Communicating with Data – Perception and Color

Dr. Ab Mosca (they/them)

Slides based off slides courtesy of Jordan Crouser (https://jcrouser.github.io/)

Notes on HW01

- Remember to note who you collaborated with or explicitly state that you collaborated with no one (per the syllabus)
- Consider working (and submitting) in groups! Lots of people did the exact same visualizations, and it's more fun to create an analyze when you have brainstorming buddies

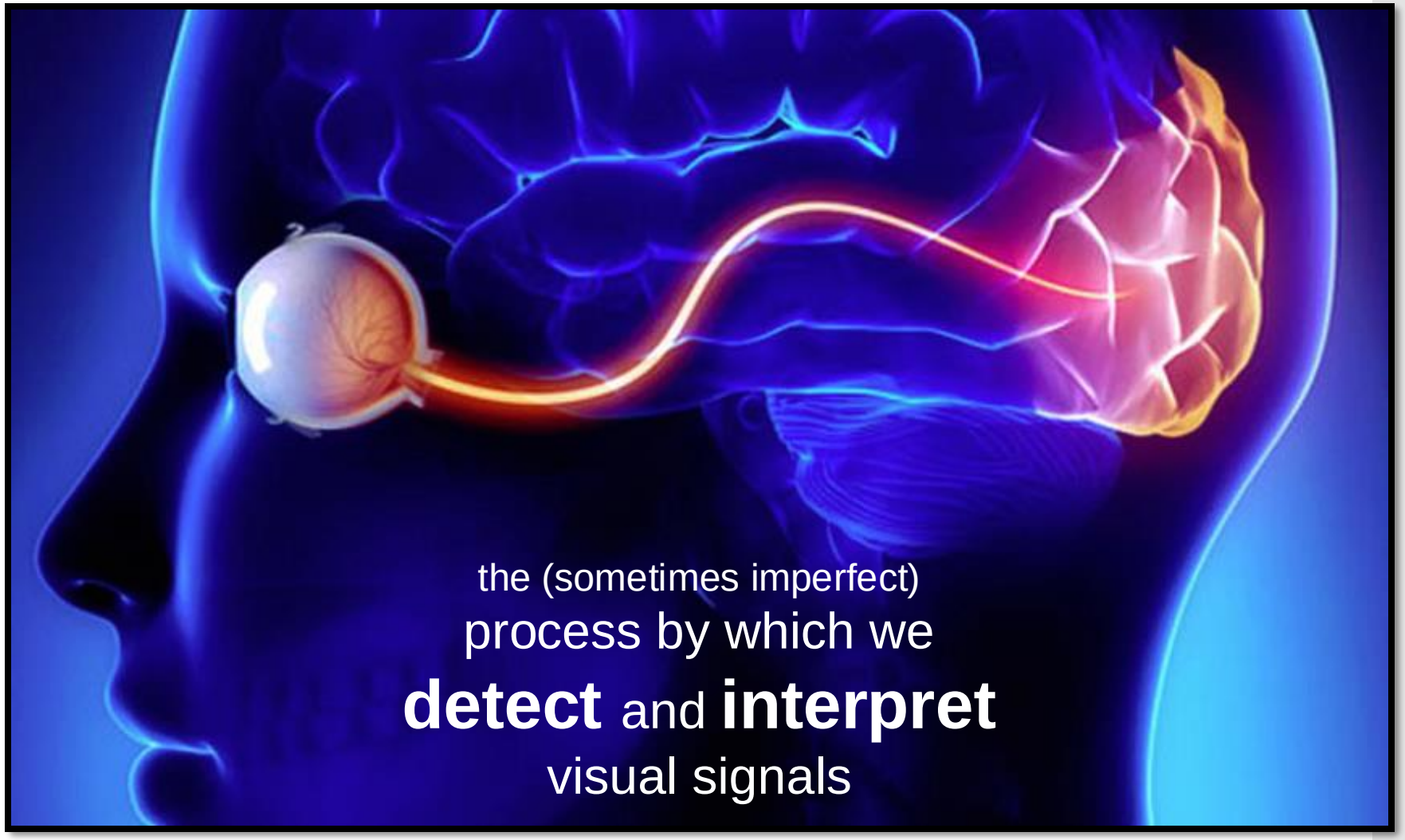
Plan for Today

- What is perception?
  - How does it work?
  - Pre-attentive processing
  - Perceptual problems
  - Estimating magnitude
- Color 101
  - How we see color
  - What this means for visualization
  - More perceptual problems
- Takeaways

