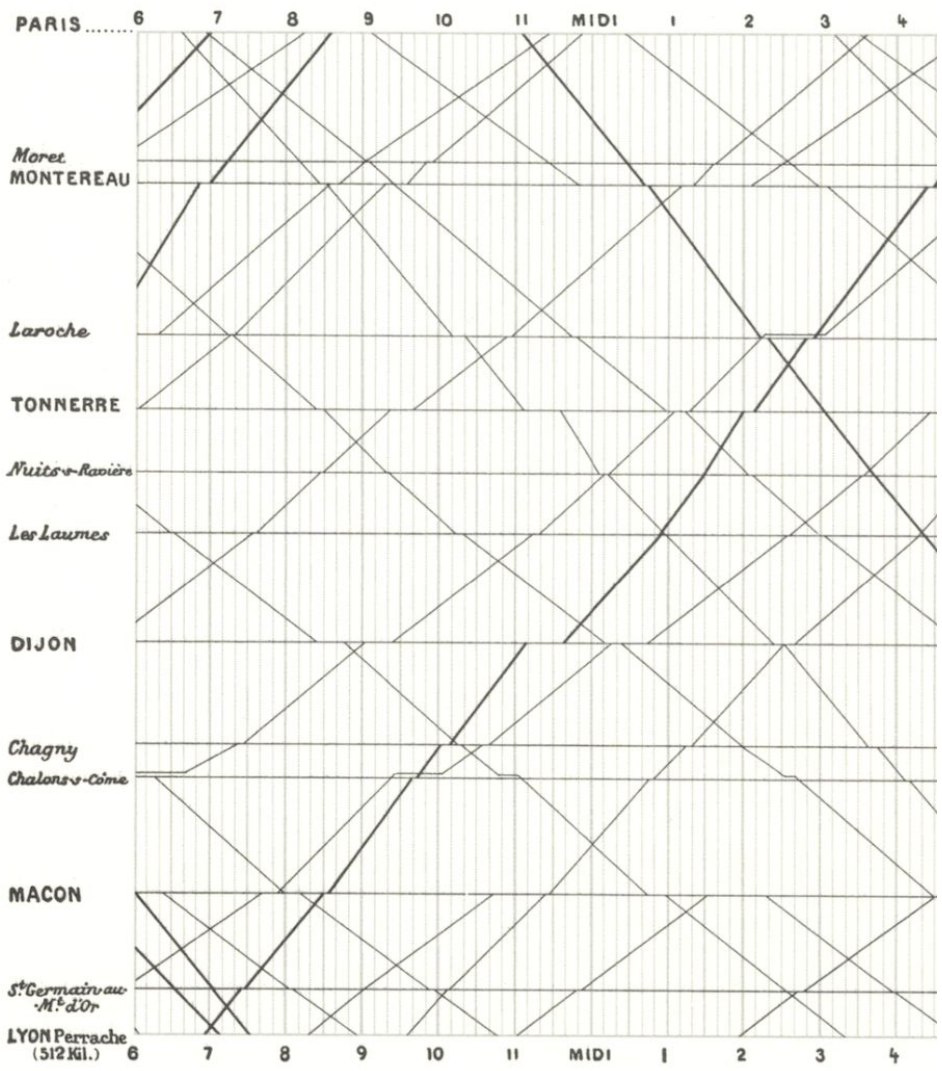


Visualization as Science 1

A Samuel Pottinger
Stat 198: IDSV
Feb 10, 2025

THE EVOLUTION OF THE EYE

TED-Ed

Where are we?

History Design **Science** Skills

Today

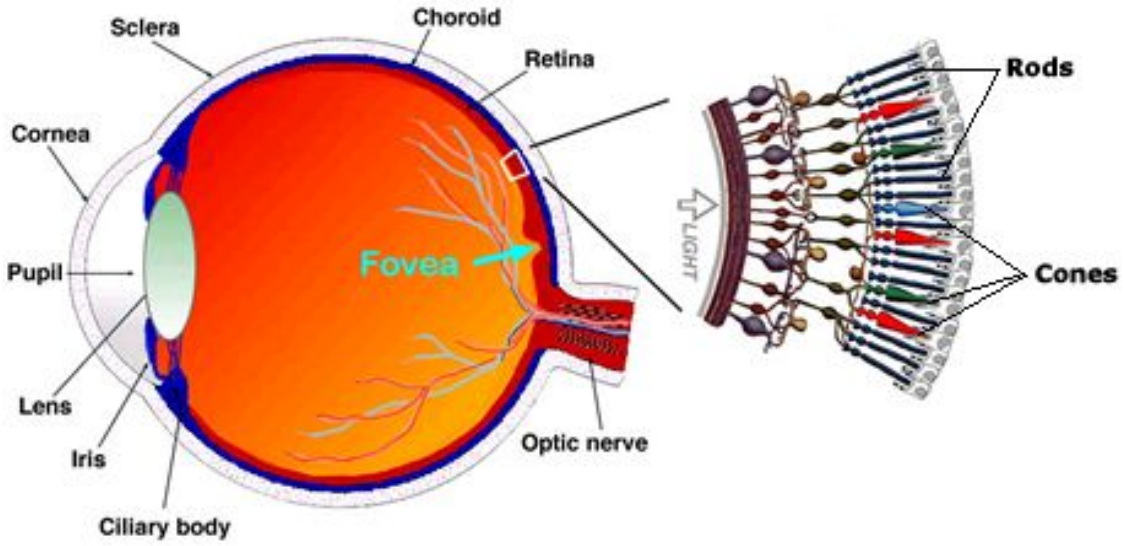
The eye: the structure and behavior essential for data visualization.

