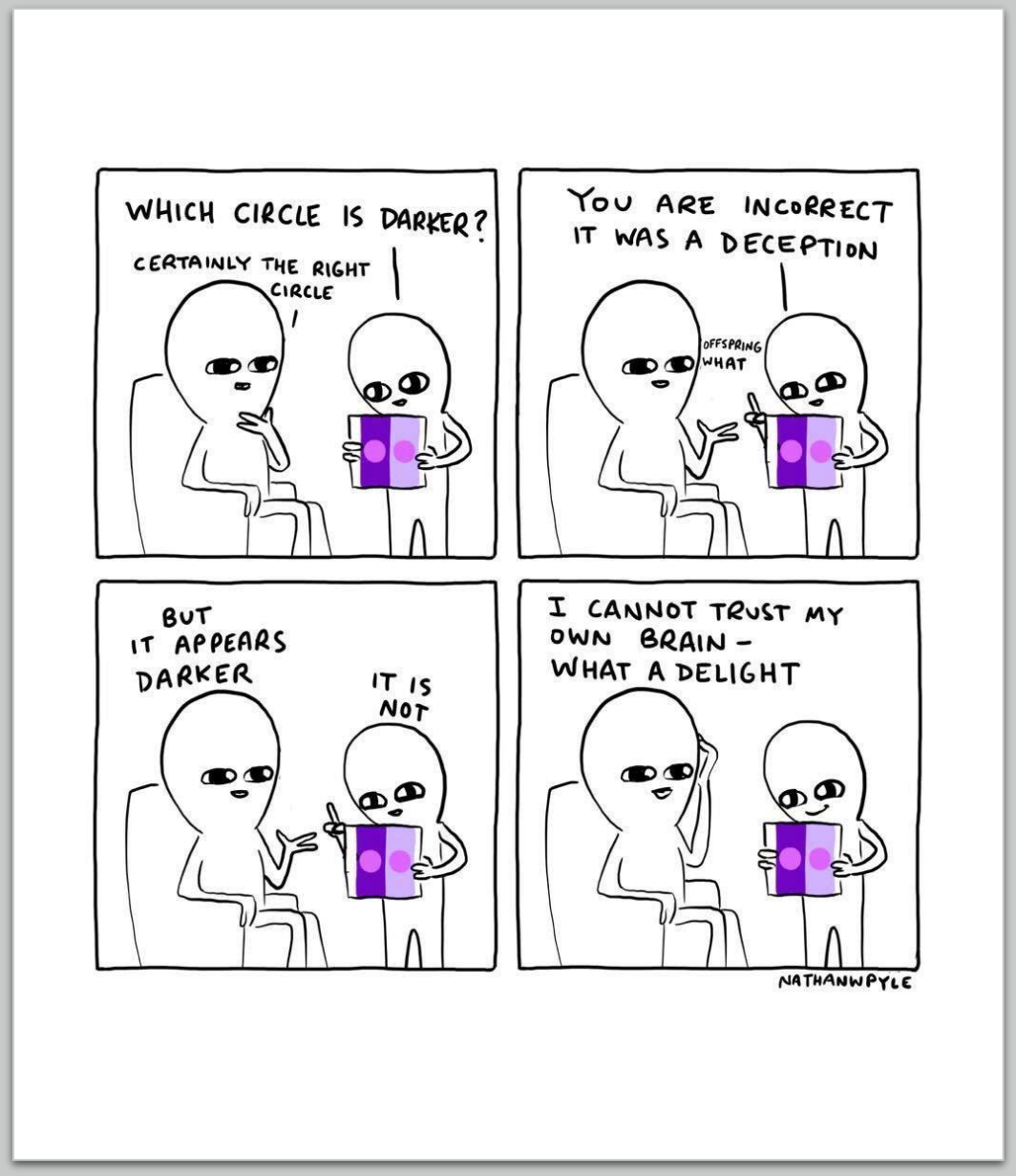


https://www.nathanwpyle.art/

Recap: Your perception is unique and influenced by many variables

- For more information about this: Kroupin, I., Davis, H. E., Lopes, A. J. P., Konkle, T., & Muthukrishna, M. (2025, February 13). Visual illusions reveal wide range of cross-cultural differences in visual perception. PsyArXiv. Retrieved from osf.io/preprints/psyarxiv/gxzcp_v2
- https://www.science.org/content/article/culture-literally-changes-how-we-see-world

By the end of the first part of this lecture, you will be able to:

- Discuss different methodologies used to examine perception and the brain and understand how different research questions require different methodology/tools
- Understand how we use psychophysics to relate physical stimuli to experiences and perception
- Understand how we can use signal detection theory to examine the decision-making process associated with perception
- Explain how looking at development can help us understand sensation and perception

Outline

Perception and the Brain

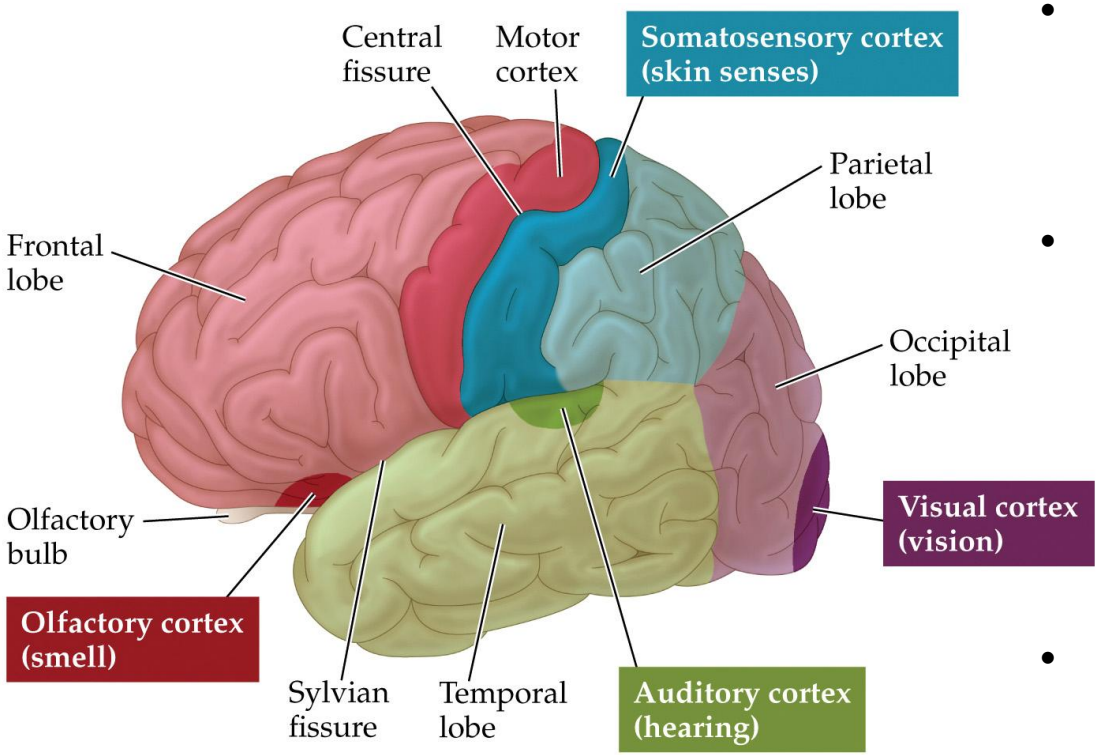
Psychophysics

Signal detection theory

Development

Perception and the Brain

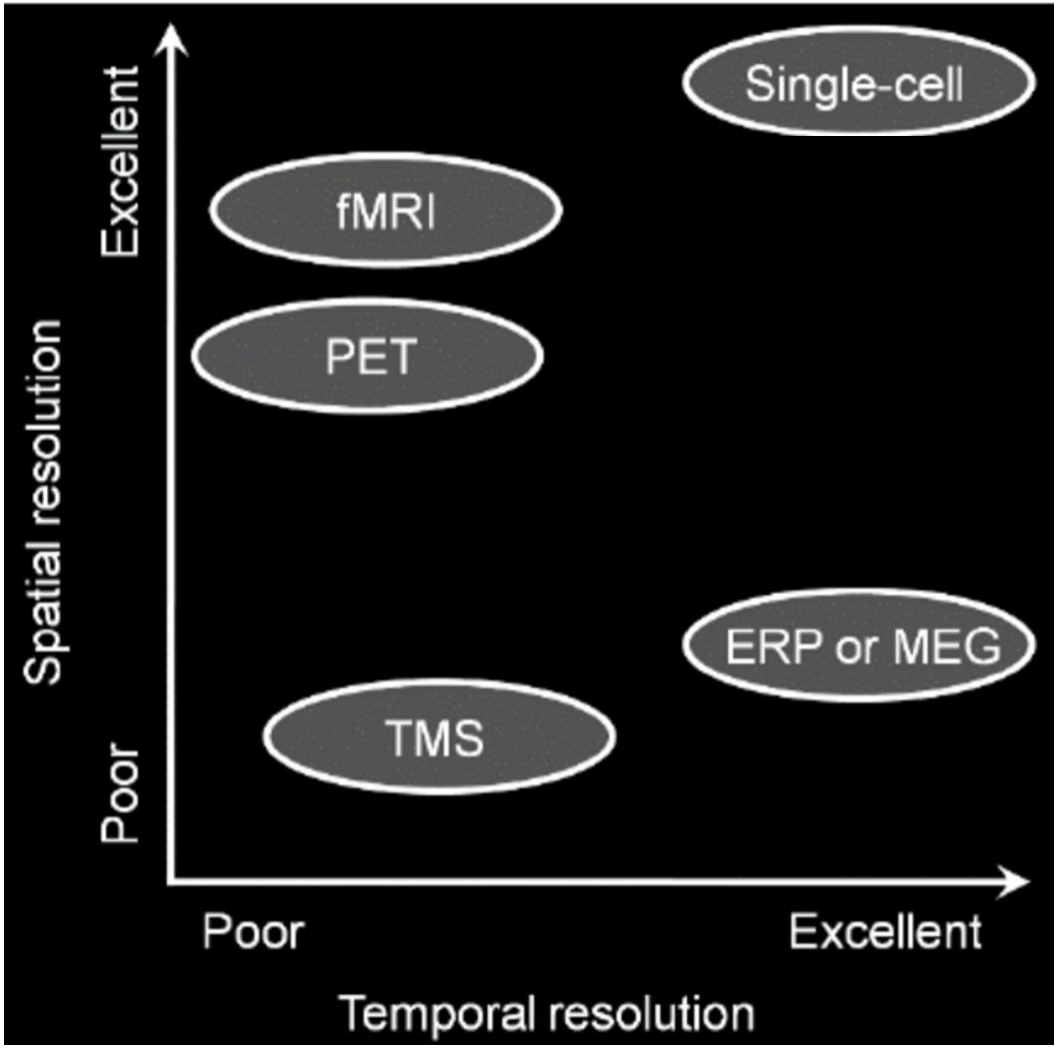
Cortex of the human brain



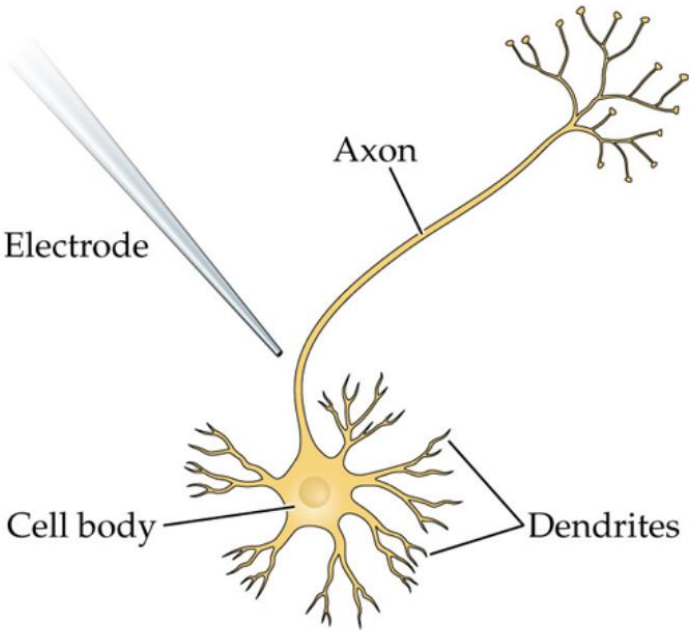
SENSATION & PERCEPTION 5e, Figure 1.21

- Different cortical areas are dedicated to specific sensory and motor tasks
- Some brain areas are polysensory (information from several senses is combined)
- Complex tasks typically involve the coordinated activity of many brain areas

Brain imaging techniques: Spatial and Temporal Resolution



Single-Cell Recording: Measuring action potentials to identify the stimulus that makes a neuron fire

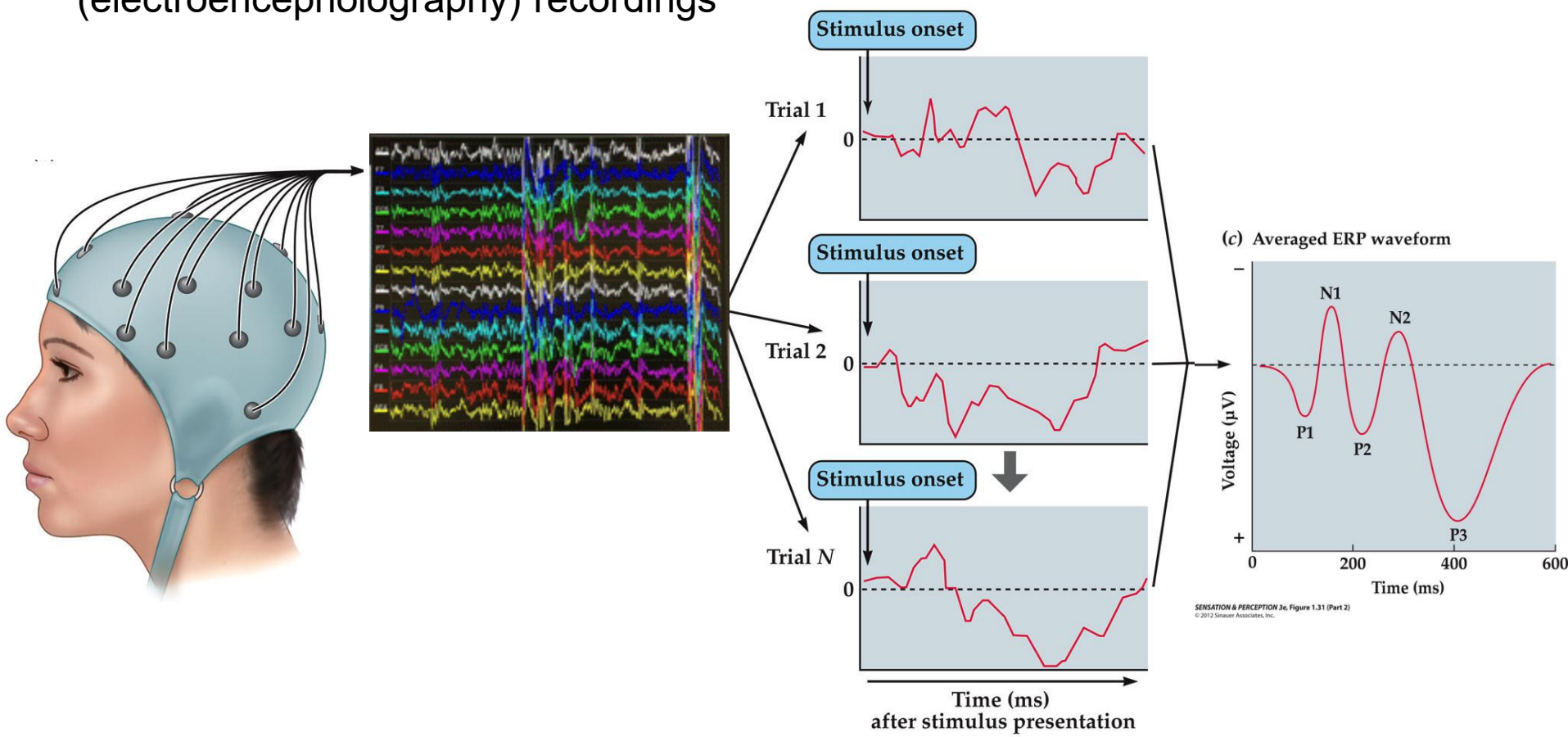


To investigate what information a neuron encodes, neuroscientists can record the activity of single neurons by placing electrodes close to the axons of neurons

e.g., to what type of visual information does a neuron in the primary visual cortex respond?

High Temporal Resolution Techniques: Event-Related Potential (ERP)

Event-related potential (ERP): A measure of electrical activity from many neurons in response to a particular stimuli that requires averaging many EEG (electroencephalography) recordings



Ex: How *quickly* can 6-month-old babies determine that two sounds they are hearing are different?