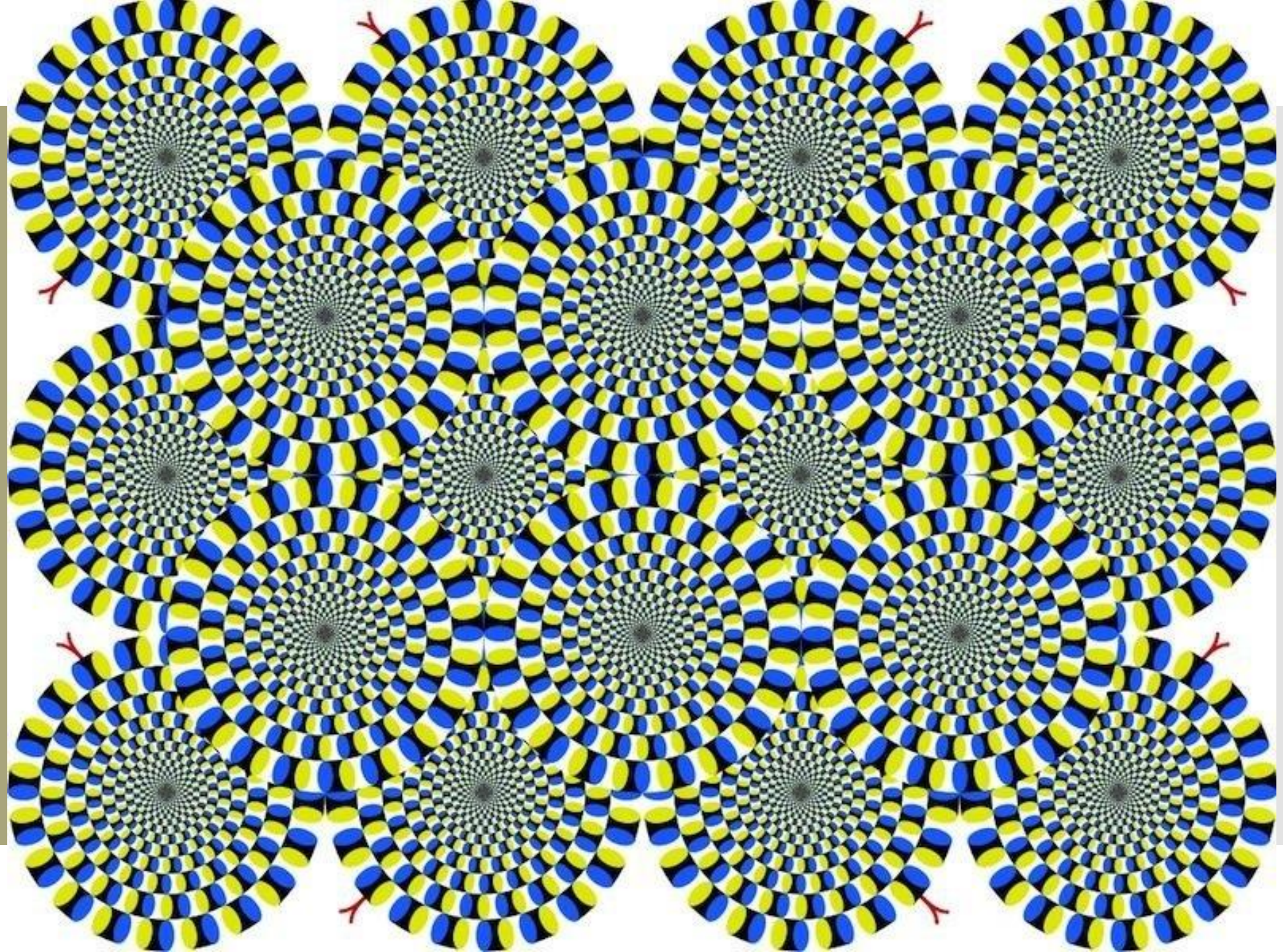
Note: I'm going to flash a bunch of slides quickly today. If that doesn't work for you, you are welcome to step out, close your eyes, etc.. (none of us will be offended and I will fill you in on anything crucial you missed!)

What is perception?

Visual perception (def.)



Do you see movement?