The stages of visual processing: how photons become information.

Contrast: how relative processing becomes important to visual understanding.

Preattentive features: how to draw attention quickly.

The eye



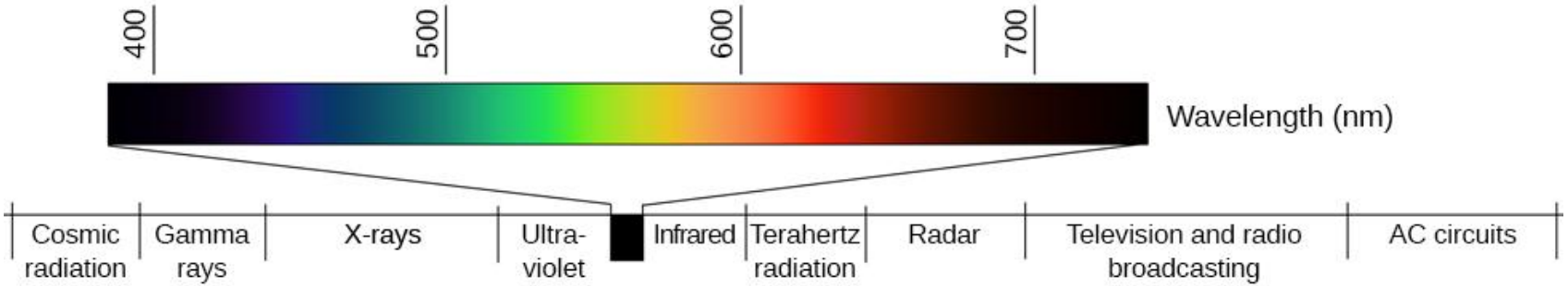
As we look across the structures of the eye, three important lessons emerge.

The “fovea” means we only see a very small area with sharpness at a time.

Our brain constructs an image over time.

Our vision is quite sharp for luminance. Hue is complicated.