High Temporal Resolution Techniques: MEG

Magnetoencephalography (MEG): measures changes in magnetic activity across populations of many neurons in the brain

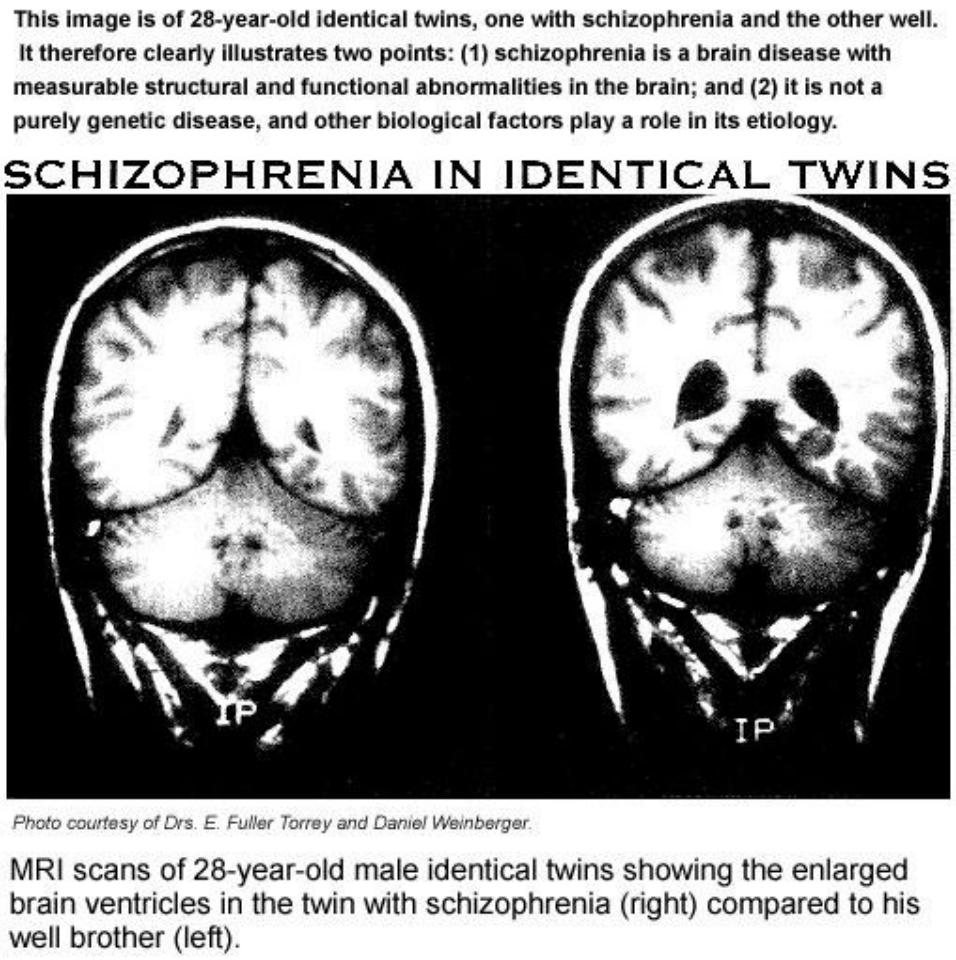
Ex: How quickly are 1-year-olds able to perceive depth in their environment?

Brain imaging technologies with high spatial resolution

CT scan and MRI only take anatomical scans!

Computerized tomography (CT): uses X-rays to create images of slices through volumes of material (e.g., the human body)

Magnetic resonance imaging (MRI): uses the responses of atoms to strong magnetic fields to form images of structures like the brain

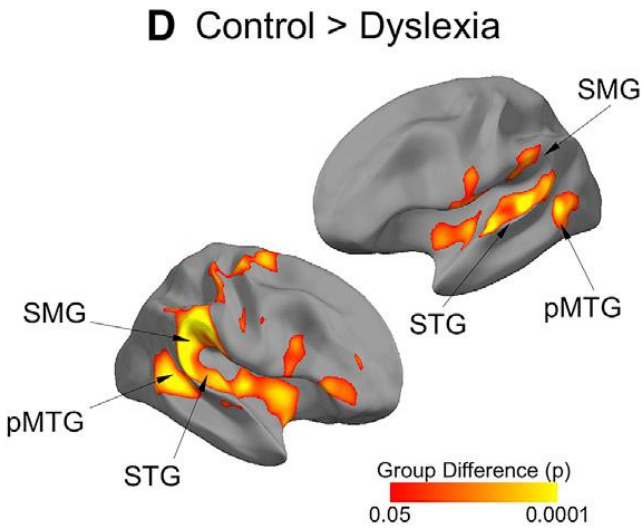


Ex: Are there any structural brain differences in people with and without schizophrenia?

High Spatial Resolution Techniques: Functional Magnetic Resonance Imaging (fMRI)

A variant of MRI that makes it possible to measure localized patterns of activity in the brain from changes in blood flow during task performance

Ex: What parts of the brain are activated when people with and without dyslexia perform an auditory processing task?



Perrachione, T.K., Del Tufo, S.N., Winter, R., Murtagh, J., Cyr, A., Chang, P., Halverson, K., Ghosh, S.S., Christodoulou, J.A. & Gabrieli, J.D.E. (2016). Dysfunction of rapid neural adaptation in dyslexia. Neuron, 92, 1383-1397.

What type of brain imaging tool could you use if you were interested in determining what part of the brain was activated when looking at pictures of faces?

0

A technique with high temporal resolution

0

A technique with high spatial resolution

0

A technique with low temporal resolution

0

A technique with low spatial resolution

0

None of the above

0

Math and Computation Models

- Bayesian models: Use Bayesian statistics to make predictions (predictive coding) based on prior knowledge about the world.
- Artificial neural networks: Computers simulate biological neurons with layers of input units massively interconnected with output units that can excite or inhibit each other (eg, deep neural nets)

Psychophysics

Psychophysics

- Examining (and quantifying) the relationship between physical and psychological (subjective) events
- Examining perceptual thresholds

Absolute Threshold

Objective: You are trying to detect the minimum intensity (loudness) for your phone ringer so you can hear it

Experiment: Turn volume down and then slowly increase phone's volume until you can detect it ringing

Absolute Threshold

This is what your results would look like:

Absolute threshold: the minimum sound intensity (loudness) at which you can detect the ring 50% of the time

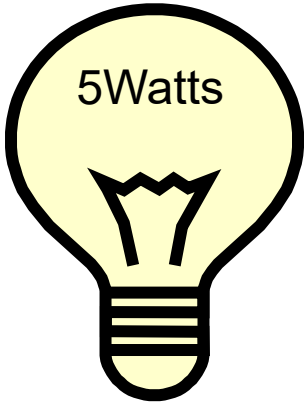
Just Noticeable Difference (JND)

- Now that you hear the phone ring, how much louder does it have to be for you to notice a change?
  - JND: smallest detectable difference between two stimuli, or the minimum change in a stimulus that can be correctly judged as different from a reference stimulus
  - The size of the JND depends on the intensity of the reference (initial) stimulus

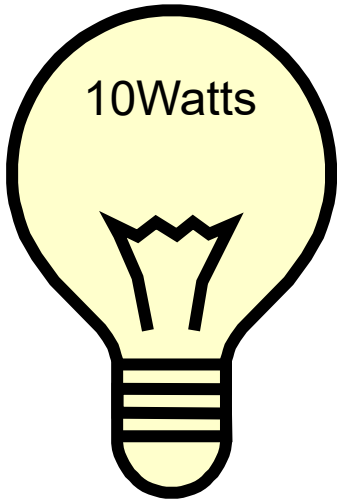
JND

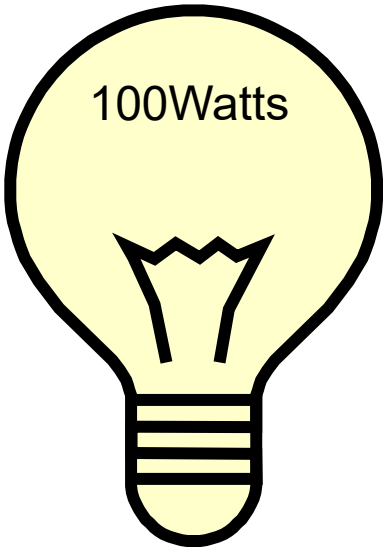
Initial Stimulus

Same or Different?

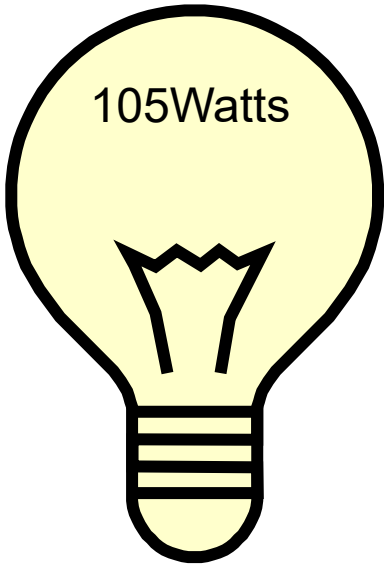


+ 5 watts





+ 5 watts



You would be less likely to notice this 5-watt increase

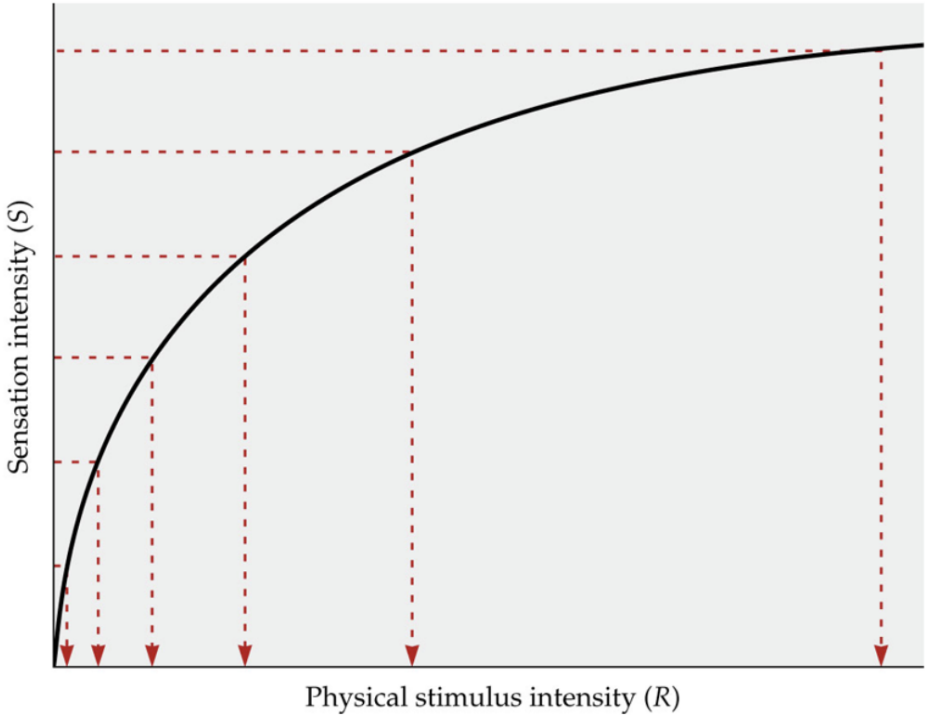
Weber-Fechner Laws

•Weber's Law: The perceived change in stimuli is proportional to the initial stimuli

- *In other words: the larger the initial stimulus intensity, the larger the JND intensity*

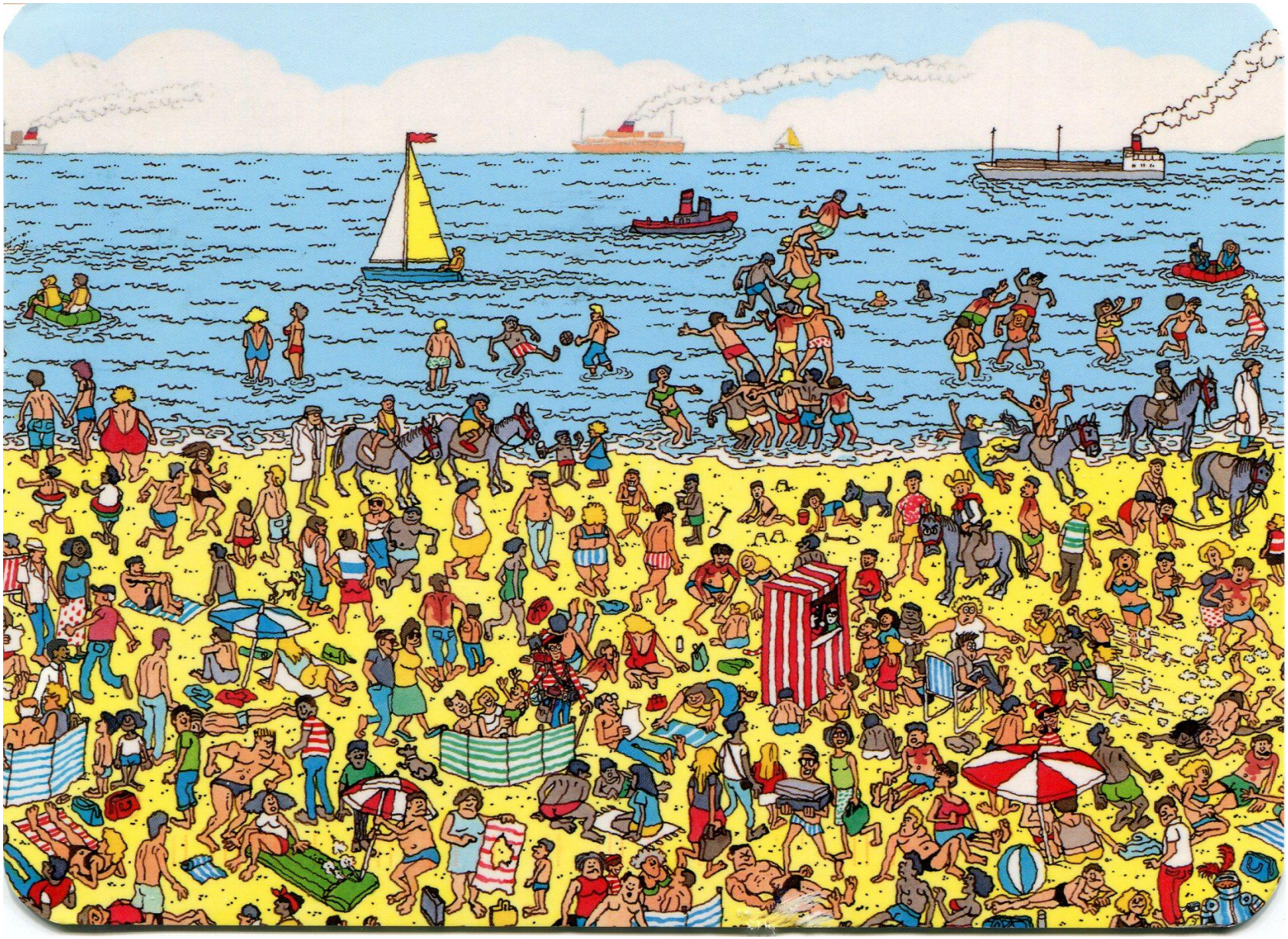
•Fechner's Law: Mathematical extension of Weber's Law

- *In other words: as the intensity of the stimulus increases, we perceive it as being more intense (logarithmically). Our psychological experience of the stimulus increases less quickly than the actual physical stimulus increases*



Signal Detection Theory

Finding the “signal” embedded in the noise...



Signal Detection Theory

Quantifies the response of an observer to the presentation of a signal in the presence of noise

Stimulus

	Signal present	Signal absent

Signal Detection Theory

Quantifies the response of an observer to the presentation of a signal in the presence of noise

Stimulus

Did you perceive stimulus?	Signal present	Signal absent
"YES"		
"NO"		

Responses

Quantifies the response of an observer to the presentation of a signal in the presence of noise

Stimulus

Did you perceive stimulus?

	Signal present	Signal absent
"YES"	**HIT**	
"NO"		**CORRECT REJECTION**

Responses

Quantifies the response of an observer to the presentation of a signal in the presence of noise

Stimulus

Did you perceive stimulus?	Signal present	Signal absent
"YES"	HIT	FALSE ALARM
"NO"	MISS	CORRECT REJECTION

Misses and false alarms are both errors. The severity of each can vary depending on the situation.

What factors might impact your ability to detect the music/a stimulus?