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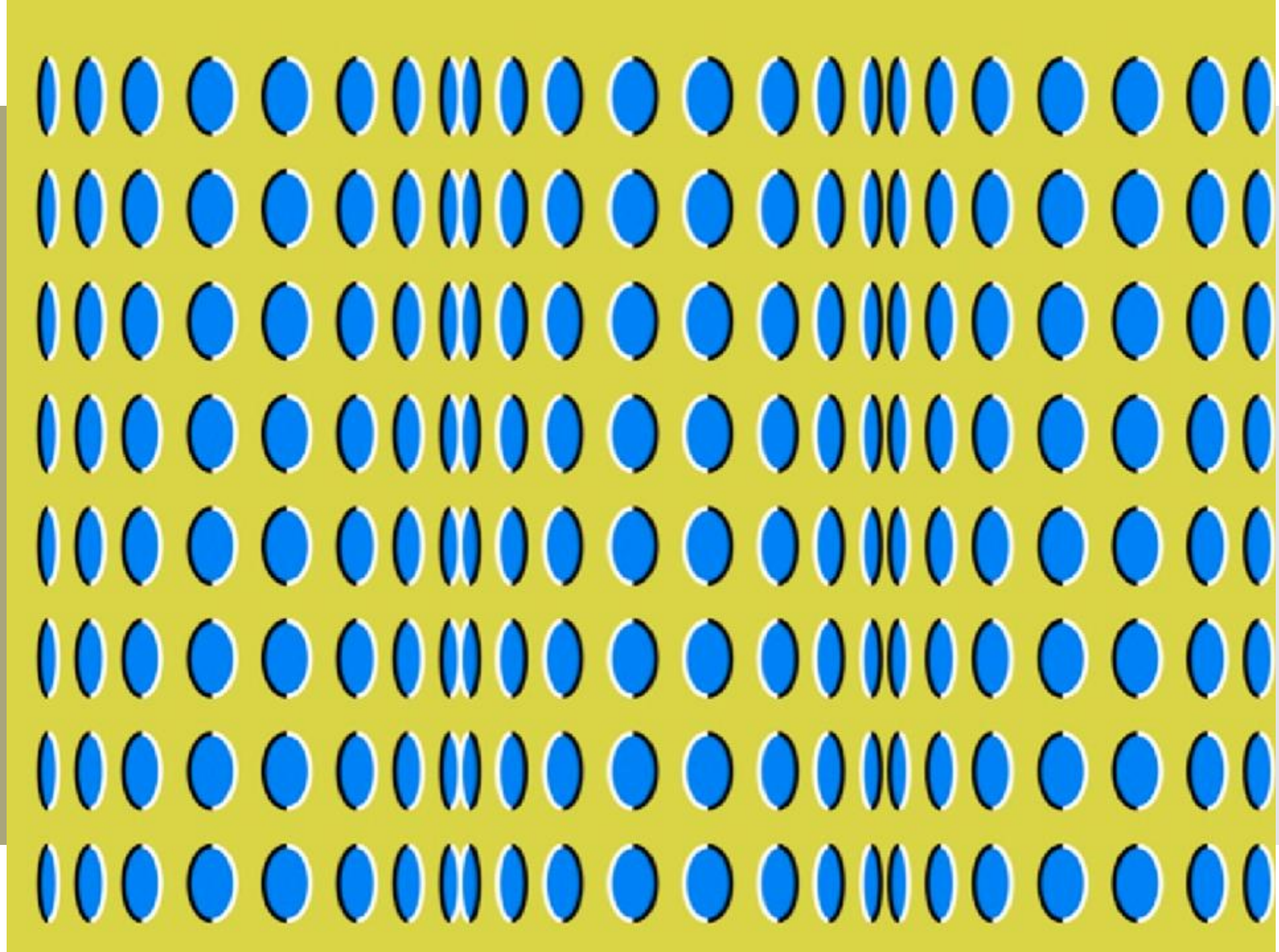
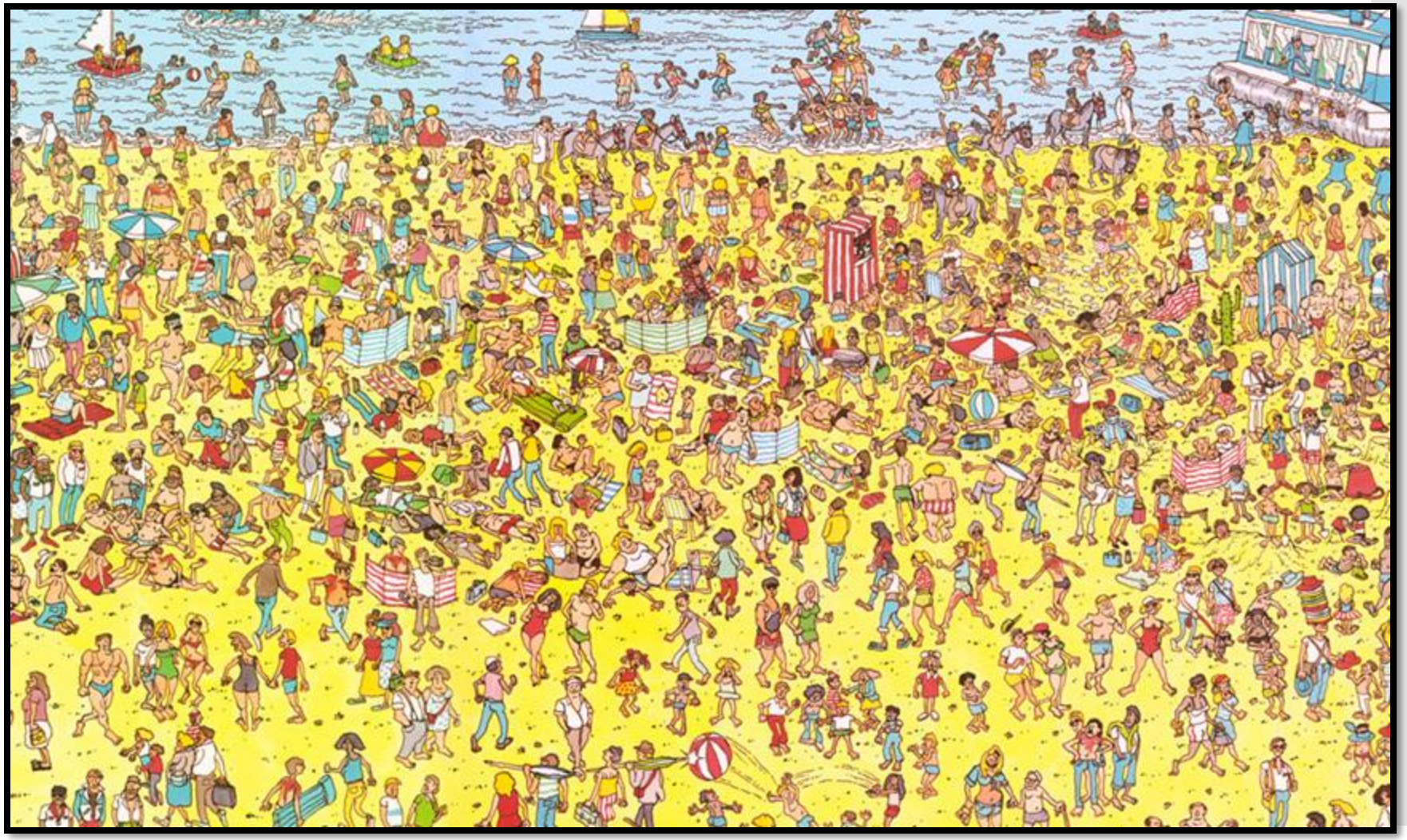