Sensitivities are skewed



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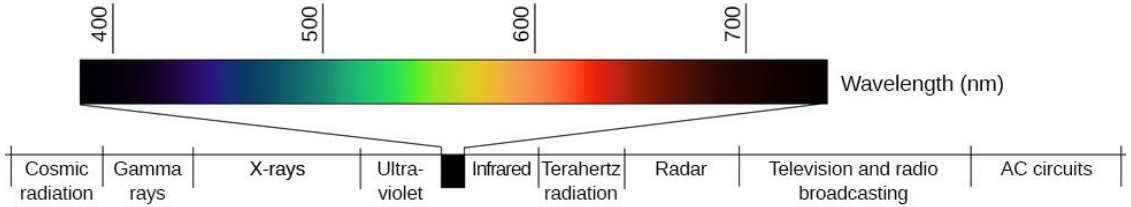
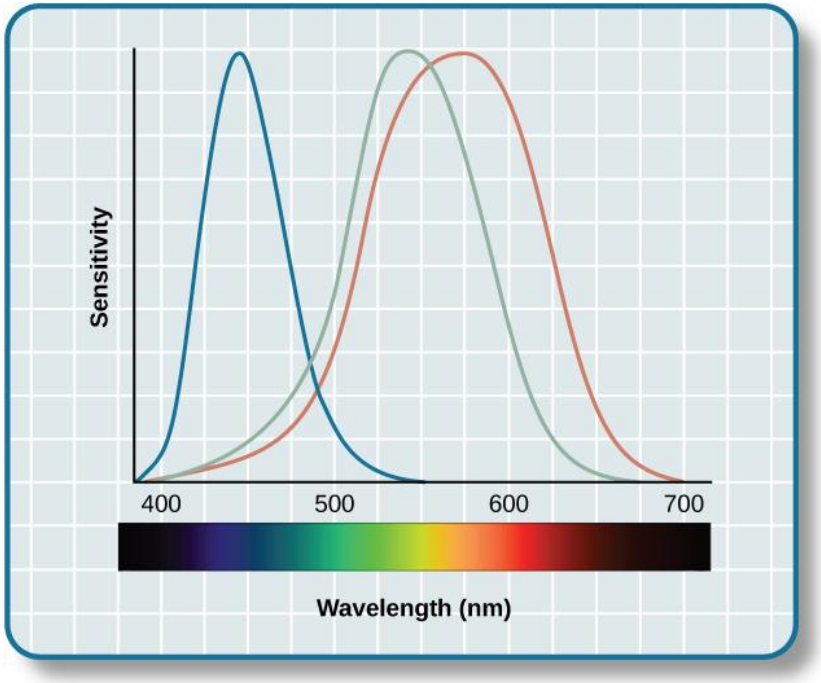
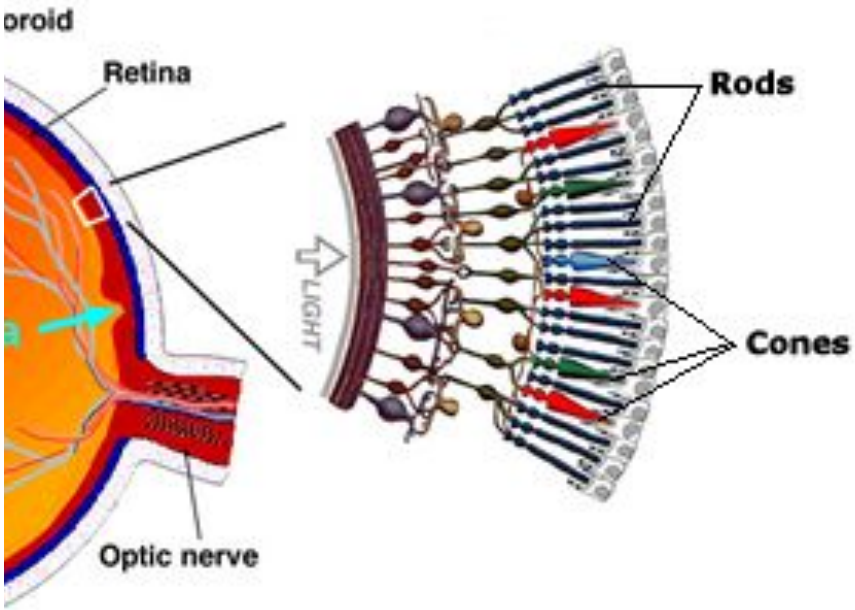
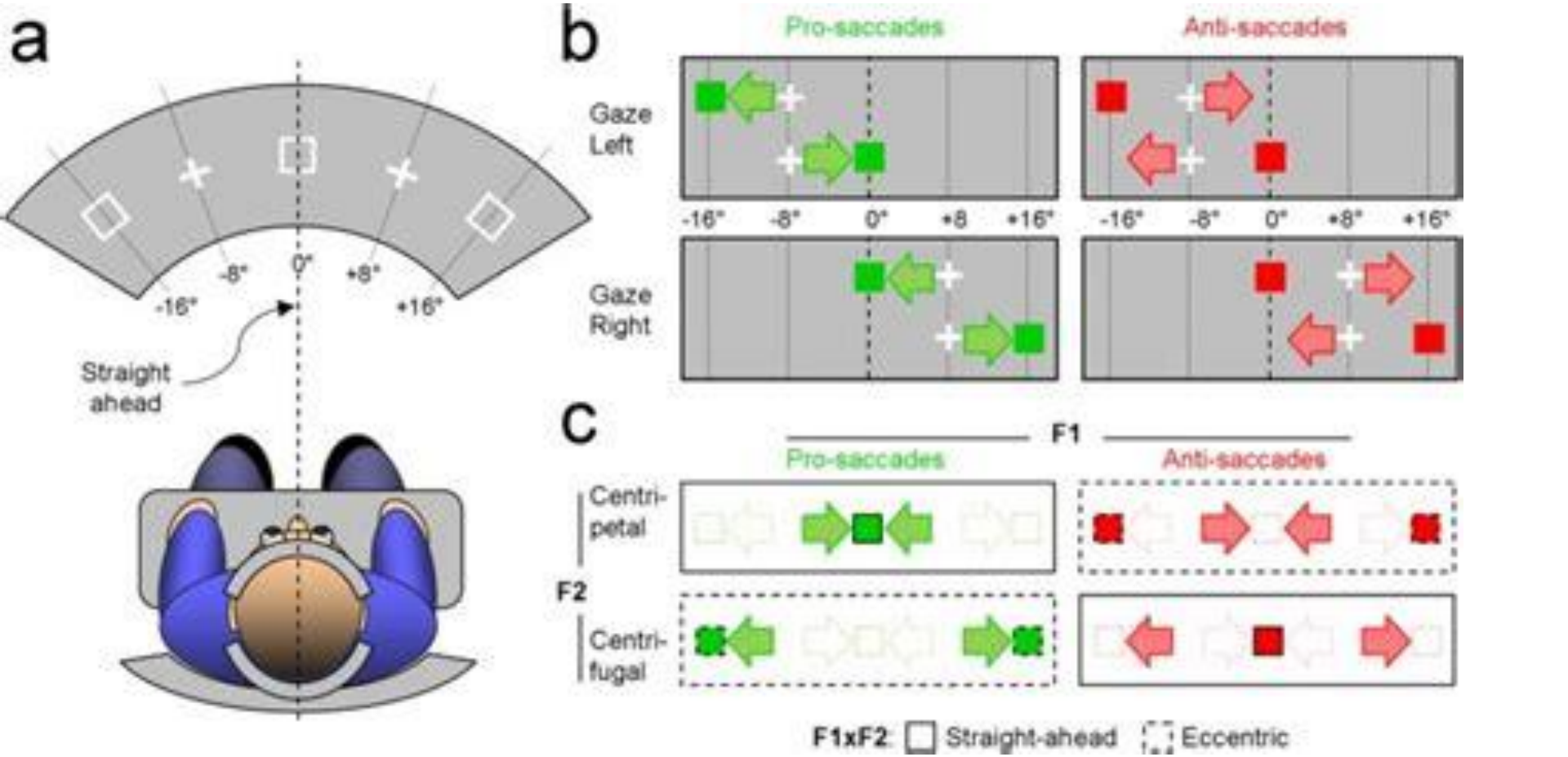