- How loud the song is playing
- Hearing ability
- Musical training
- Types of noise
- Background noise
- external sounds
- Too noisy
- White noise in background
- how loud the static is
- pitch of distraction noise
- level of focusing
- eyes closed/open
- Attention
- expectations
- concentration abilities
- Knowing what you're listening for
- Expectations
- familiarity
- seeing someone else's answer and letting it impact your answer
- thinking you have to hear something so trying to force yourself to hear

And more!

Factors impacting detection and decision

1. Stimulus intensity (think about absolute threshold – too small, won't be detected)

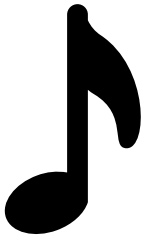
2. Noise in the environment (other distractors, like any other sounds)

3. Criterion a person sets for deciding if stimulus was present

Sensitivity (d’ = d prime):
ability to differentiate between signal and noise

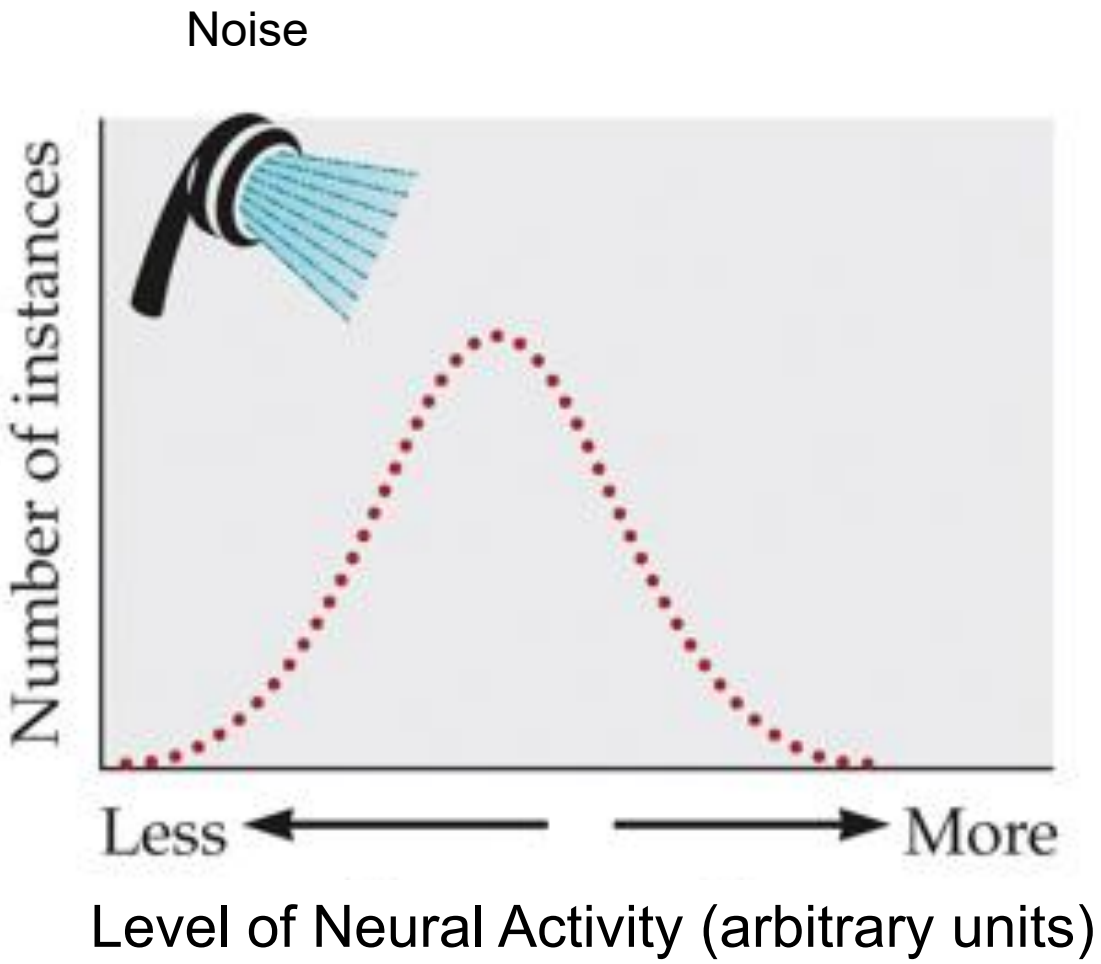
Signal and noise intensity will impact whether we detect the signal (or stimulus) in our environment

Large signal intensity
Small noise intensity
High sensitivity = larger d’ values

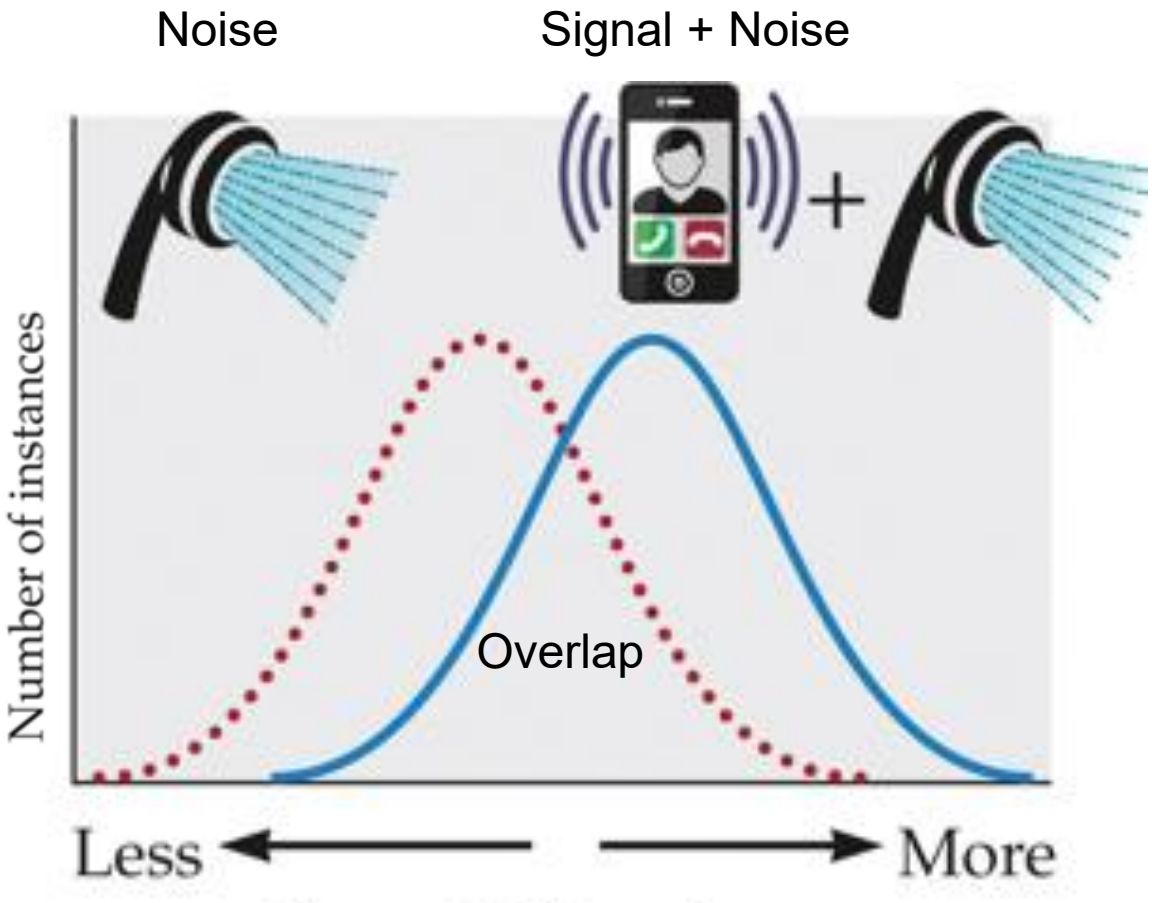


Small signal intensity
Large noise intensity
Low sensitivity = smaller d’ values

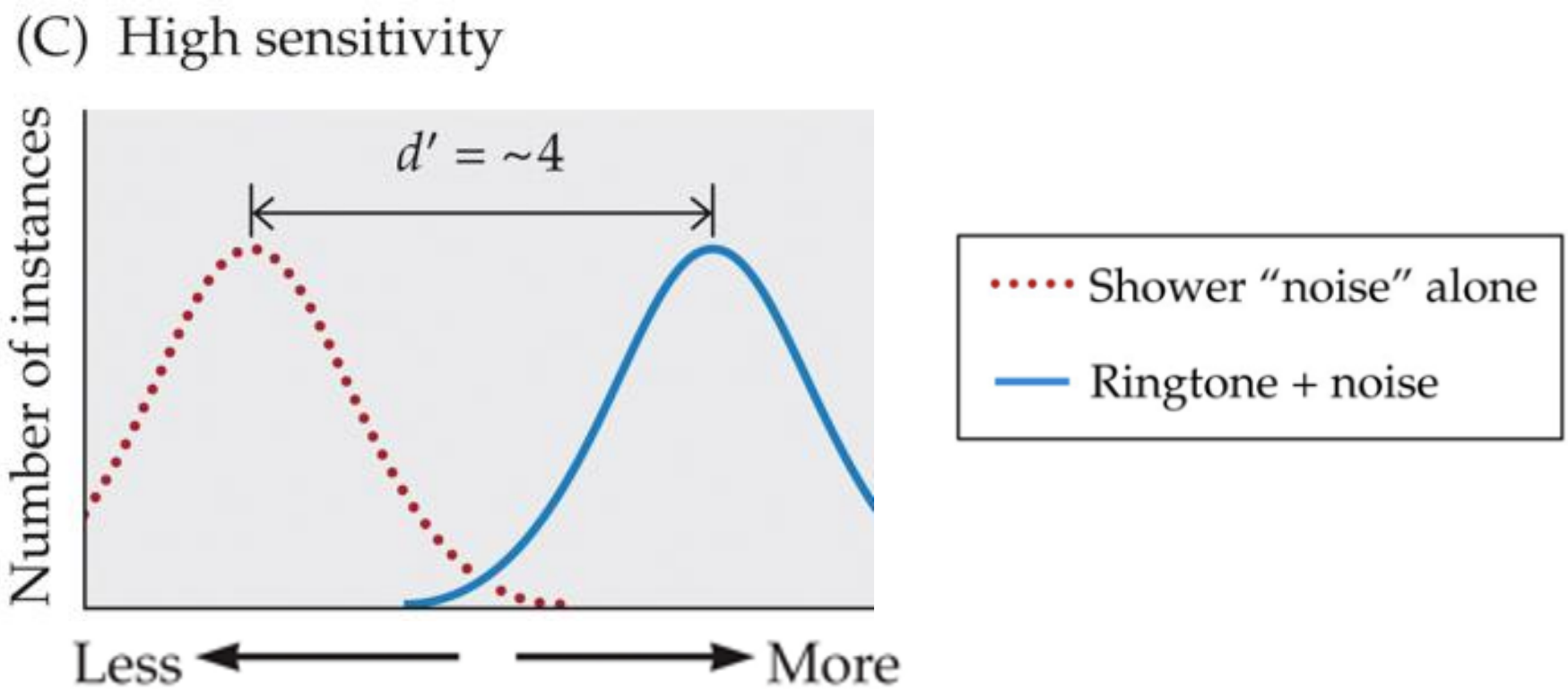
Noise


Noise
Number of instances
Less
More
Level of Neural Activity (arbitrary units)

Signal + Noise



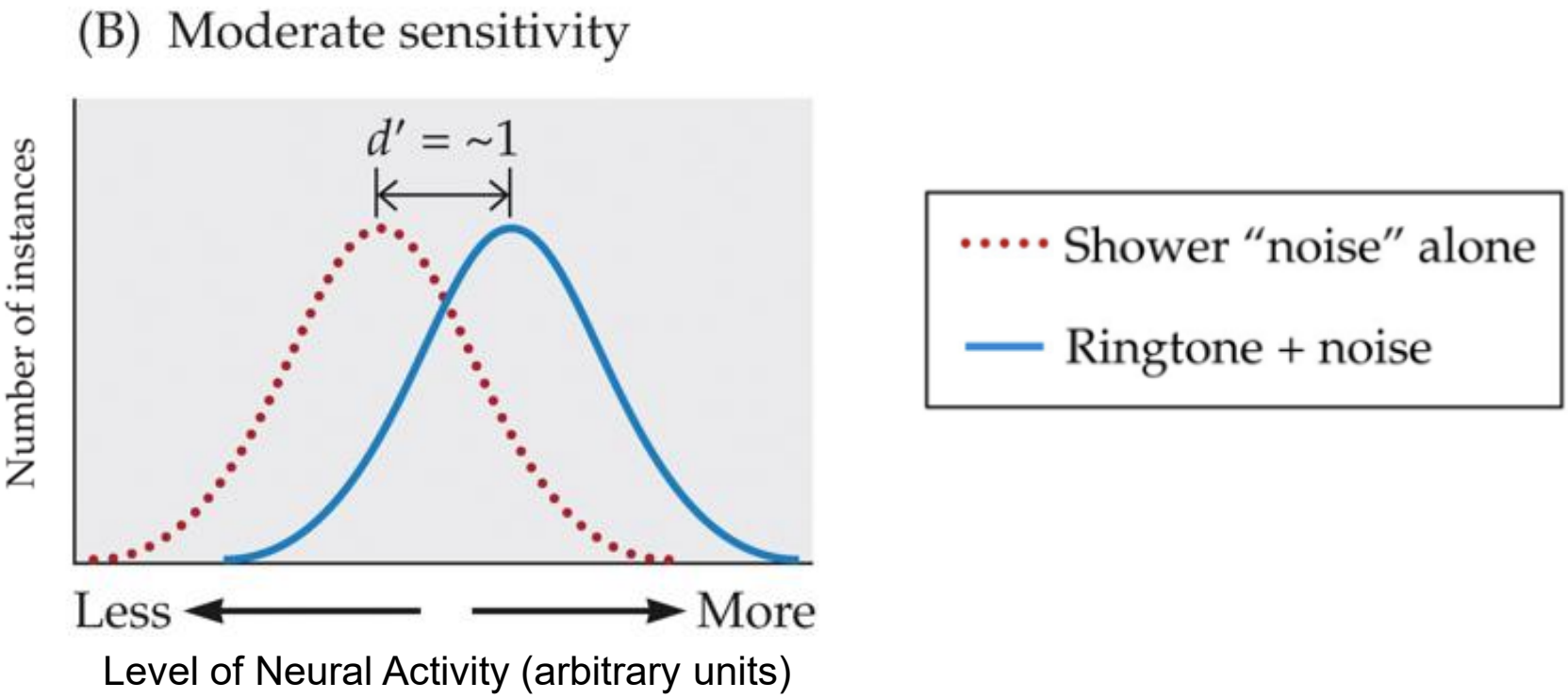
Sensitivity (d')



Larger d' values = greater ability to detect ringing phone

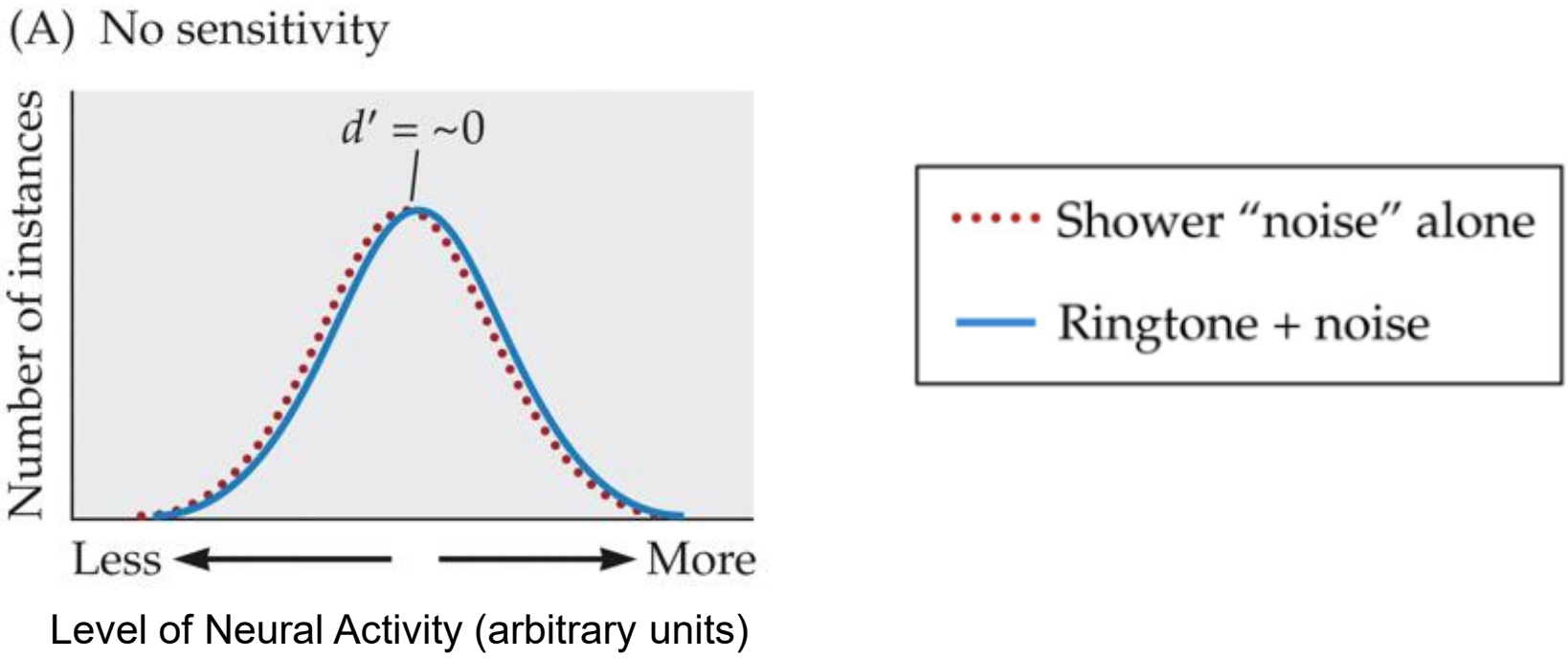
Large signal intensity
Small noise intensity
High sensitivity = larger d' values

Sensitivity (d')



Small signal intensity
Large noise intensity
Low sensitivity = smaller d' values

Sensitivity (d')



Sometimes the difference between the signal and noise is so small that you are not able to differentiate between them. In this case, d' would be 0 (or close to it).