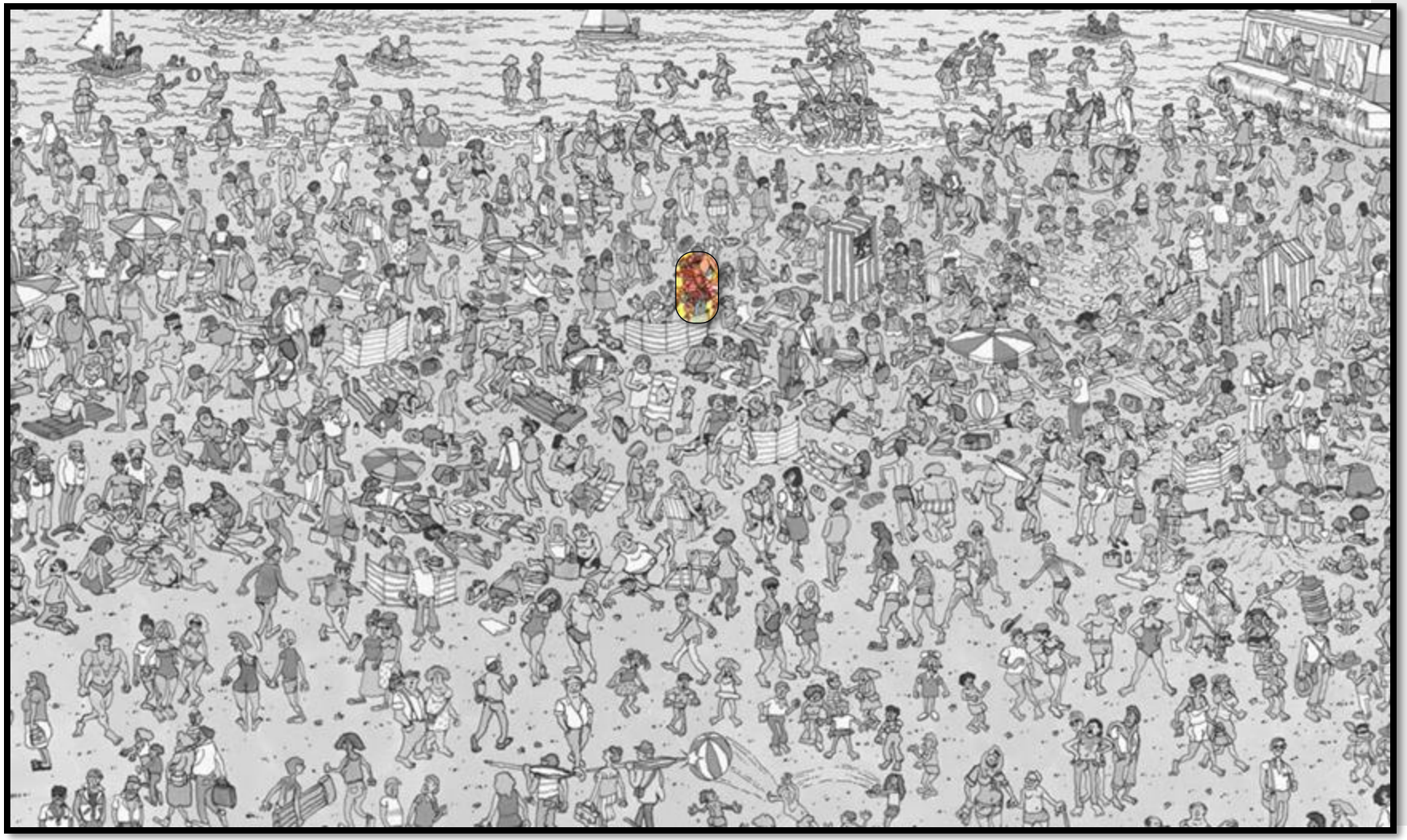
Visual perception

Some things are processed slowly



Visual perception

Others are incredibly fast

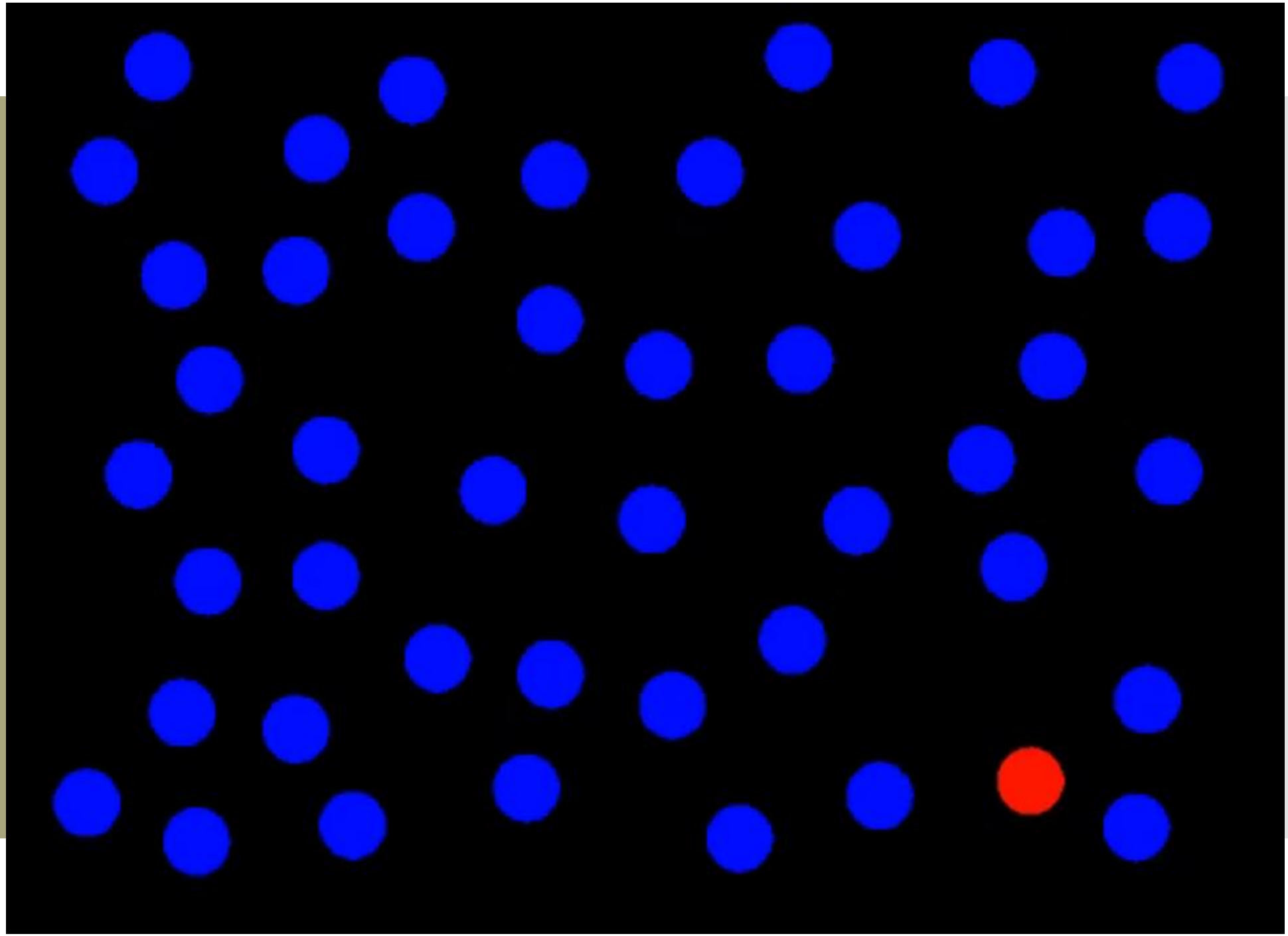


Visual perception

Fast = “pre-attentive processing”

- Things that happen in <200ms of visual stimulation
- Performed in parallel across the entire visual field
- Example…

Perception: Preattentive Processing



Perception: Preattentive Processing

What did you see?