About saccades



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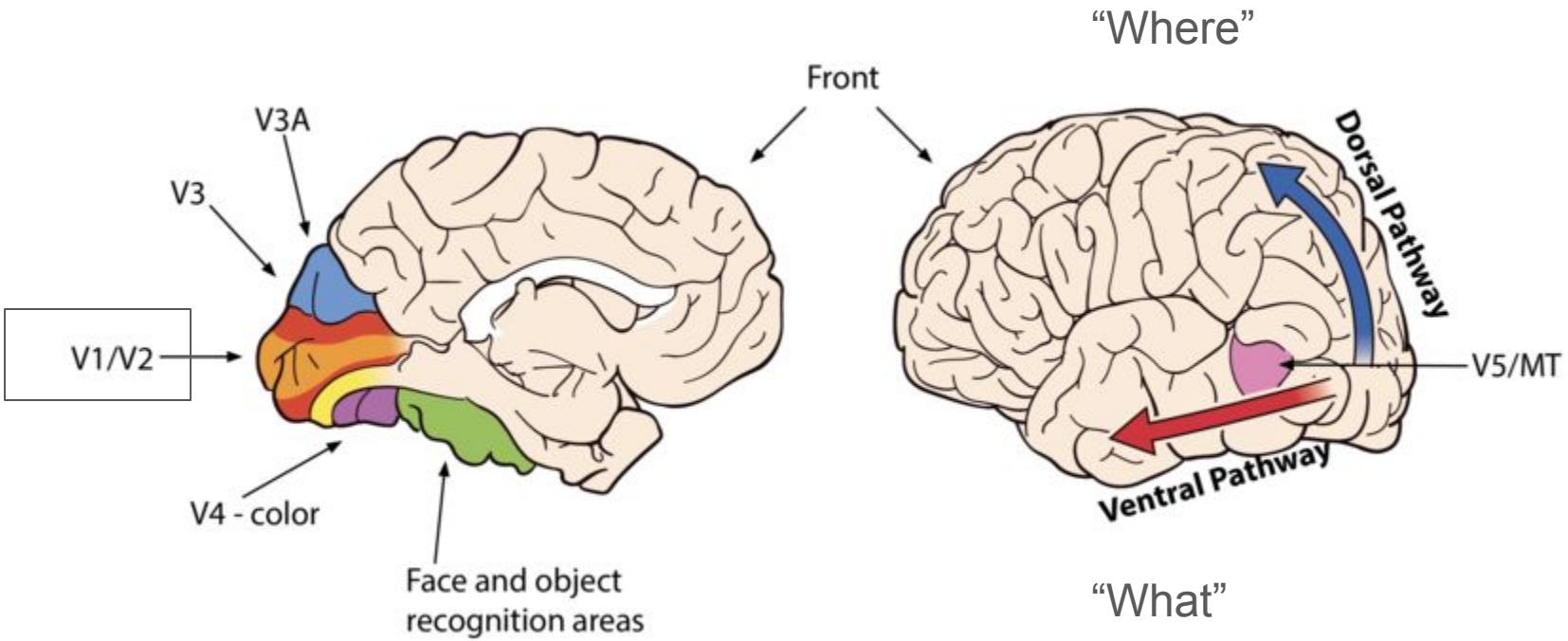
About the brain



Two processes

Feature driven / bottom-up

vs

Context driven / top-down

Visual processing is fast, memory is limited

Having users remember visual items is hard.

We generally only get about 4 items which can be reliably remembered.

It is typically better to have a visual reference even if it is far away.

Visual processing is fast, memory is limited

We should avoid scanning as much as possible.

The fovea and visual memory are limited.

Manual scanning of a scene is slow. It is better to try to use something that the visual cortex is already good at identifying.