Factors impacting detection and decision

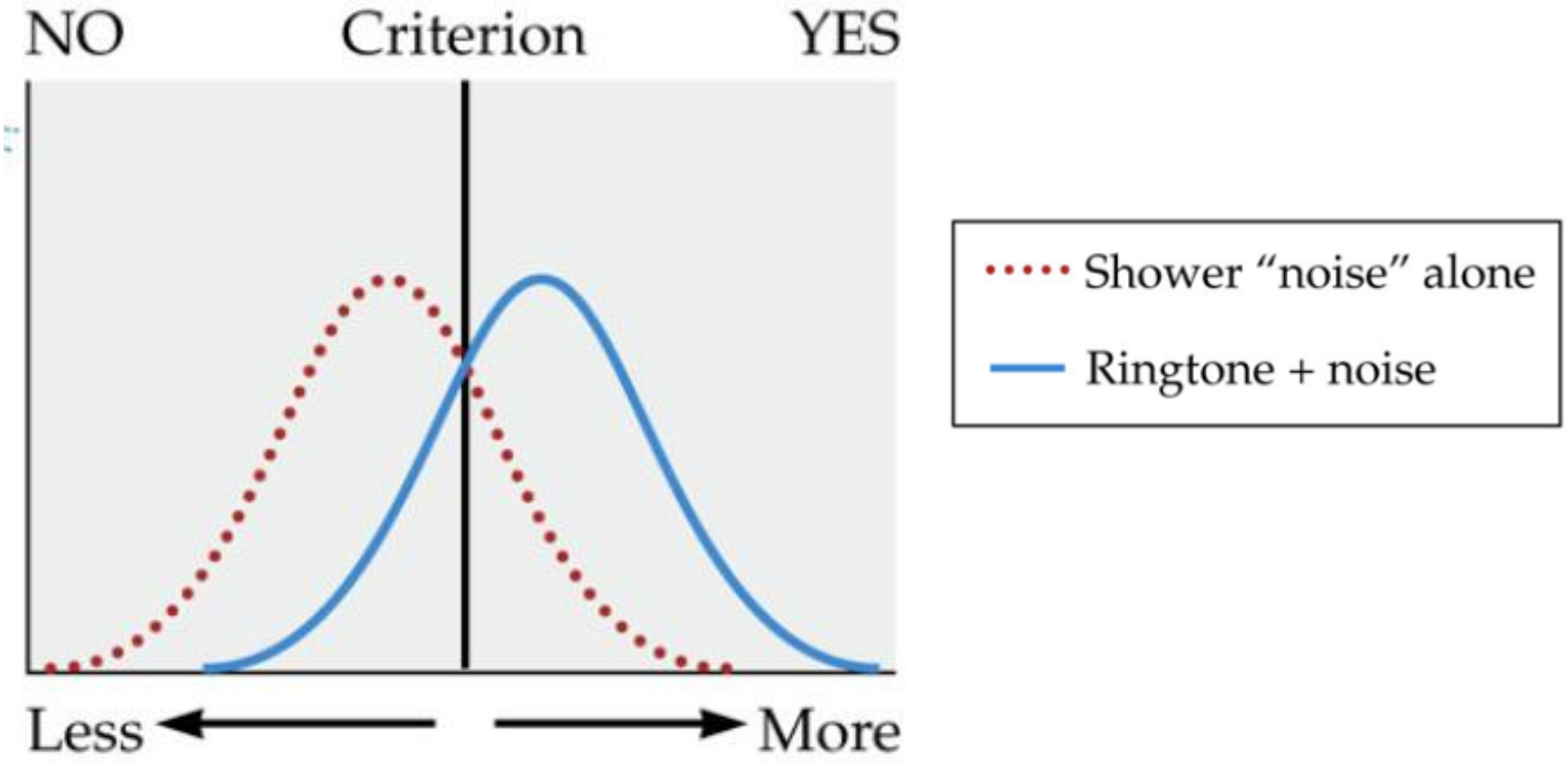
1. Stimulus intensity (think about absolute threshold – too small, won't be detected)

2. Noise in the environment (other distractors, like other normal or abnormal spots on the image)

3. Criterion a person sets for deciding if stimulus was present

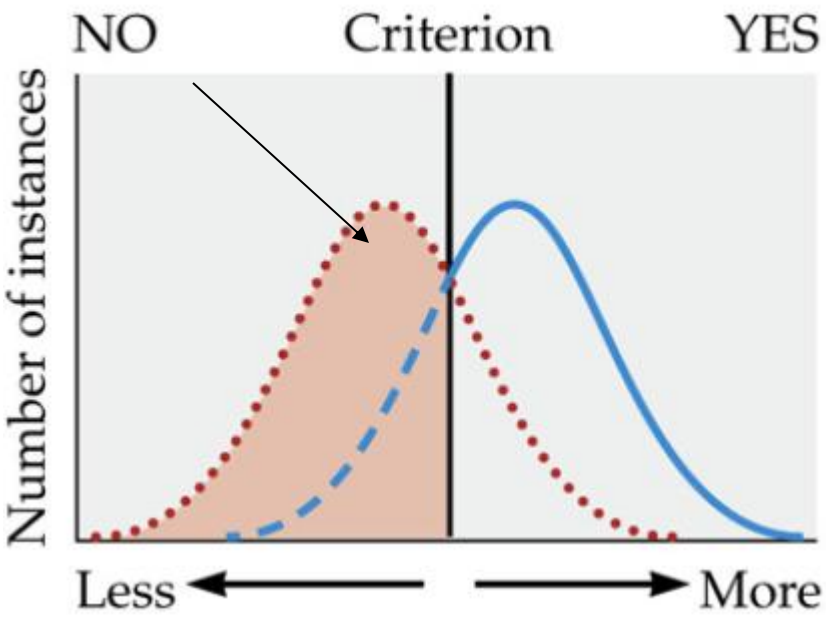
Response bias (also called “response criterion”)

Criterion a person sets for deciding if stimulus was present



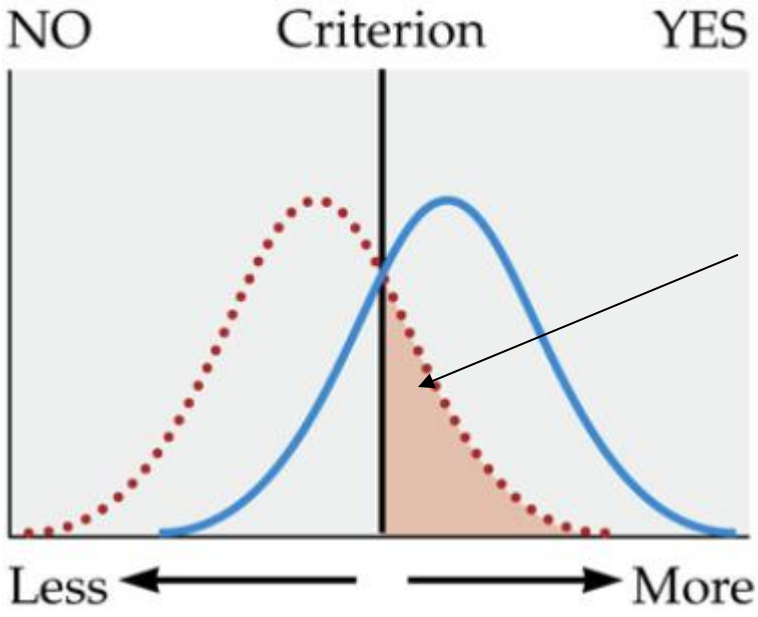
Response bias (also called “response criterion”)

Let’s first look at the dotted red curve (reality: the ringtone is ABSENT)



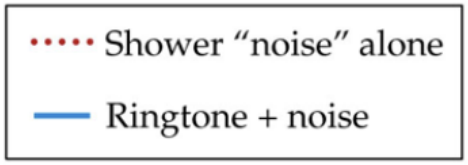
Shaded area: You did not detect the ringtone (“no”) and in reality the ringtone was ABSENT

CORRECT REJECTION



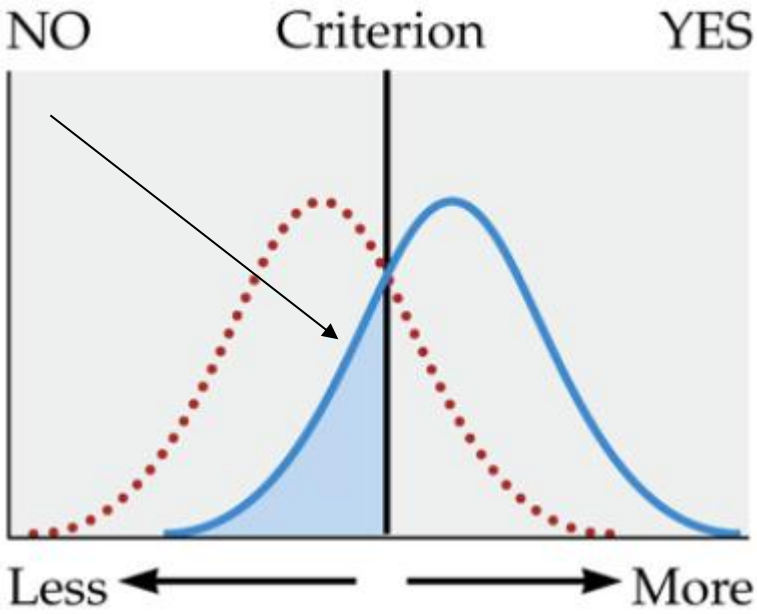
Shaded area: You detected the ringtone (“yes”) but in reality the ringtone was ABSENT

FALSE ALARM



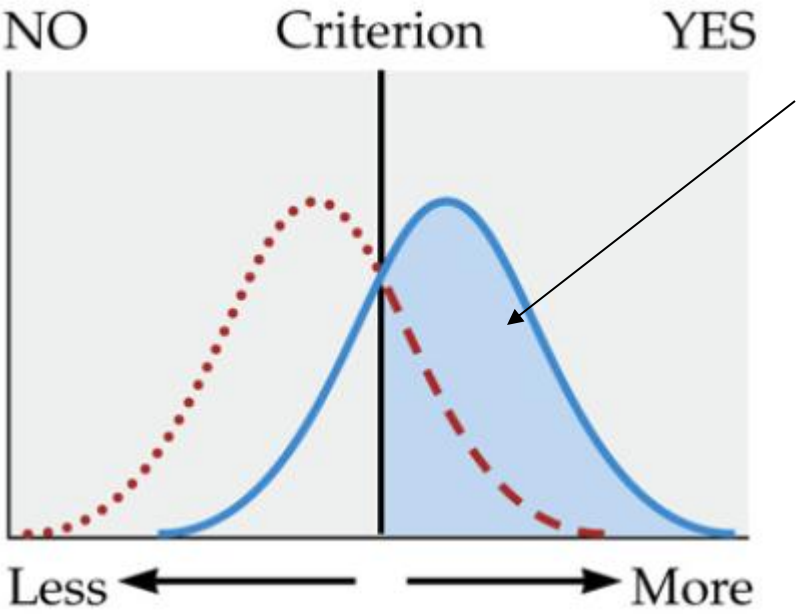
Response bias (also called “response criterion”)

Now let’s look at the solid blue curve (reality: the ringtone is PRESENT)



Shaded area: You did not detect the ringtone (“no”) but in reality the ringtone was PRESENT

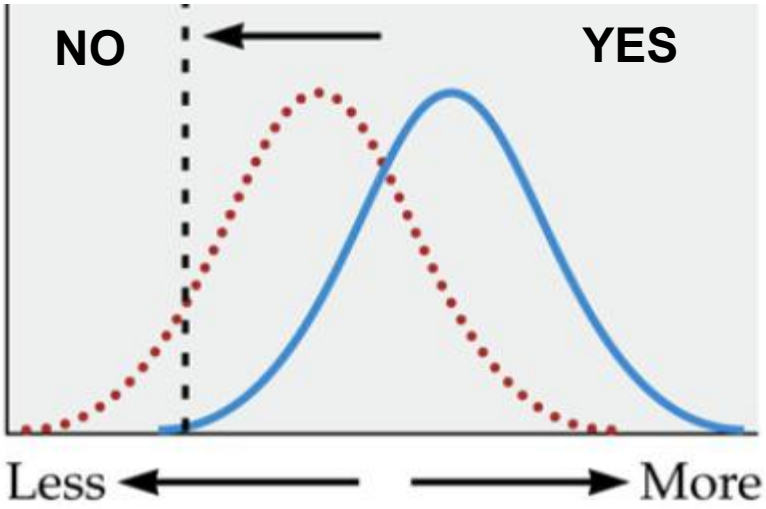
MISS



Shaded area: You detected the ringtone (“yes”) and in reality the ringtone was PRESENT

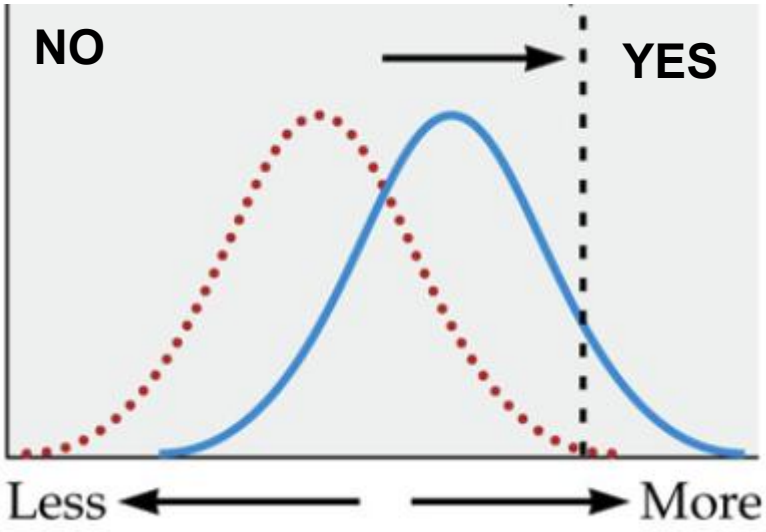
HIT

For a fixed *d´*, all you can do is change the pattern of your errors by shifting your response criterion



"Gotta get that call!"
Almost perfect hit rate but very high false alarm rate!