Pre-attentive processing

"An understanding of what is processed pre-attentively is probably the **most important** contribution that visual science can make to data visualization" (Ware, 2004, p. 19)

Pre-attentive processing facilitates:

- Target detection (presence or absence)
- Boundary detection / grouping
- Region tracking
- Counting and estimation

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- On the next slide I want you to count how many zeros you see as fast as you can. Raise your hand (do not shout the number) when you have the answer.

Attentive counting

128176875613897654698450698562498282676298098584582245198564589450984599859435859891330249945959595772564675750678974567884578981982167765487636496856091294968 6

How many zeros are there?

Attentive counting

We’ll do the same on the next slide for threes.

Pre-attentive counting

1281768756138976546984506985604982826762

9809858458224509856458945098450980943585

9091030209905959595772564675050678904567

8845789809821677654876364908560912949686

How many threes are there?

Pre-attentive processing for visualization

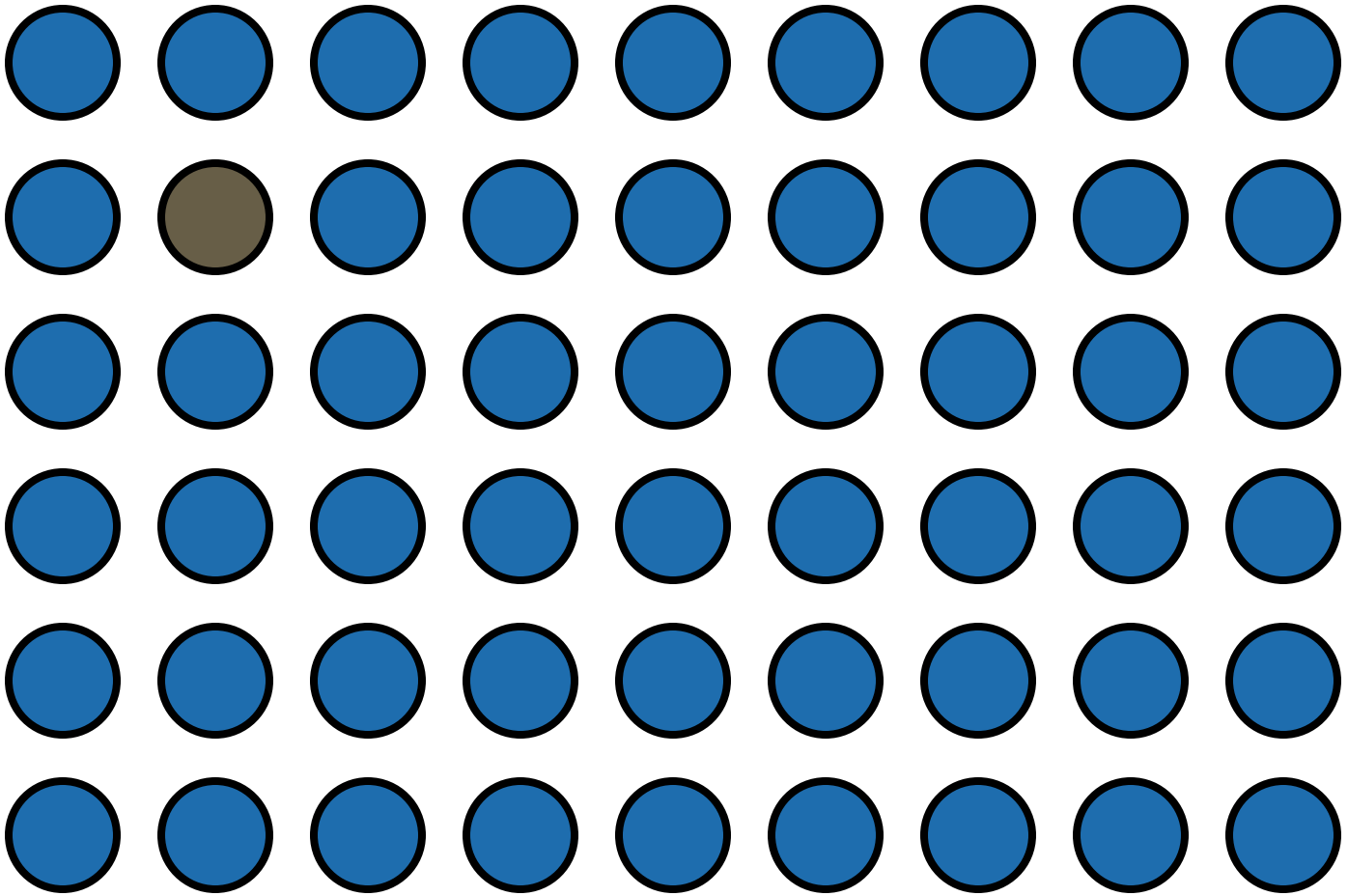
Question 1: how do we (vis designers) use pre-attentive processing to our advantage?

Question 2: what do we need to watch out for?