Visual processing is fast, memory is limited

Using structures can aid processing

The brain is trying to identify structure and features. Glyphs not pixels.

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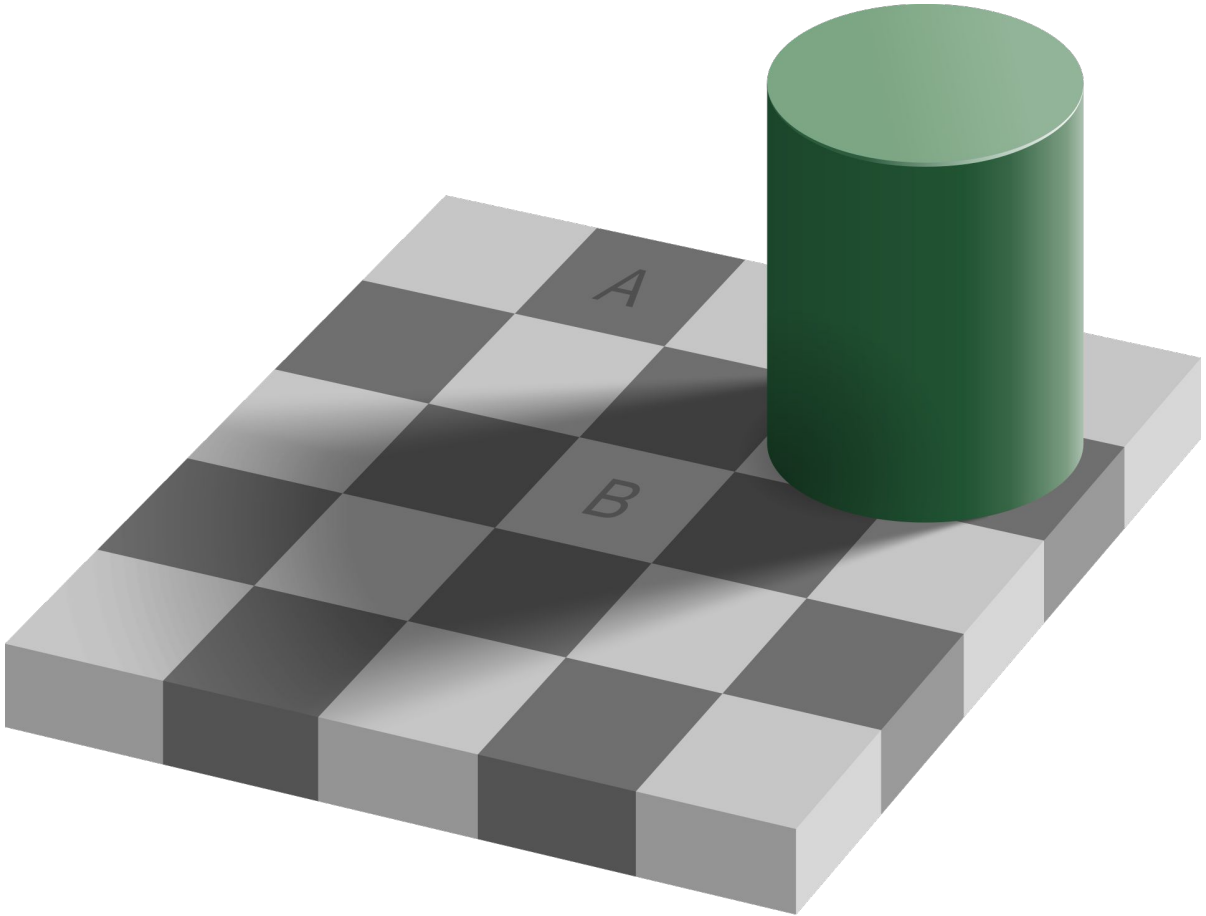
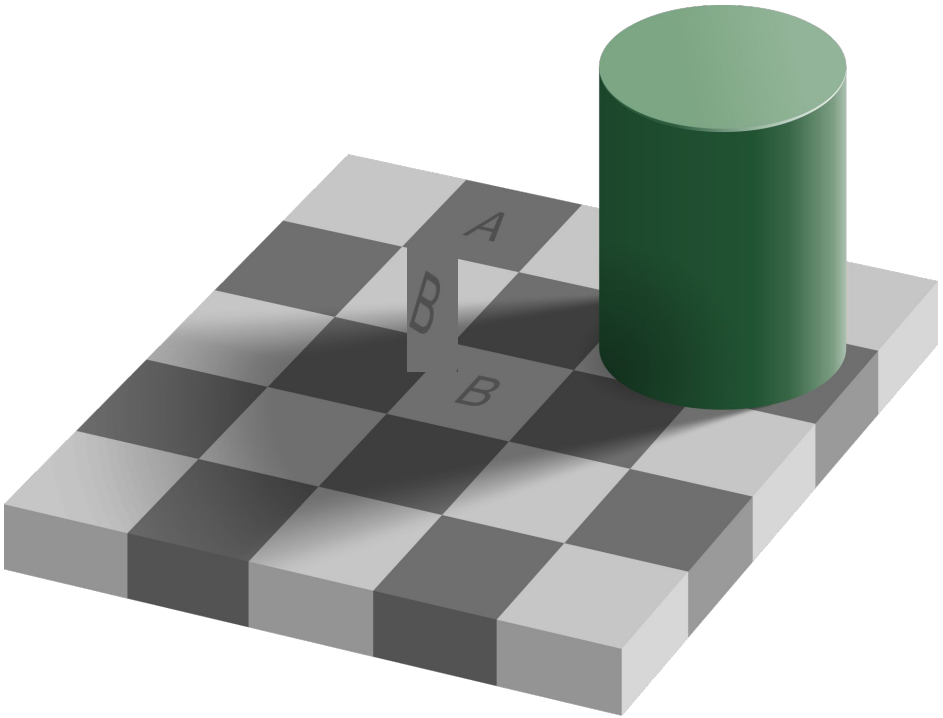
Contextual interpretation