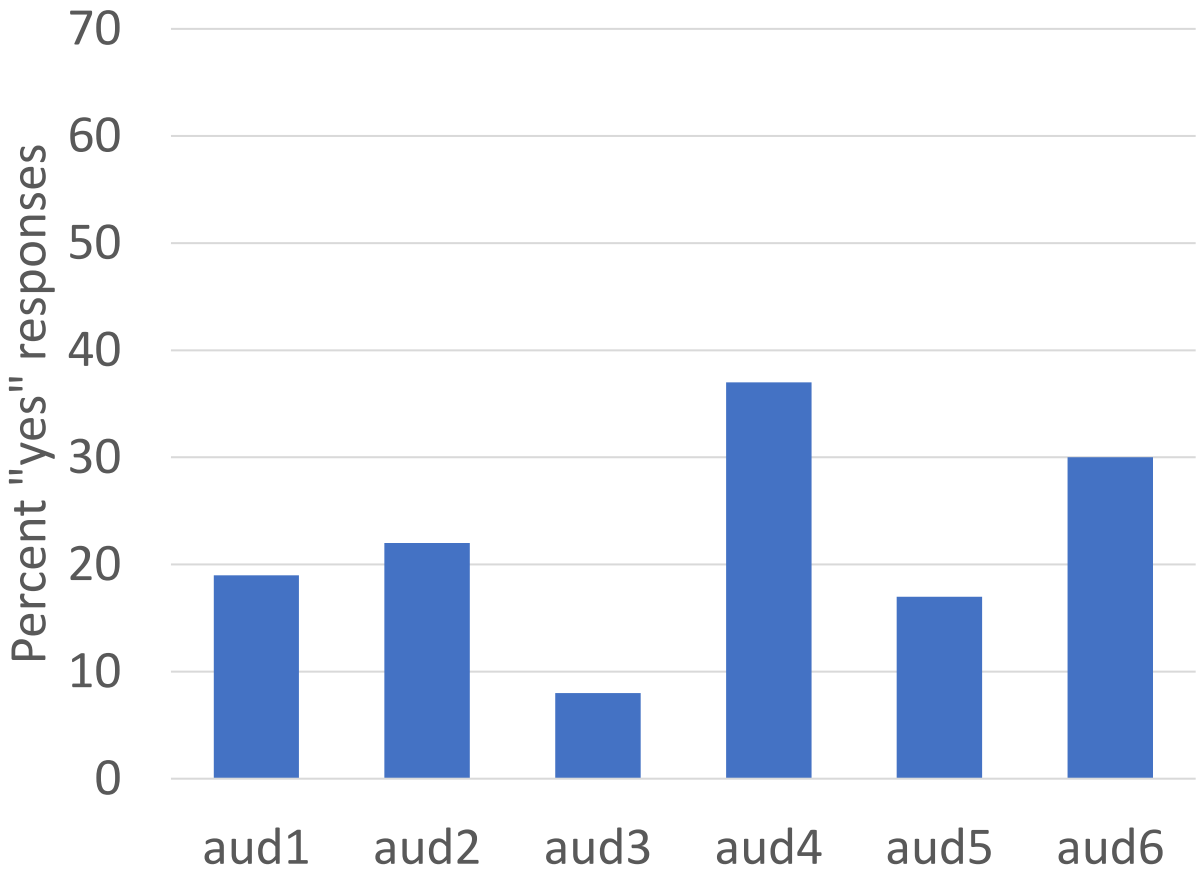
Lenient response criterion



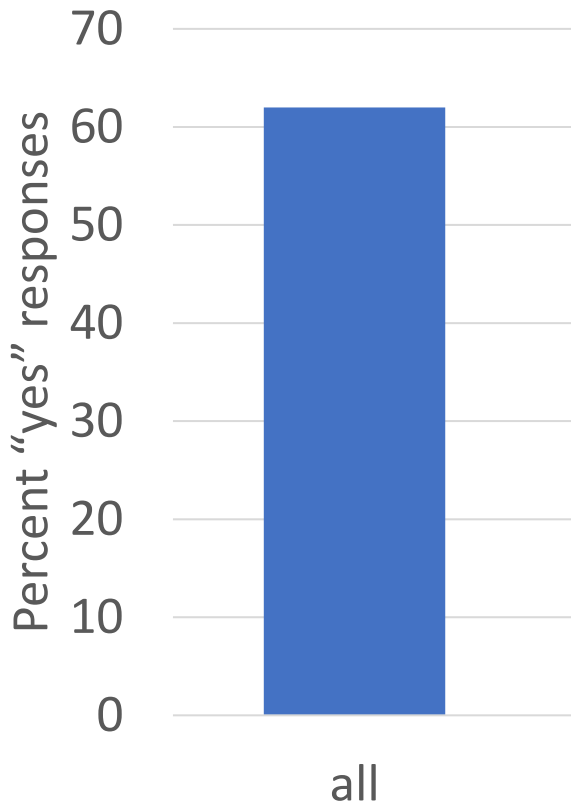
"That's not the phone"
Almost perfect correct rejection rate but very high miss rate!

Conservative response criterion

Experiment #1 Results: Do You Hear What I Hear?



Experiment #1 Results: Do You Hear What I Hear?



Consistent with previous findings: Merckelbach & van de Ven (2001): 32% of college students reported hearing White Christmas

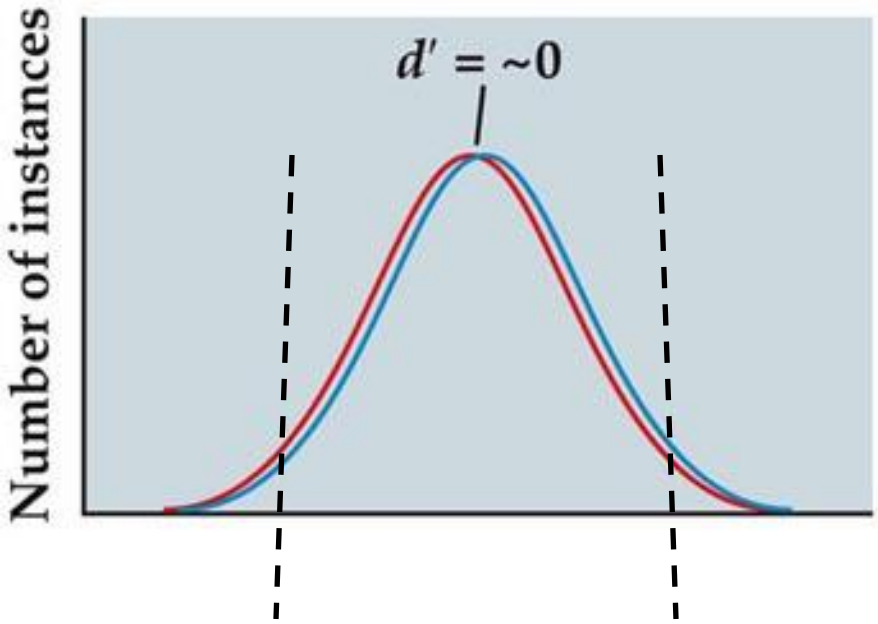
What factor(s) do you think contributed to your responses (factors can be related to you as an individual, experiment methodology, etc)?

0

Nobody has responded yet.

Hang tight! Responses are coming in.

For our study, all you could do was change the pattern of your errors by shifting your response criterion

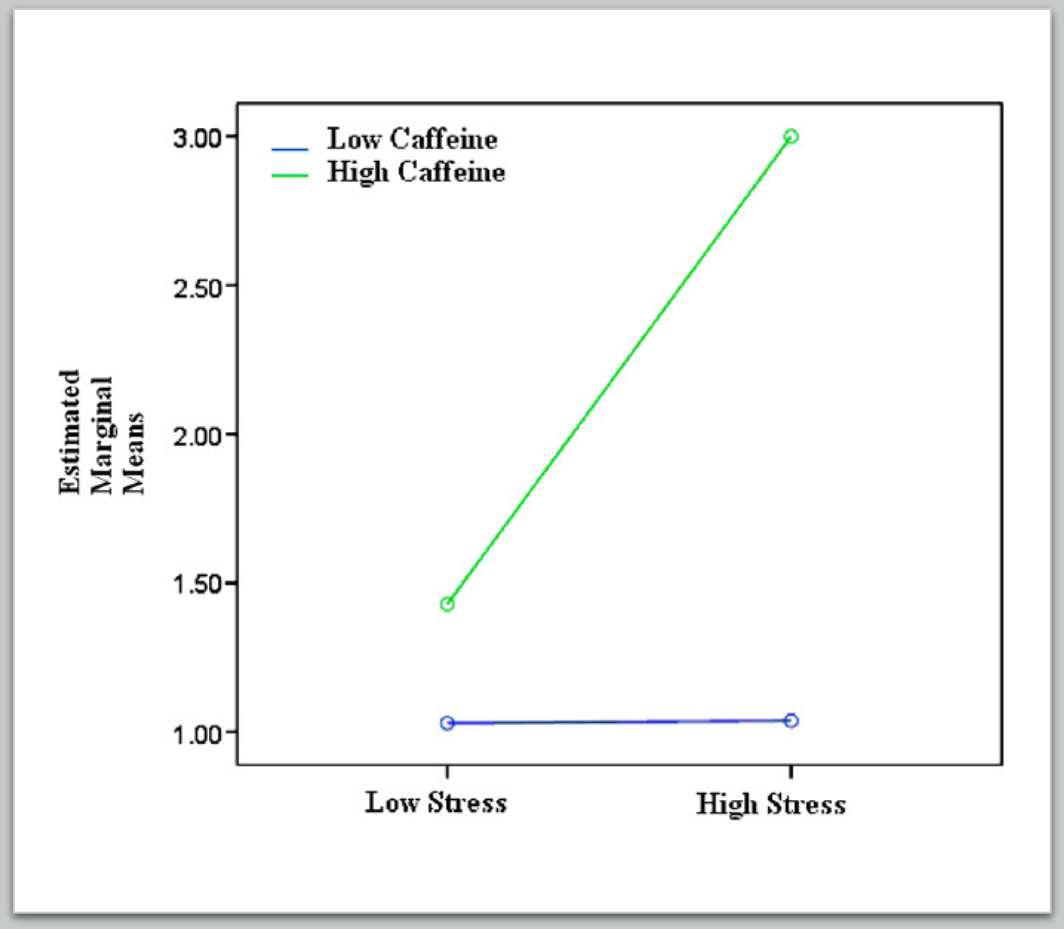


More likely to say “yes.” This would result in a high false alarm rate.

Less likely to say “yes.” This would result in a high correct rejection rate.

I’m dreaming of a White Christmas…

Crowe et al. (2011) found that the likelihood of hearing the White Christmas song was linked to high stress and high caffeine intake.



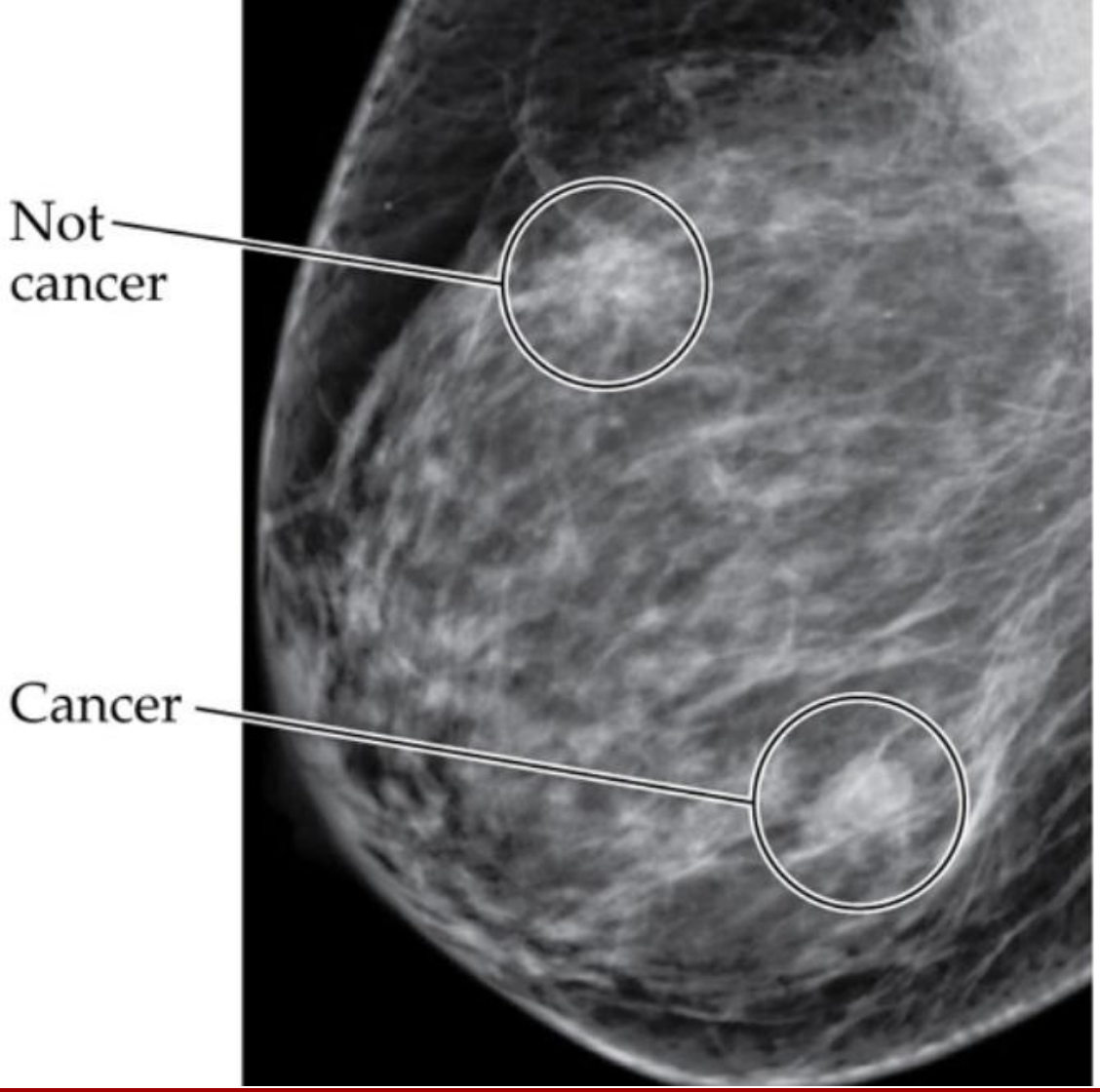
Crowe et al (2011). The effect of caffeine and stress on auditory hallucinations in a non-clinical sample.

What are some potetial real-world implications of these results?

0

Nobody has responded yet.

Hang tight! Responses are coming in.



A real-world example

Real-World Implications: Interpreting Breast Cancer Biopsy Specimens

Elmore, J. G., Longton, G. M., Carney, P. A., Geller, B. M., Onega, T., Tosteson, A. N., ... & Weaver, D. L. (2015). Diagnostic concordance among pathologists interpreting breast biopsy specimens. JAMA, 313(11), 1122-1132.

Figure 3. Comparison of 115 Participating Pathologists' Interpretations vs the Consensus-Derived Reference Diagnosis for 6900 Total Case Interpretations[a]

		Participating Pathologists' Interpretation				
		Benign without atypia	Atypia	DCIS	Invasive carcinoma	Total
Consensus Reference Diagnosis[b]	Benign without atypia	1803	200	46	21	2070
	Atypia	719	990	353	8	2070
	DCIS	133	146	1764	54	2097
	Invasive carcinoma	3	0	23	637	663
	Total	2658	1336	2186	720	6900

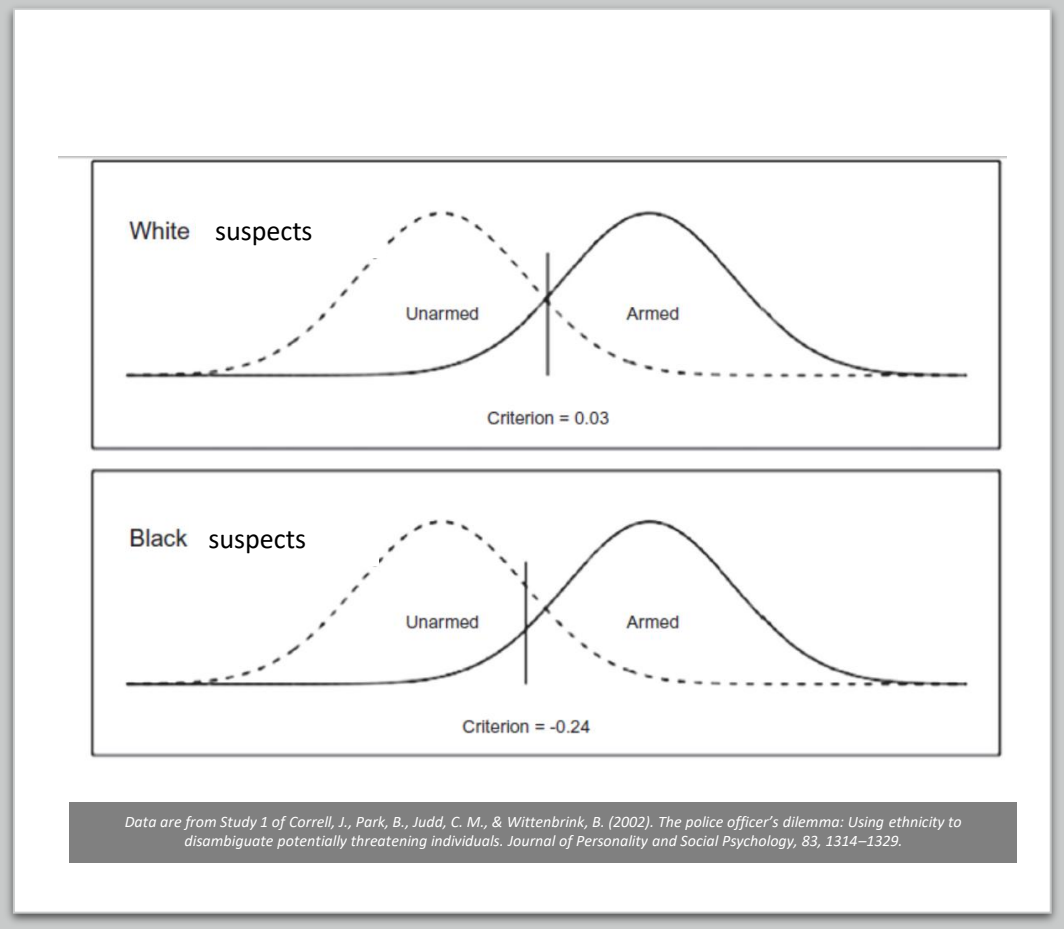
Overall agreement between the individual pathologists' interpretations and the expert consensus–derived reference diagnoses was 75.3%, though this agreement rate varied dramatically by the different types of breast cancer.