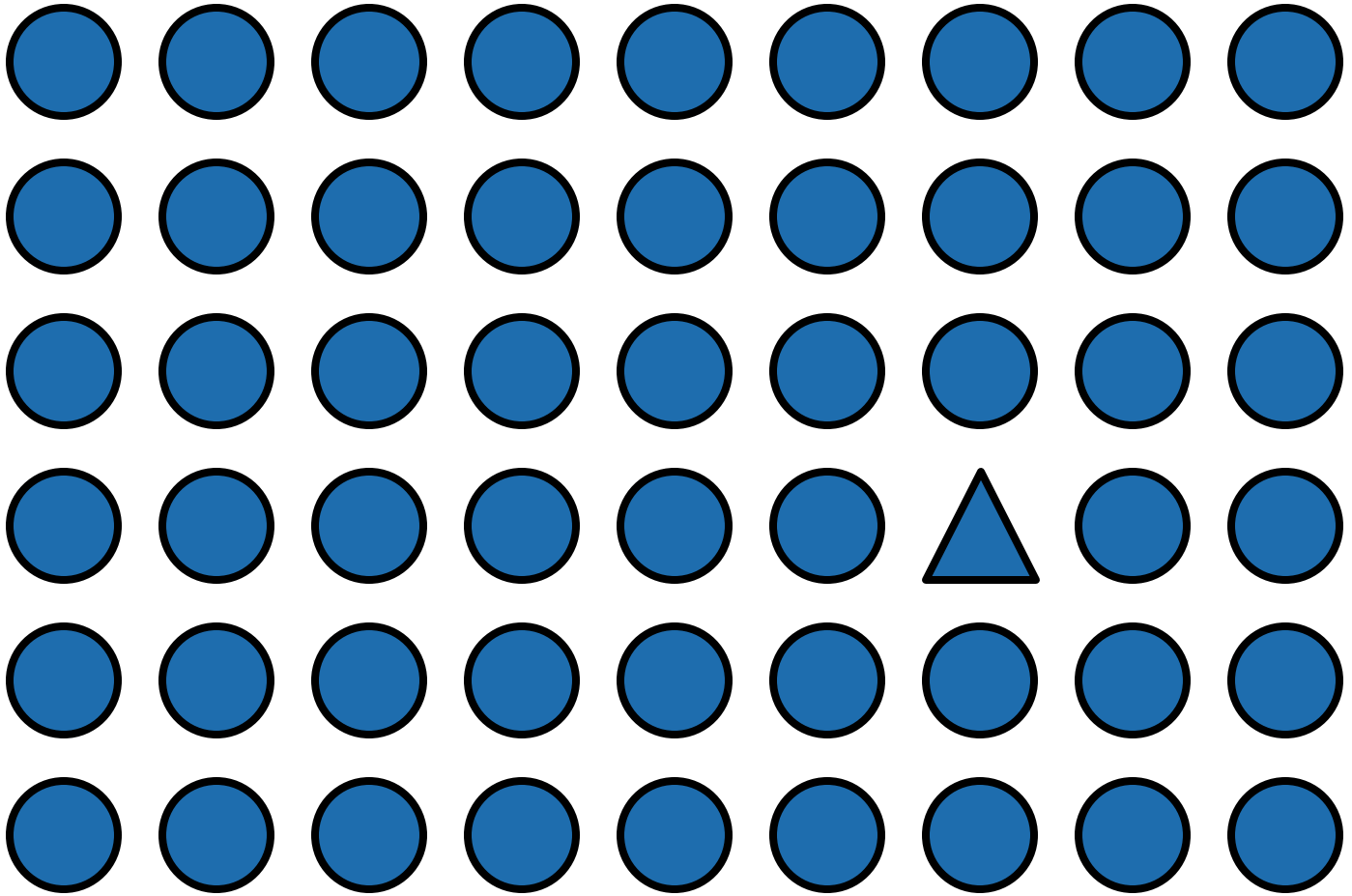
Pre-attentive processing for visualization

There’s only one instance of something on each of the next slides. What is it?

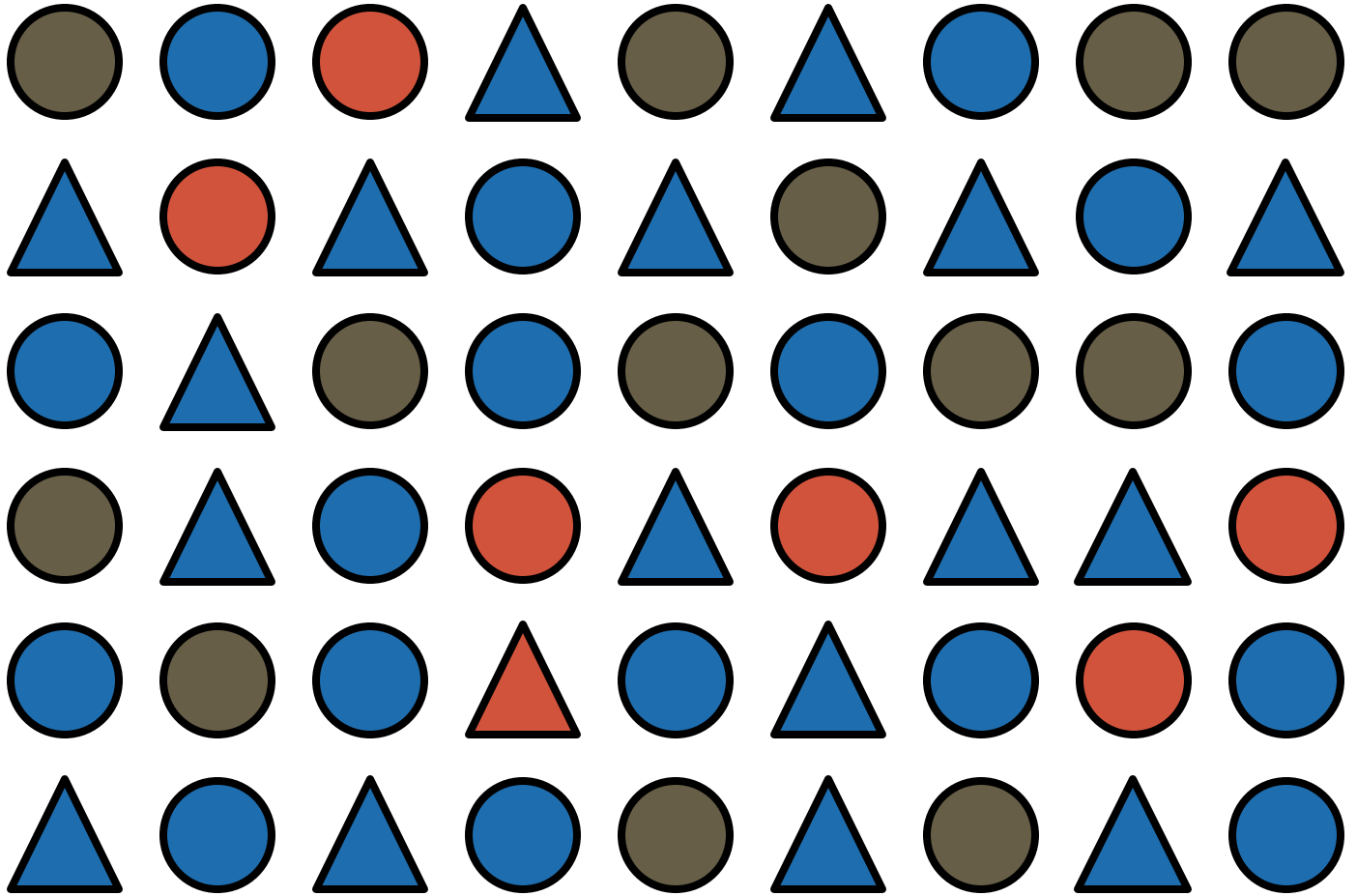
Pre-attentive processing: color (hue)