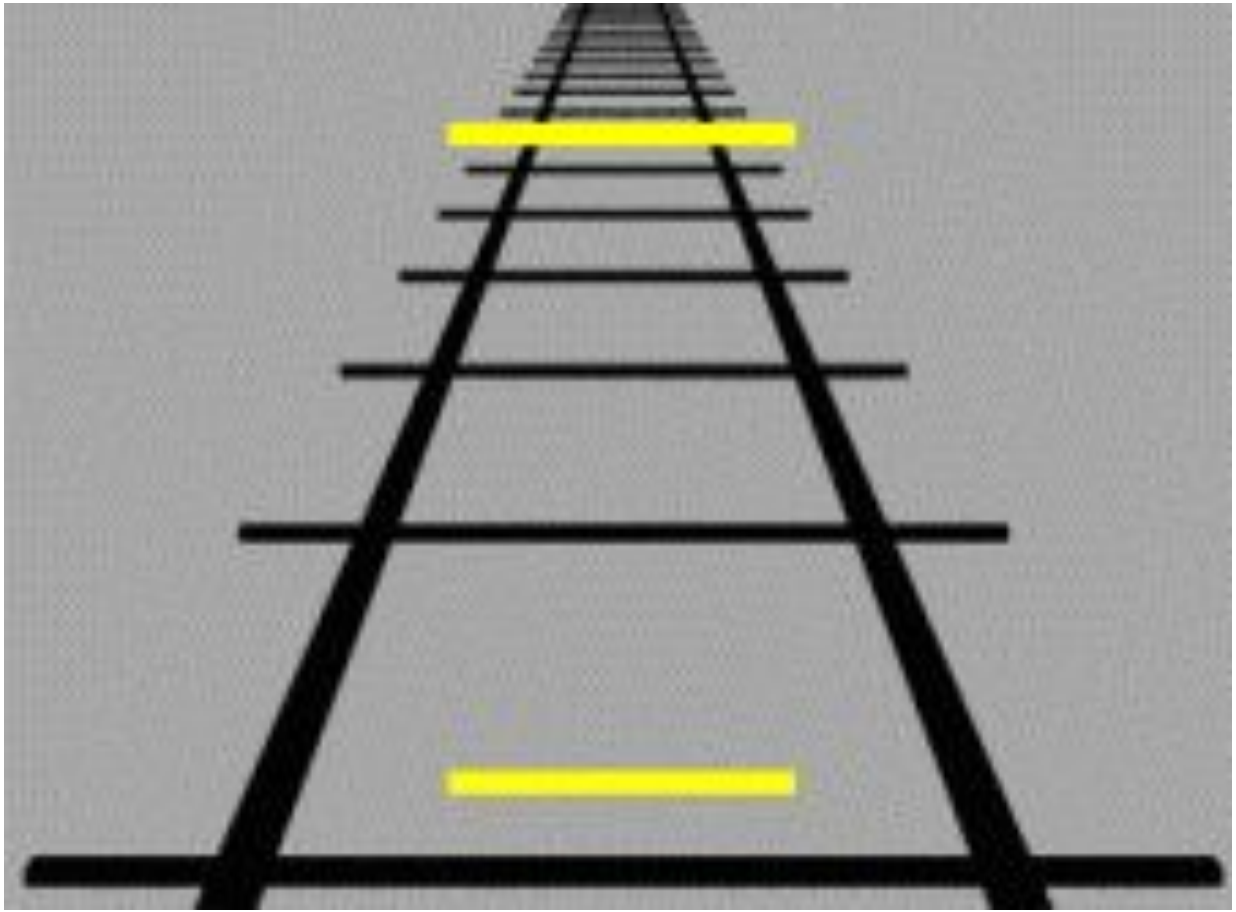


Contextual interpretation



Role of contrast

Role of expectations



Some lessons

Use structures: We will return to this in the next lecture but the “gestalt principles” let us use some of this machinery to make shortcuts. However, in general, consider the intentional and unintentional figures created by glyph proximity or connectedness.