Real-World Implications: Threat Detection and Race

Sensitivity did not differ for White and Black suspects.

Response criterion was lower (and so more lenient) for Black suspects than for White suspects.

Payne, B. K., & Correll, J. (2020). Race, weapons, and the perception of threat. Advances in Experimental Social Psychology, 62, 1-50.



Data are from Study 1 of Correll, J., Park, B., Judd, C. M., & Wittenbrink, B. (2002). The police officer's dilemma: Using ethnicity to disambiguate potentially threatening individuals. Journal of Personality and Social Psychology, 83, 1314–1329.

Development

Would a newborn understand anything about the meaning of emojis?

SENSATION & PERCEPTION 5e, Figure 1.38

Development over the Life Span

- What comes with the system?
- What has to be learned?
- What changes with age?

Final Thoughts

- We are attempting to make sense of our world by quickly and efficiently interpreting all sensory information available to us.
- Our sensory systems have limitations.
- We need to understand why some of these limitations exist and how we use heuristics to shape our interpretations.

By the end of the next part of the lesson, you will be able to describe:

- Properties of light
- The parts of the eye
- How light travels through the eye

Outline

Part 1: What Is Light?

Part 2: Anatomy of the Eye

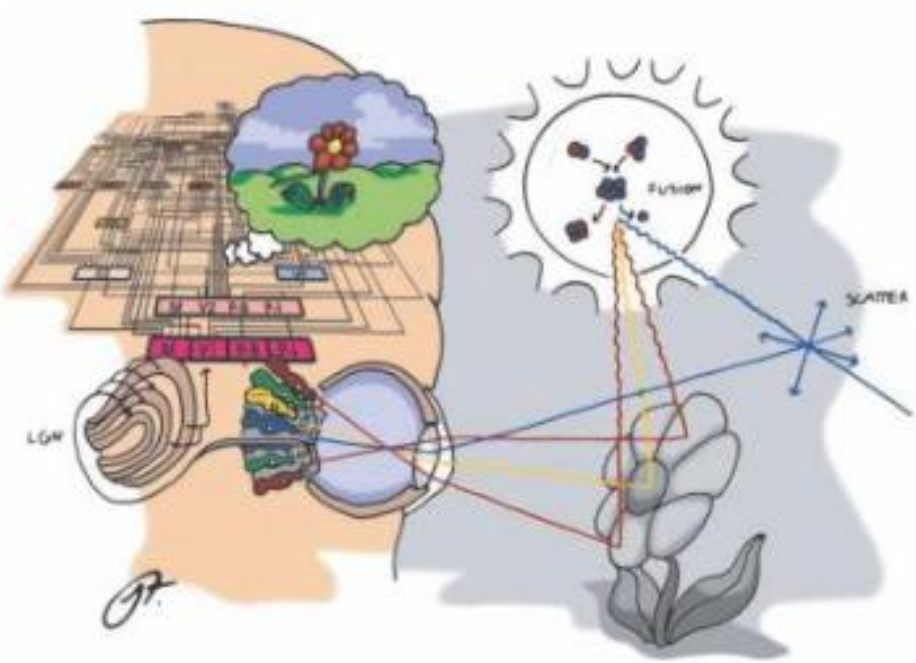
Part 3: The Retina

Part 4: Transduction in the Retina

Part 5: Dark and Light Adaptation

Part 6: Retinal Information Processing

Part 7: Receptive Fields of Ganglion Cells

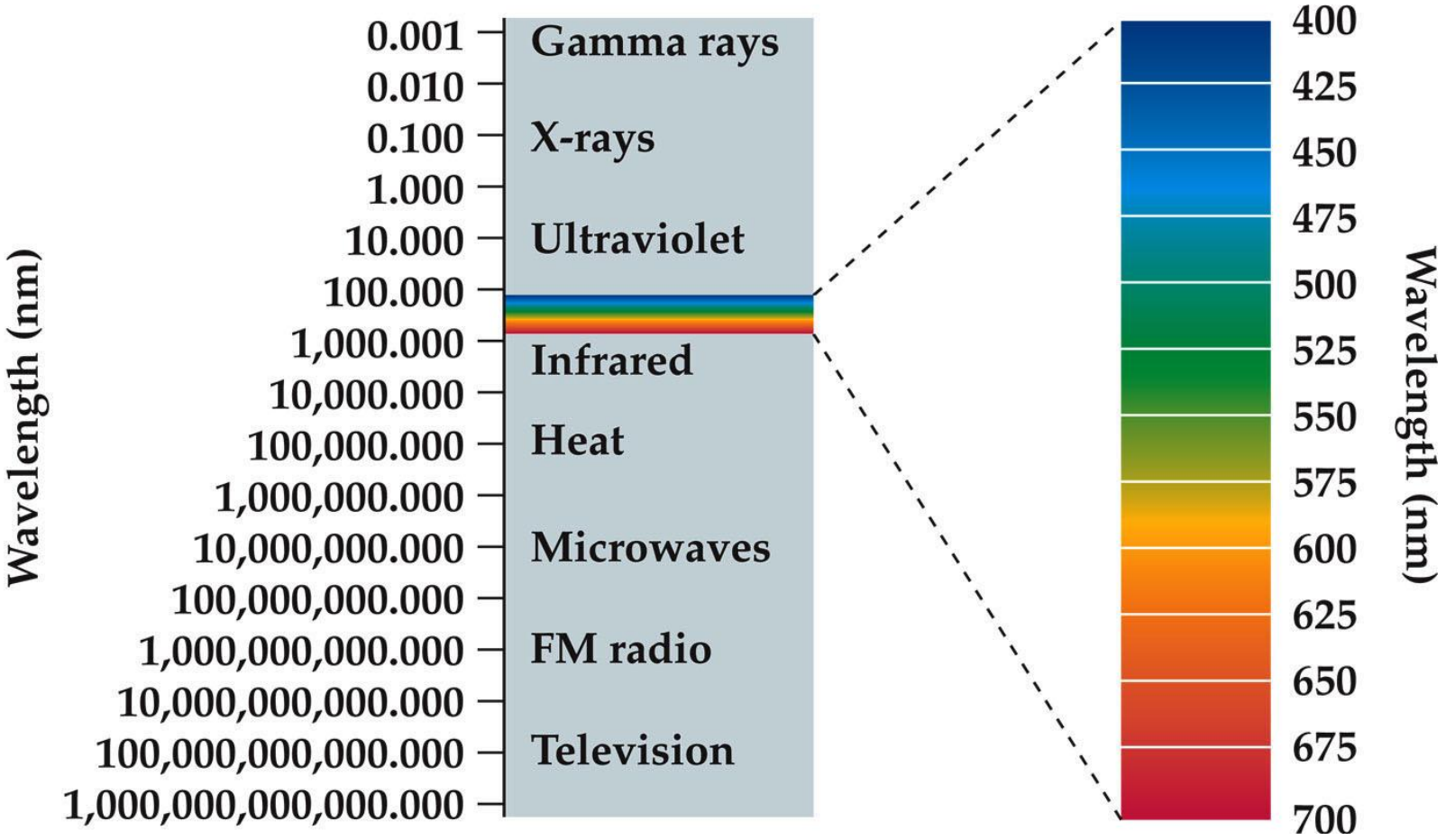


Snowden, R., Thompson, P., & Troscianko, T. (2012). *Basic Vision: An introduction to visual perception*. Oxford: Oxford University Press.

What is light?

Light

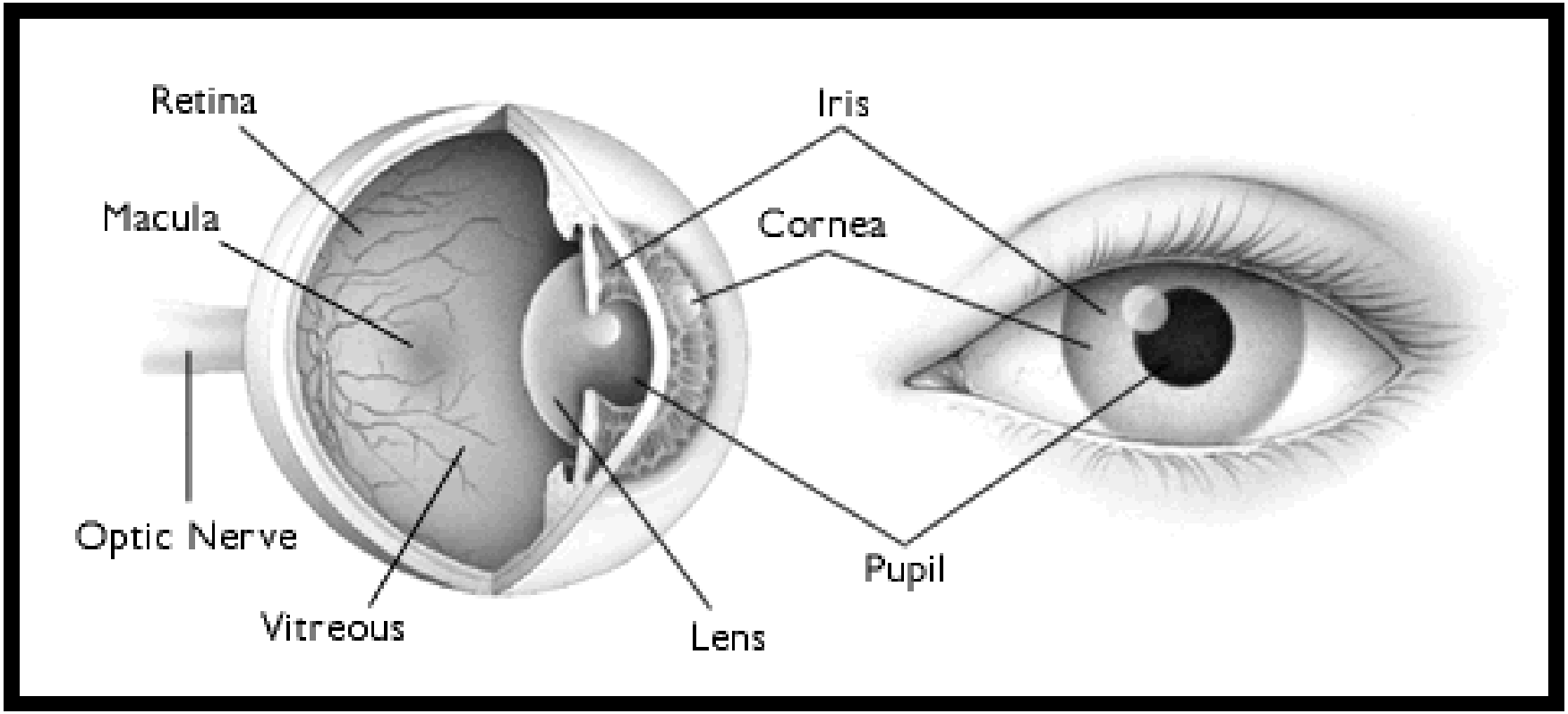
Light: A narrow band of electromagnetic radiation that can be conceptualized as a wave or a stream of photons



Light

- Transmitted: Passes through a surface
- Absorbed: Not transmitted at all
- Scattered: Dispersed in an irregular fashion
- Reflected: Redirected when it strikes a surface
- Refracted: Bent as it passes into another medium

Anatomy of the Eye



Anatomy of the Eye: Cornea

- Cornea: The transparent "window" into the eyeball
  - Curved and responsible for 2/3 of eye's focusing power
  - Most light photons transmitted through

- Light travels faster through air than through your cornea, leads to refraction

Anatomy of the Eye

Aqueous humor: watery fluid in the anterior chamber behind the cornea, provides nutrients to cornea and lens

NORMAL VISION

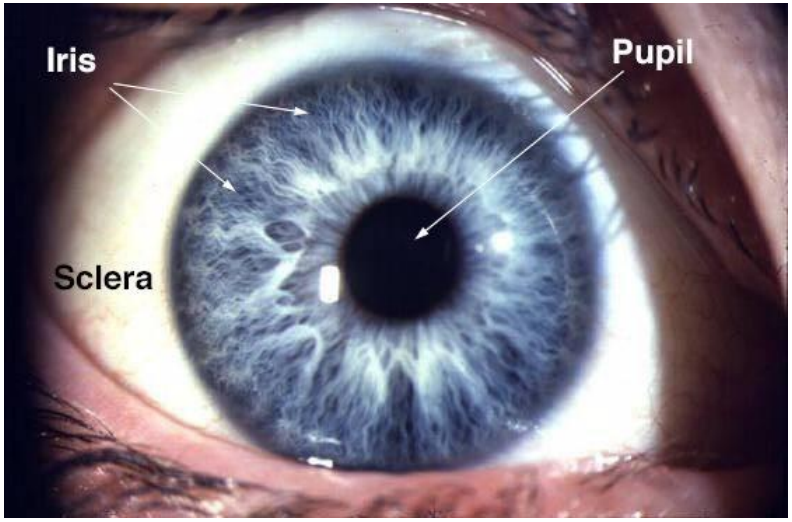
EARLY GLAUCOMA

ADVANCED GLAUCOMA

Glaucoma: disease in which the aqueous humor pressure is too high; can result in loss of peripheral vision

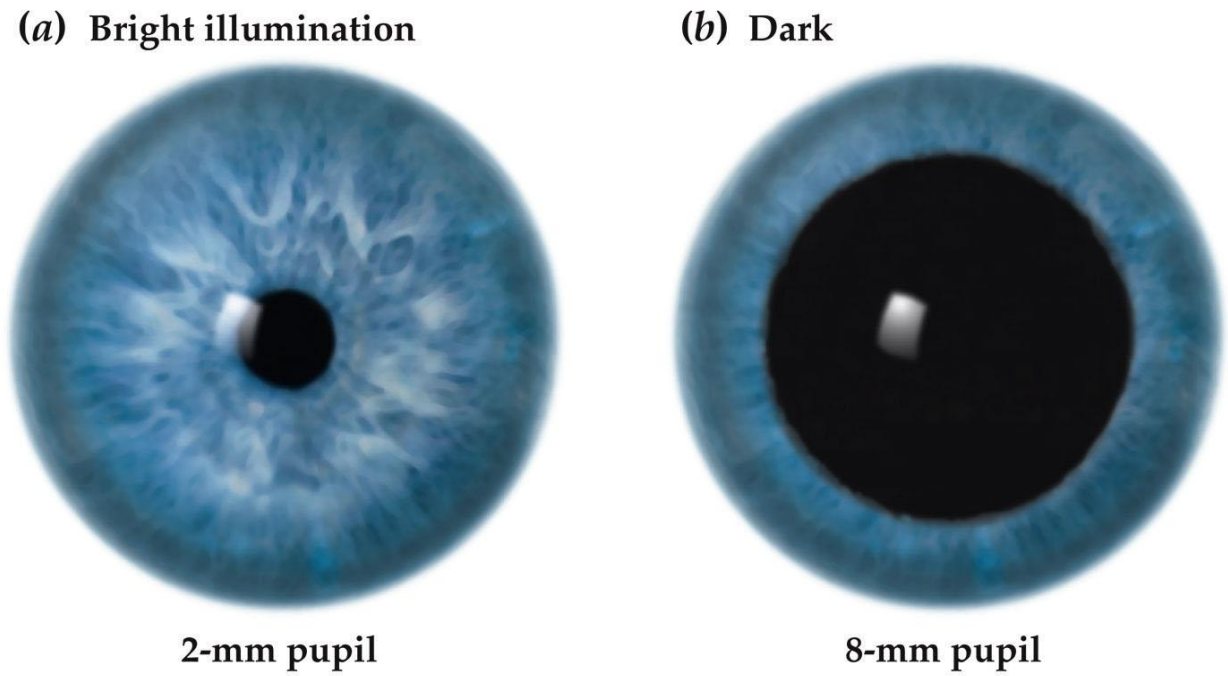
Anatomy of the Eye

Iris: The colored part of the eye, consisting of a muscular diaphragm surrounding the pupil and regulating the light entering the eye by expanding and contracting the pupil



Anatomy of the Eye

Pupil: The dark circular opening at the center of the iris in the eye, where light enters the eye



SENSATION & PERCEPTION 3e, Figure 2.18

Pupils also respond to expectation of light changes!