Pre-attentive processing: shape (curvature)



Pre-attentive processing: shape + color?



Discussion: what's going on here?

Answer: this is called "conjunction"

- If you search for red things, you get a bunch of red circles (as well as the red **triangle**).
- Similarly, if you search for search for **triangles**, you get a bunch of blue **triangles** (as well as the red **triangle**).
- Either way, you have to search through them all one by one!

Pre-attentive processing for visualization

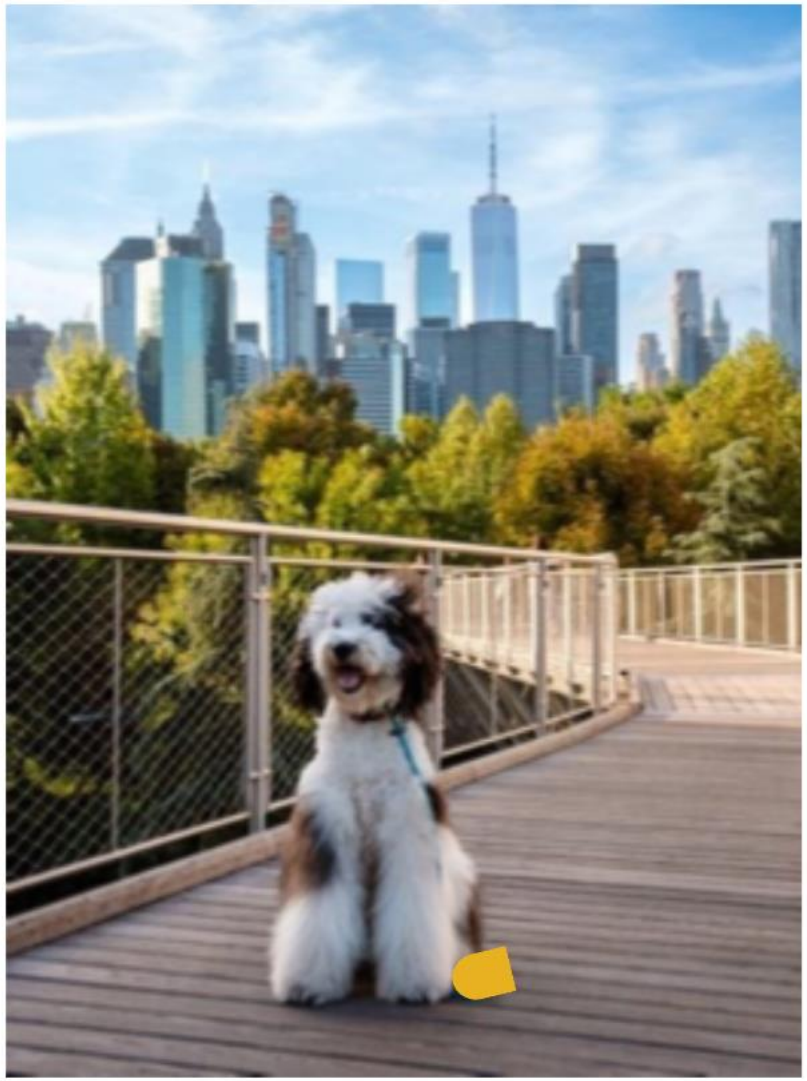
- Whatever draws our eyes draws our attention
- This can be useful
- It can also be problematic:

Pre-attentive processing for visualization: The downsides

Ex. flicker can cause change blindness

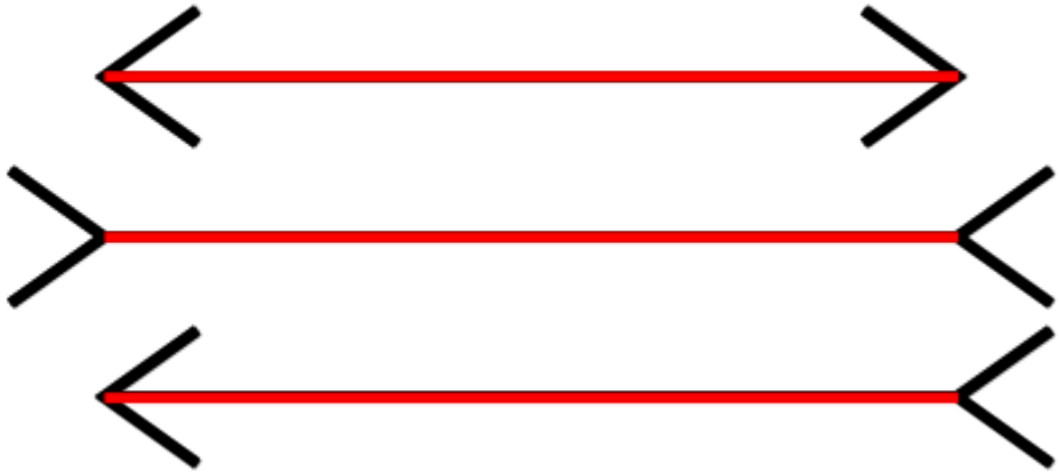
Pre-attentive processing for visualization: The downsides

Can you see it now?