Minimal contrast: If reliable reading of figure is required, ensure sufficient contrast to background (we will come back to this).

References: Manipulate borders to emphasize nearby contrast or absolute value.

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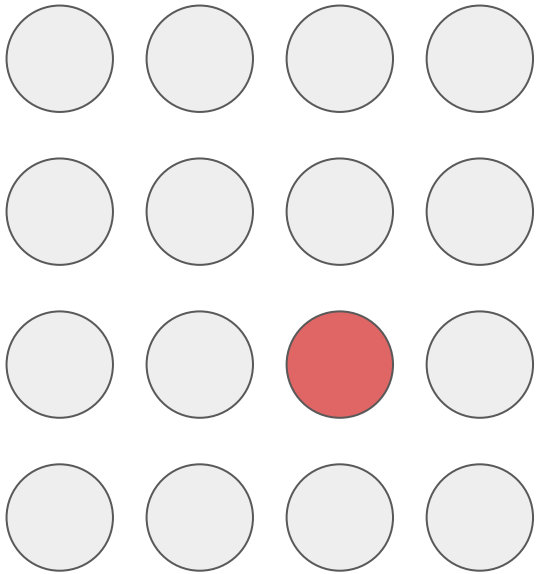
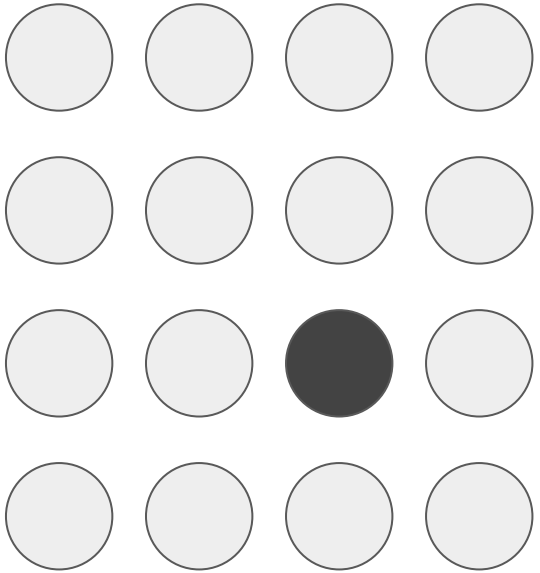
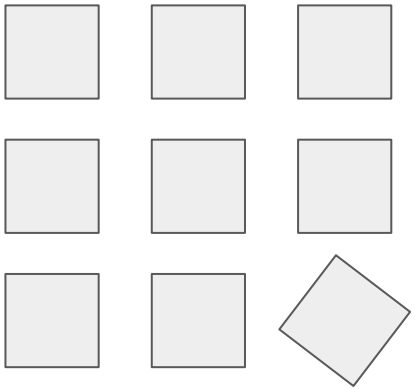
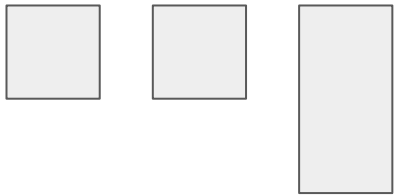
Preattentive features: **Color**

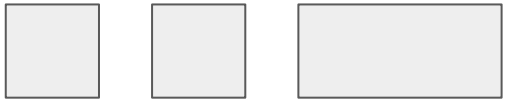


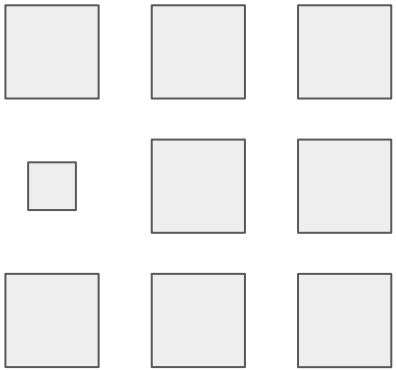


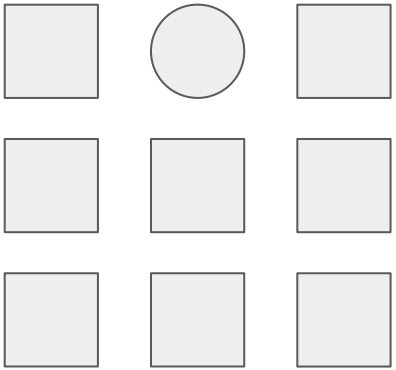
Preattentive features: **Form and orientation**

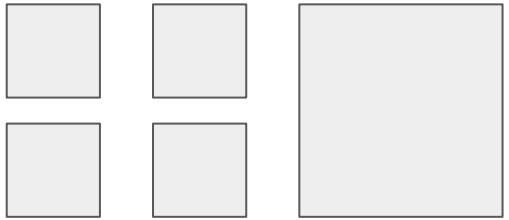












Preattentive features: **Position and Motion**

We are going to save 2.