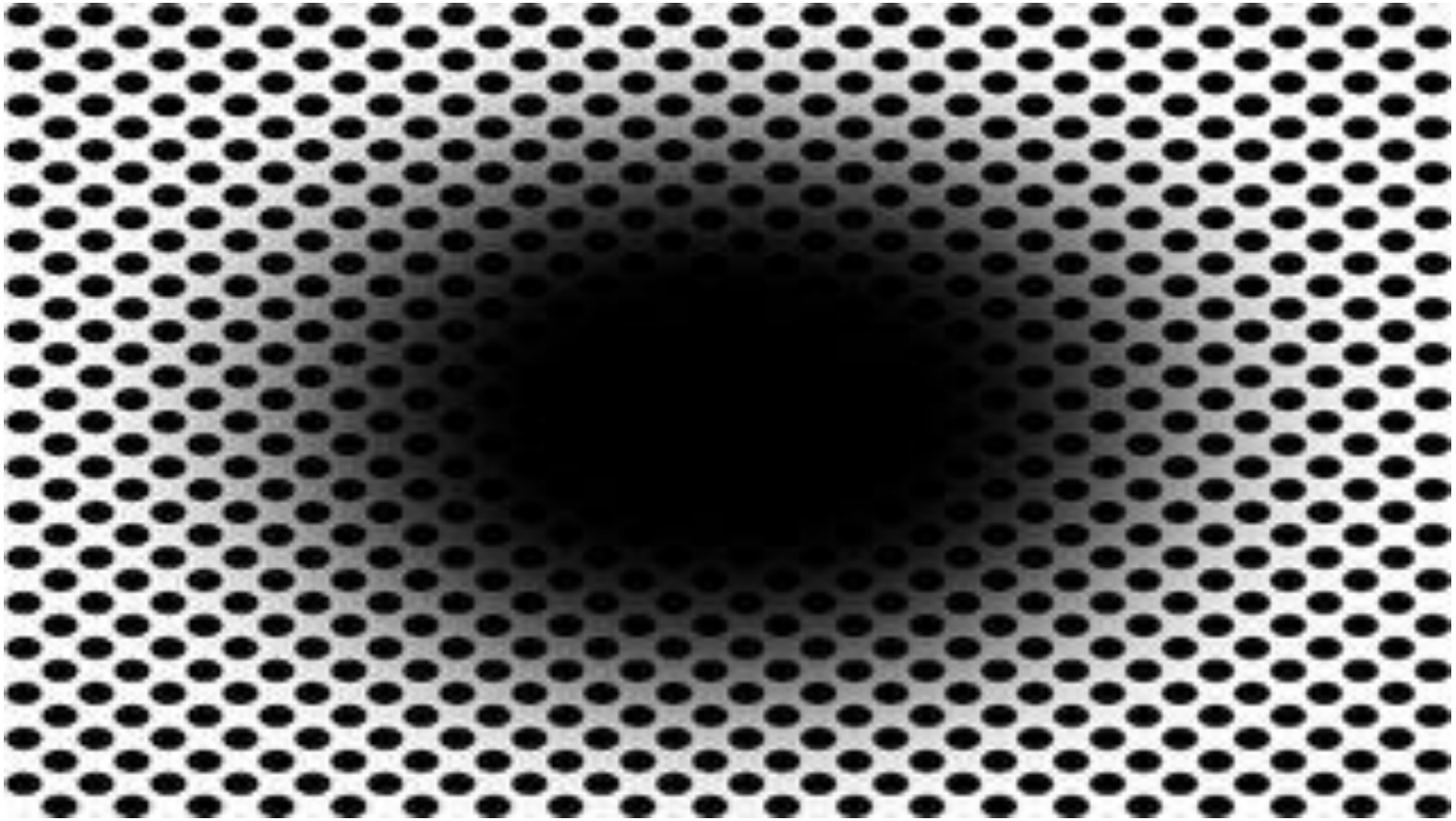


Image credit:Frontiers in Human Neuroscience

Pupils dilate in response to visual illusions of entering a dark cave

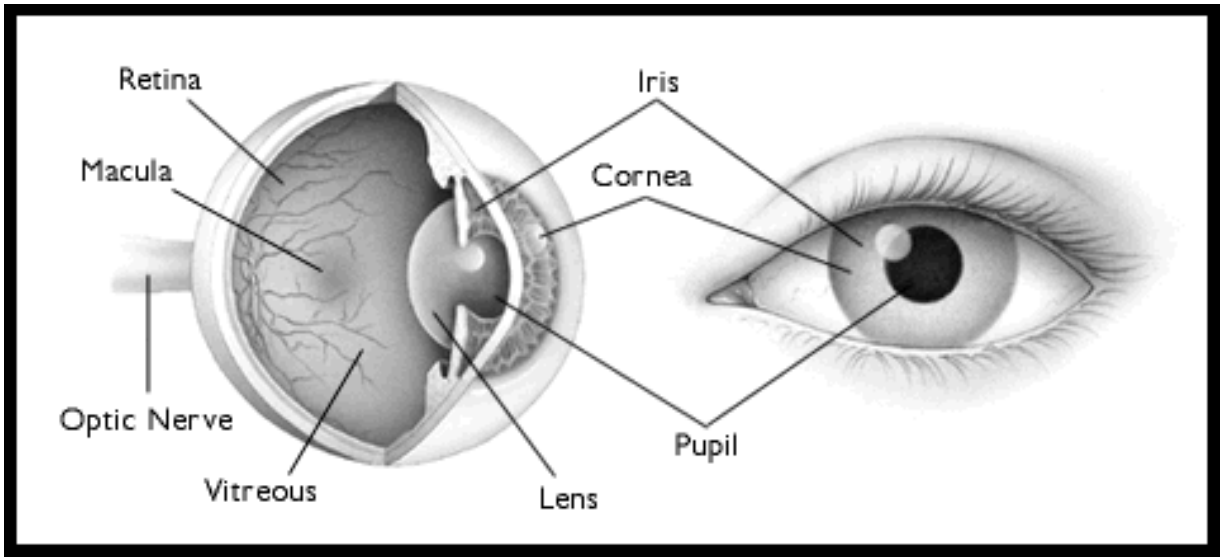
Pupils constrict when looking at black-and-white pictures of the sun (relative to pictures of the moon and other controls)

Binda, P., Pereverzeva, M., & Murray, S. O. (2013). Pupil constrictions to photographs of the sun. *Journal of Vision, 13*(6), 8-8. doi:10.1167/13.6.8

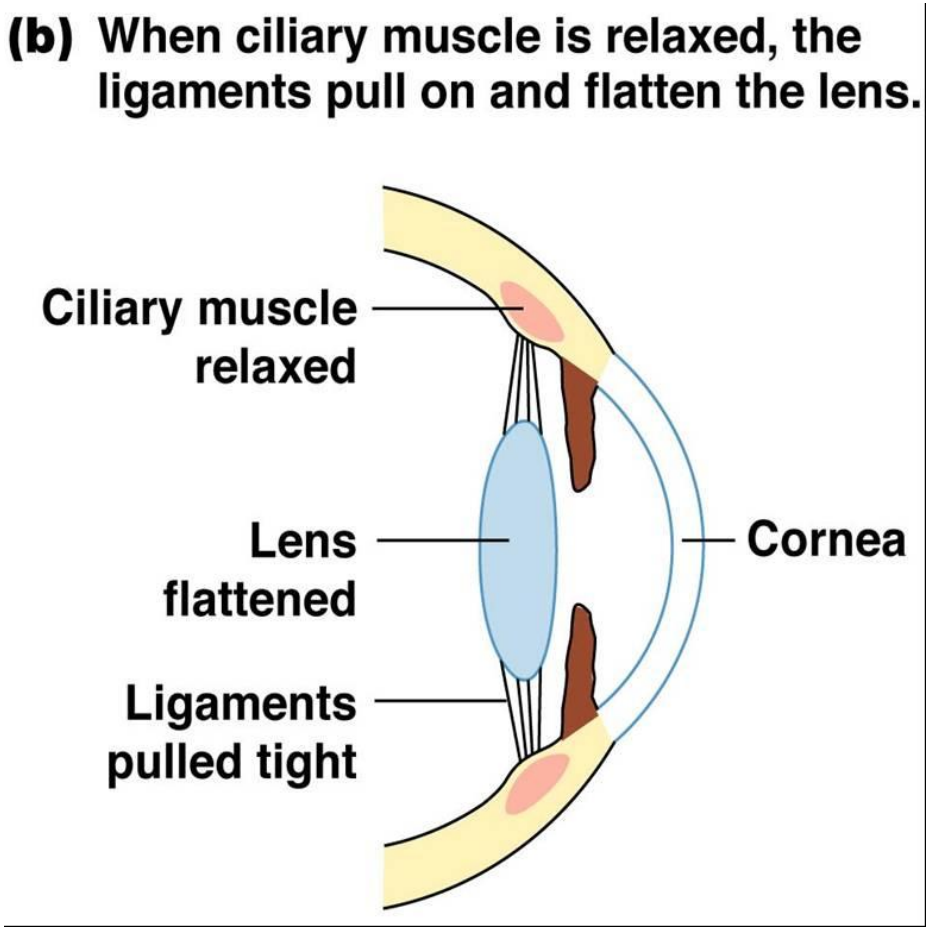
Anatomy of the Eye: Lens

The lens inside the eye helps focus light

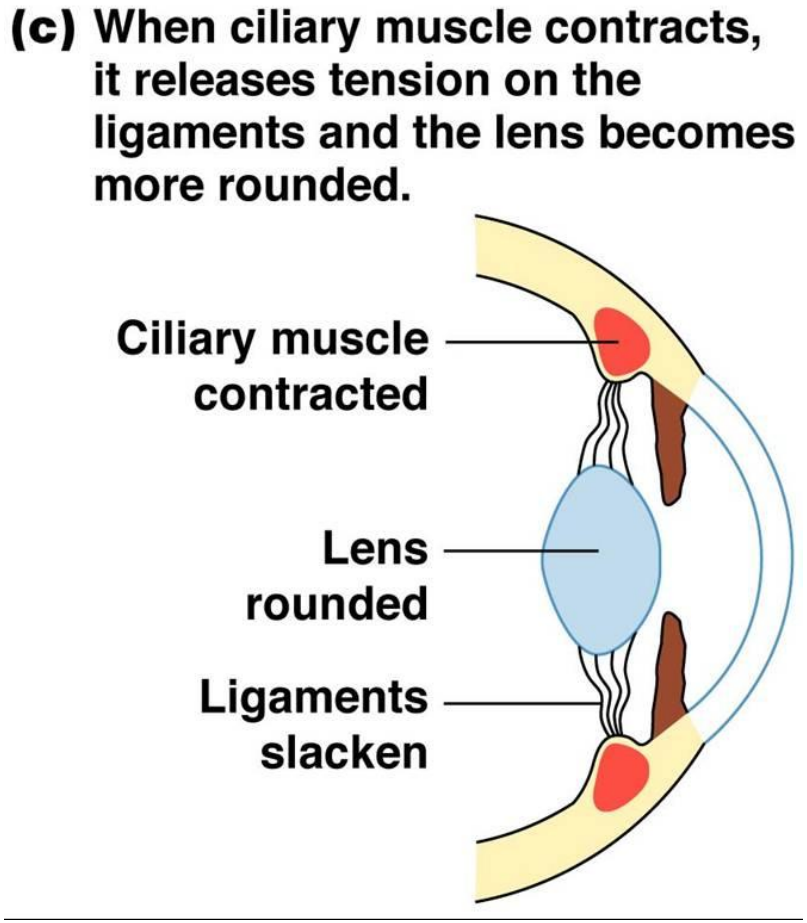
- Accommodation: the lens changes its shape, which alters its refractive power
    - The ciliary muscles in the eye control how thick or thin the lens is at any given time.



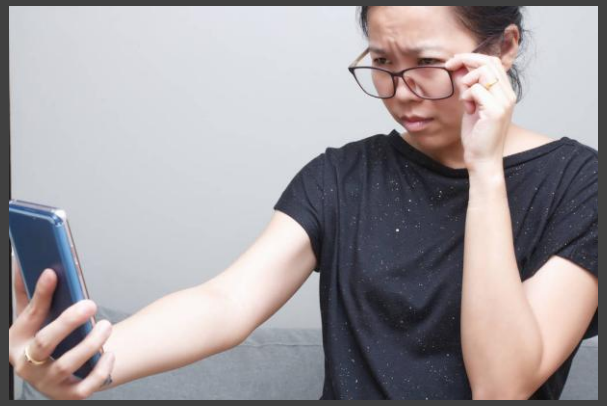
Accommodation



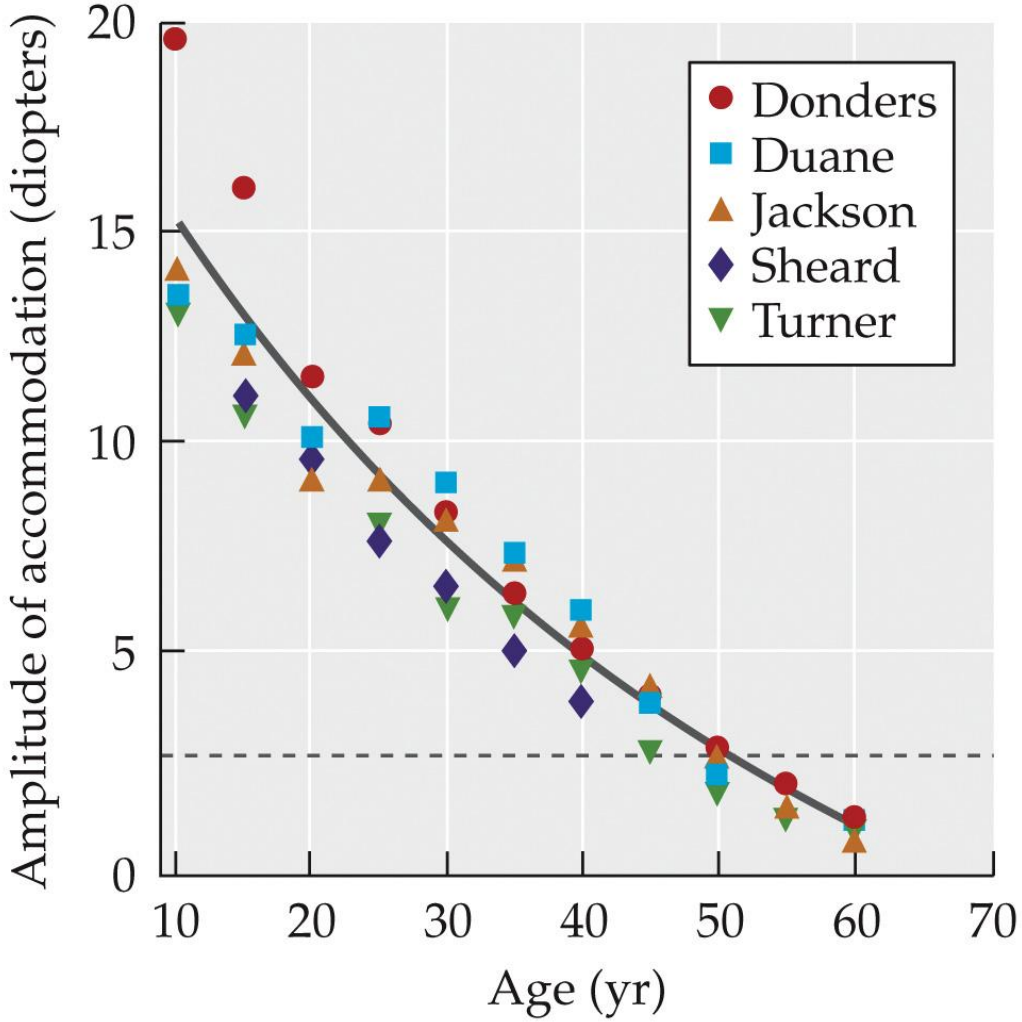
Distance vision



Near vision



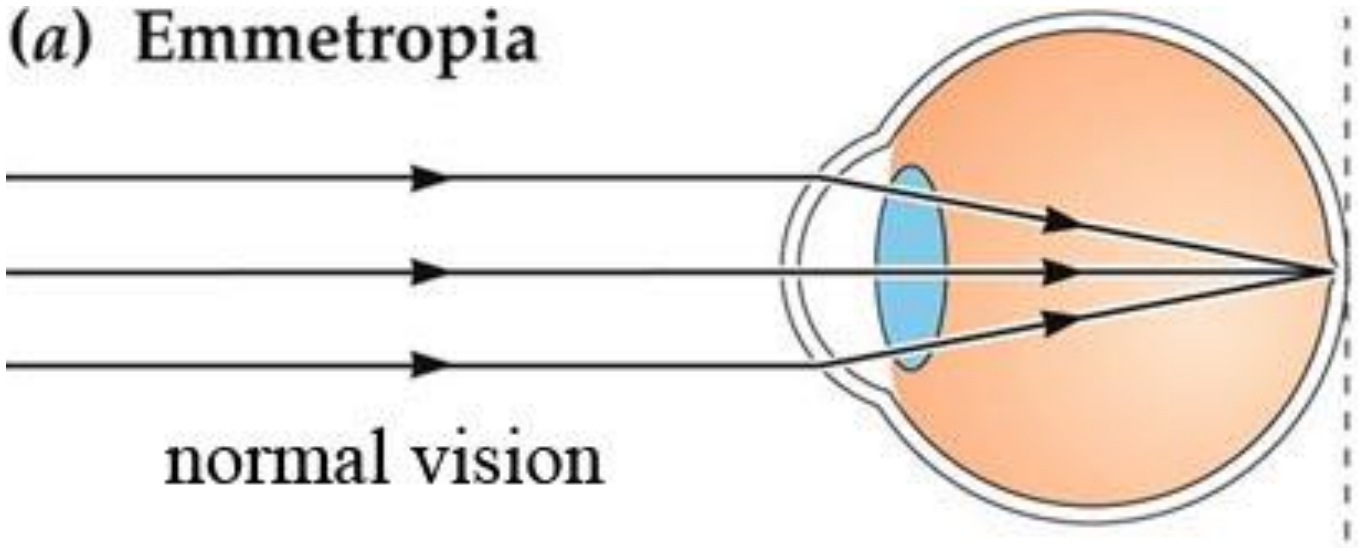
Accommodation ability declines with age (presbyopia)