These are the basic properties we can manipulate. However, we will come back to **movement** in game design / interactivity. We will come back to **gestalt principles** next lecture.

Preattentive features: **Reminder**

The preattentive features vary somewhat from author to author but see the reading for a pretty good list.

Group activity: school info

School	Graduation Rate	Annual Cost
Santa Clara University	92%	44000
Stanford University	97%	11000
California Institute of Technology	94%	17000
UC Berkeley	94%	17000
USC	93%	29000
UC Davis	89%	16000
Loyola Marymount University	82%	45000
San Jose State University	75%	14000
UC Santa Barbara	86%	15000
UC Irvine	87%	12000
UCLA	93%	16000
CA State Sacramento	70%	11000

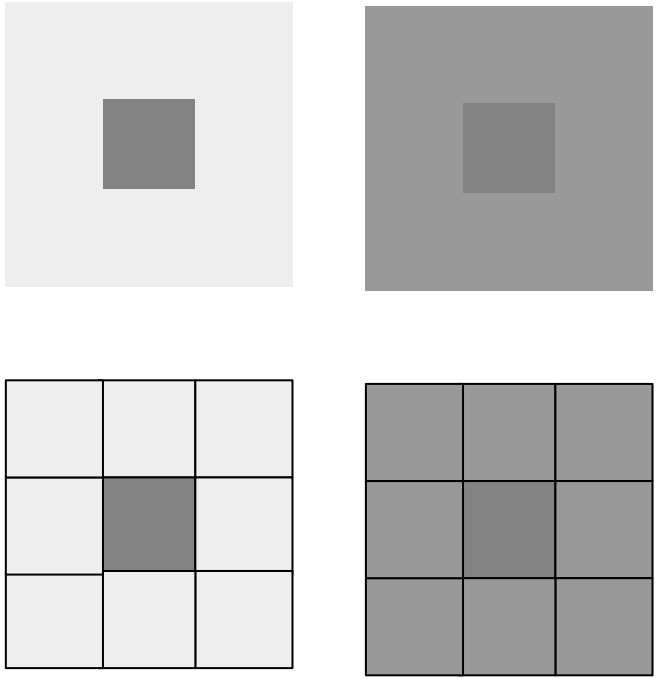
I have a small dataset on graduation rate and salary.

Work with a partner to use preattentive features to highlight Berkeley in a visualization.

We will share with another group in 10 minutes.

Recap: what are some of the viz takeaways?

- Having users remember visual items is hard. When possible, keep it visible.
- We can use preattentive features to avoid scanning.
- What we see depends on what is around it.
- We can have things touch each other to emphasize relative comparison. We can create borders or consistent background to emphasize absolute value extraction.
- Ensure sufficient contrast for feature extraction.



New language: Another look at next steps.

Science 2: More on preattention and color vision (color, gestalt principles).

Skills labs: Playing with visual processing (form, motion, and interaction).

Formalizing glyphs: Encoding (how we put info into graphics), decoding (how our brains get that info out). Revisit dimensions and attributes.

Works Cited

B. Adhikari, "Marey's train schedule," University of Missouri Saint Louis, 2021. Available: https://badriadhikari.github.io/data-viz-workshop-2021/minards/

S. Bell, “Introduction and Perceptual Elements of Colour,” University of Saskatchewan. Available: https://openpress.usask.ca/introgeomatics/chapter/introduction-and-perceptual-elements-of-colour/

J. Harvey, “The evolution of the human eye,” TED Ed, 2015. Available: https://www.youtube.com/watch?v=qrKZBh8BL_U

D. Camors, Y. Trotter, P. Pouget, S. Gilardeau & J. Durand, “Visual straight-ahead preference in saccadic eye movements,” Nature Communications, 2016. Available: https://www.nature.com/articles/srep23124

OSC Rice, “Vision,” Washington State University. Available: https://opentext.wsu.edu/psych105nusbaum/chapter/vision/

“Vision,” CourseHero. Available: https://www.coursehero.com/study-guides/wmopen-psychology/outcome-vision/

E. Adelson, “Checker shadow illusion,” Wikimedia, 2018. Available: https://en.wikipedia.org/wiki/Checker_shadow_illusion#/media/File:Checker_shadow_illusion.svg

DancingPhilosopher, “Mach Bands,” Wikimedia, 2012. Available: https://en.wikipedia.org/wiki/Optical_illusion#/media/File:Mach_bands_-_animation.gif

US Department of Education, “College Scorecard,” US Department of Education. Available: https://collegescorecard.ed.gov/search/?sort=salary:desc&page=0&state=CA

C. Ware, “Information Visualization: Perception for Design,” MK Press.

C. Ware, “Visual Thinking for Design,” MK Press.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