SENSATION & PERCEPTION 6e, Figure 2.4

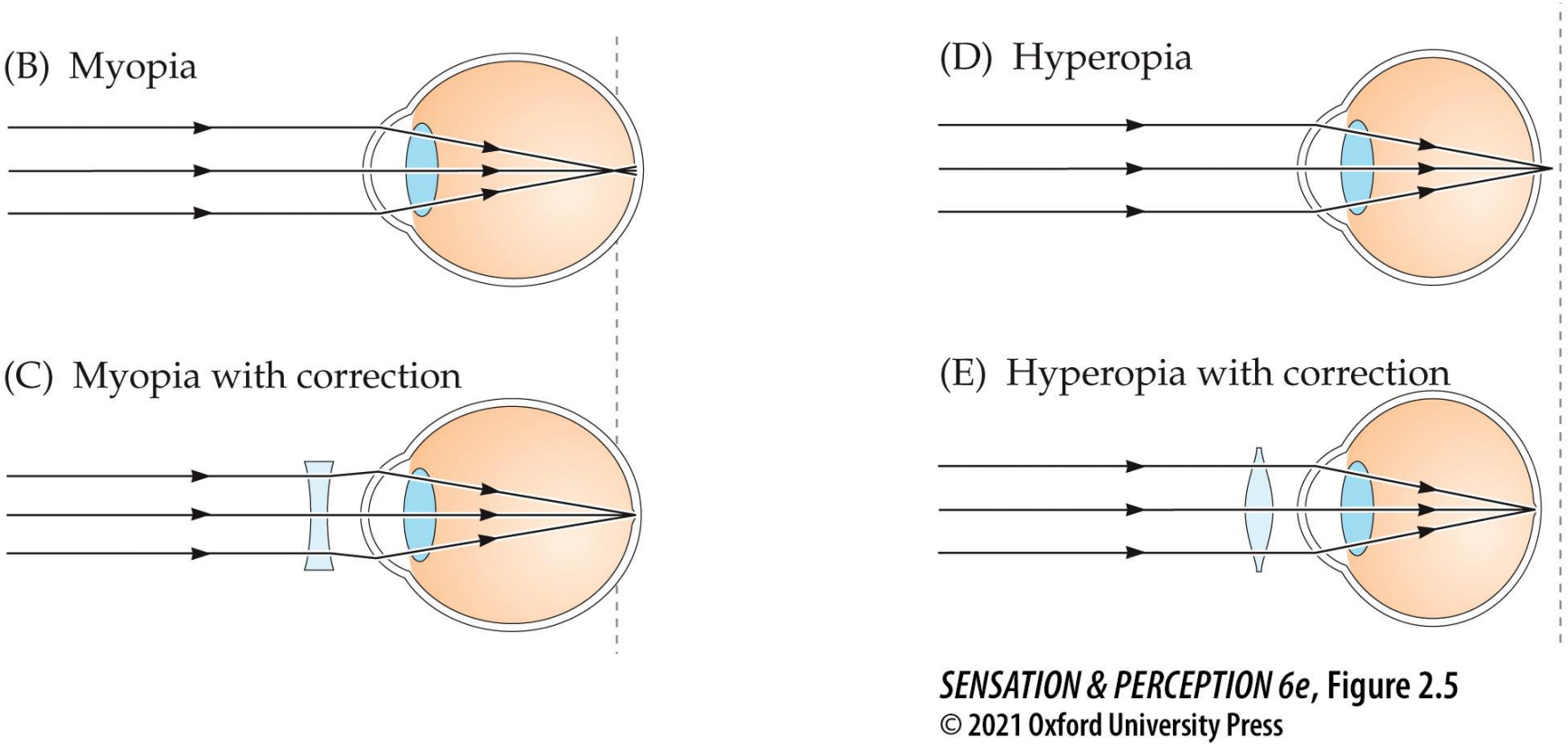
*dashed horizontal line indicates the amplitude of accommodation required to focus at a distance of 40 cm

Refraction is necessary to focus light rays onto the retina



Problems of refraction

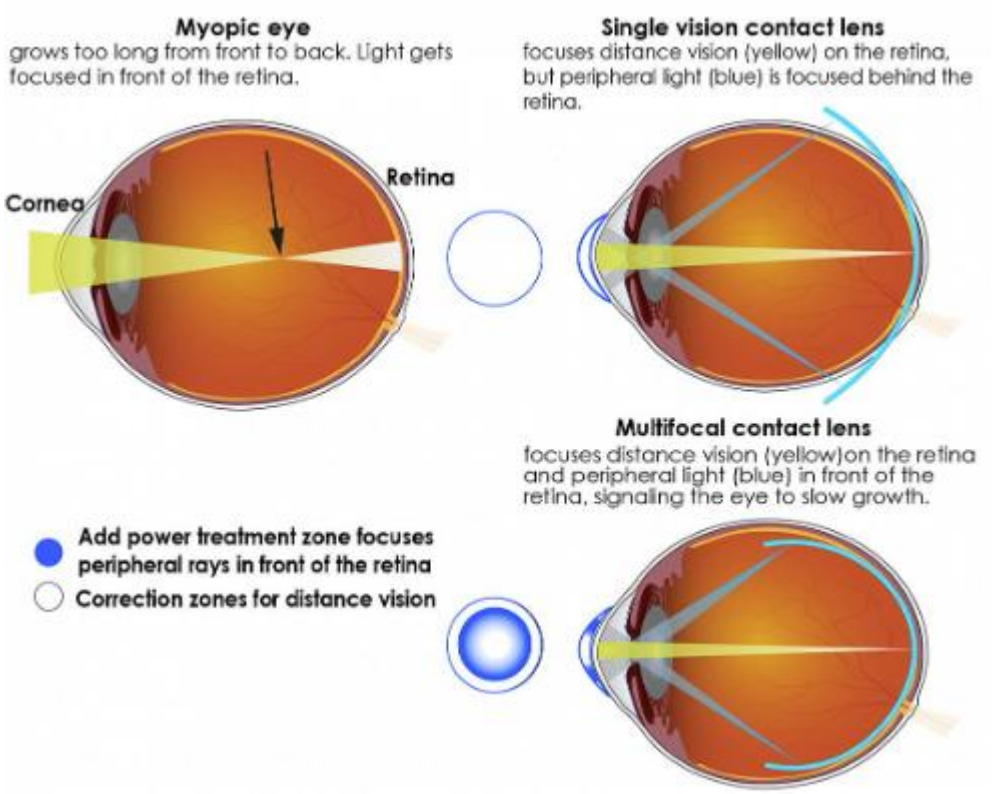
The lens may focus the image either in front of or behind the retina. In these cases, corrective lenses are needed for normal vision.



SENSATION & PERCEPTION 6e, Figure 2.5

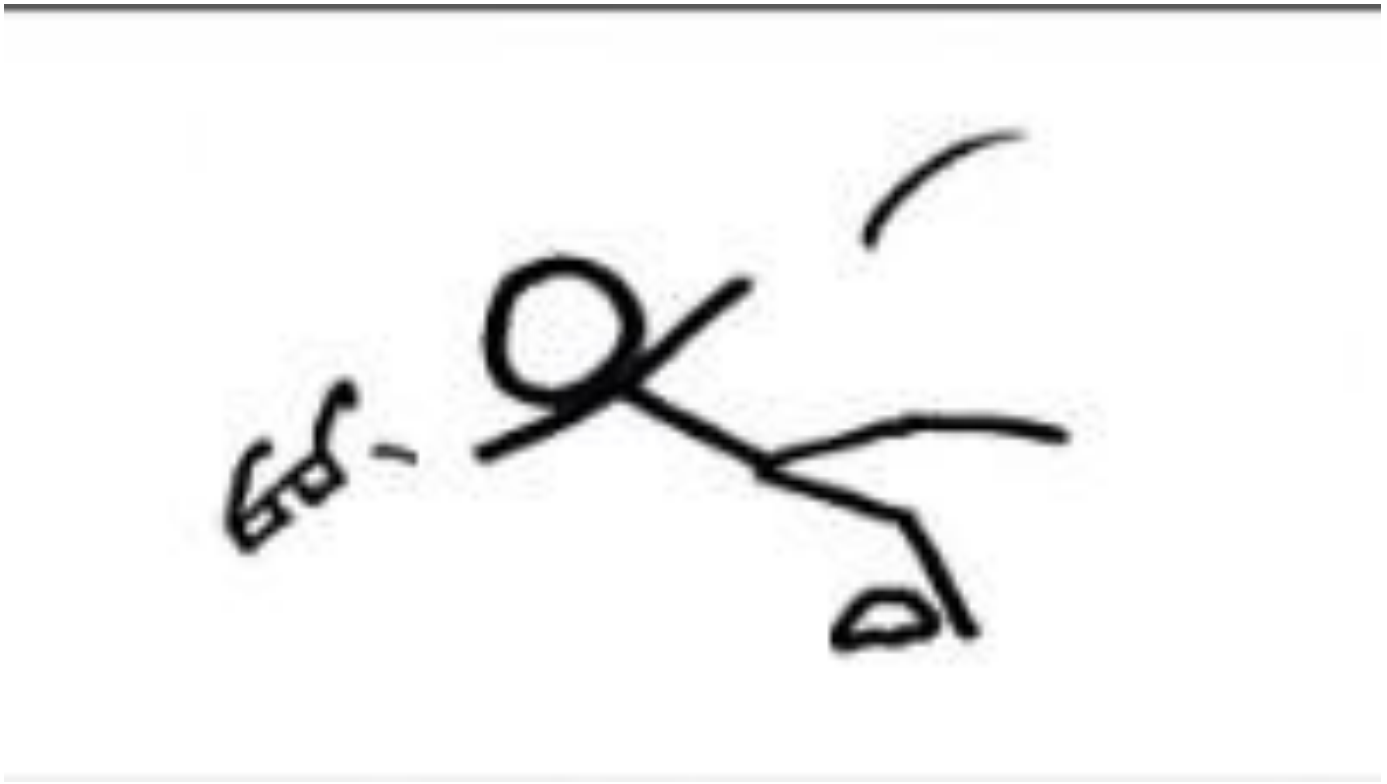
Astigmatism: A visual problem caused by the unequal curving of one or more of the refractive surfaces of the eye, usually the cornea

Perception in the news: Multifocal contact lenses can slow the progression of myopia in children!



https://www.nih.gov/news-events/news-releases/multifocal-contact-lenses-slow-myopia-progression-children

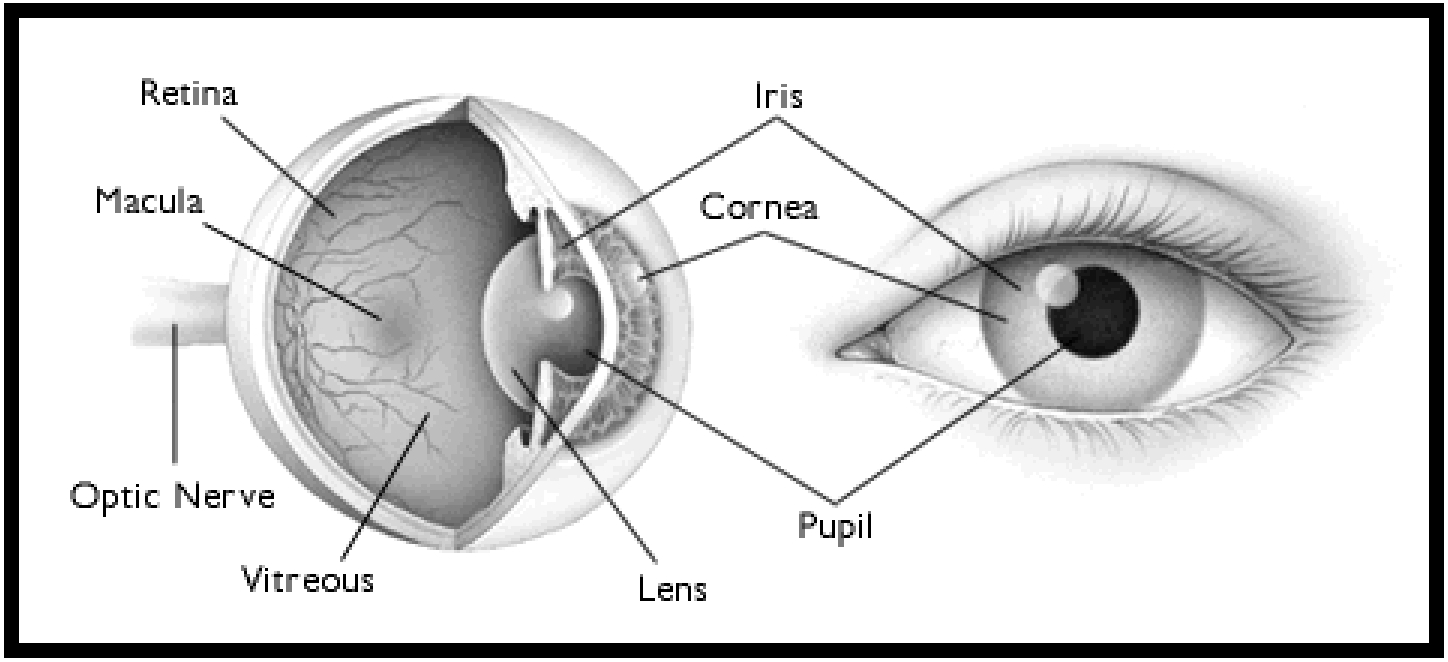
Walline, JJ; Walker, MK; Mutti, DO; Jones-Jordan, LA; Sinnott, LT; Gaume Giannoni, A; Bickle, KM; Schulle, KL; Nixon, A; Pierce, GE; Berntsen, DA "Effect of high add power, medium add power, or single vision contact lenses on myopia progression in children: the BLINK randomized clinical trial," published August 11, 2020 in JAMA. DOI: 10.1001/jama.2020.10834



https://youtu.be/OydqR_7_DjI

Eyes That See Light

- Vitreous humor: The transparent fluid that fills the large chamber in the posterior part of the eye
- Retina: A light-sensitive membrane in the back of the eye that contains photoreceptors (rods and cones), which receive an image from the lens and send it to the brain through the optic nerve (CN II)



Upcoming Assignments

Week	Date	Topic	Quiz*	Reading	Discussion**	Experiment***
2	9/9	Vision – Anatomy		Chapter 2	Practice questions *Due 9/12; responses due 9/15*	
3	9/16	Vision in the Brain	Quiz 1: Mods 1&2 *Due 9/22*	Chapter 3		

This week:
5 Practice questions by Friday
2 Responses (1-2 sentence explanations) by Monday

Thinking ahead: What visual information do we get from our periphery and what information do we get from our central vision?