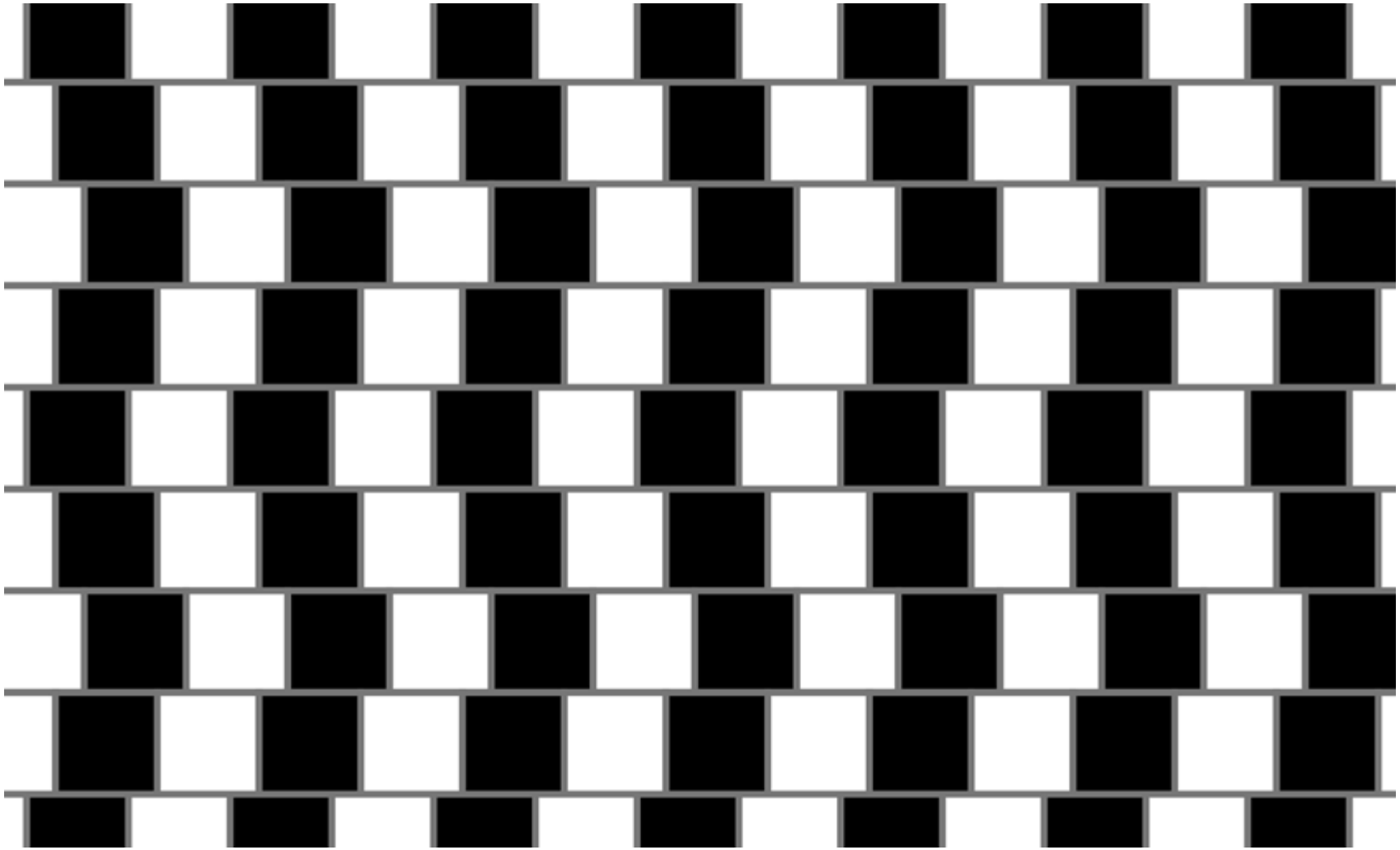
Pre-attentive processing for visualization: The downsides

Sometimes gestalt & pre-attention compete



Pre-attentive processing for visualization: The downsides

Sometimes gestalt & pre-attention compete



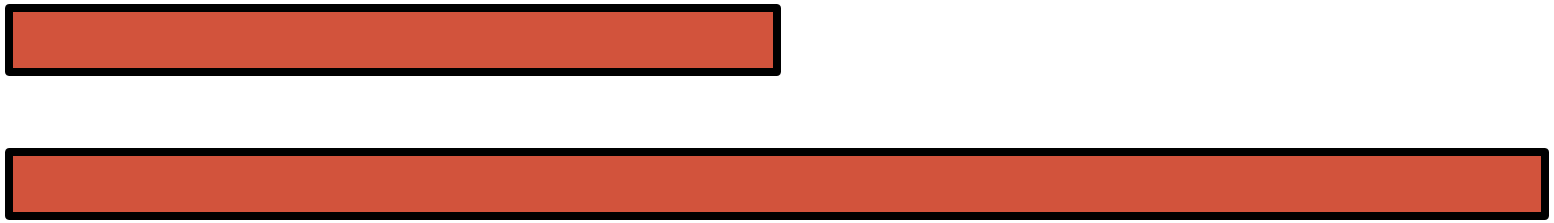
Attentive processing

Okay, what about **attentive** processing?

Attentive processing

Magnitude estimation

Question: How much **bigger** is the lower bar?

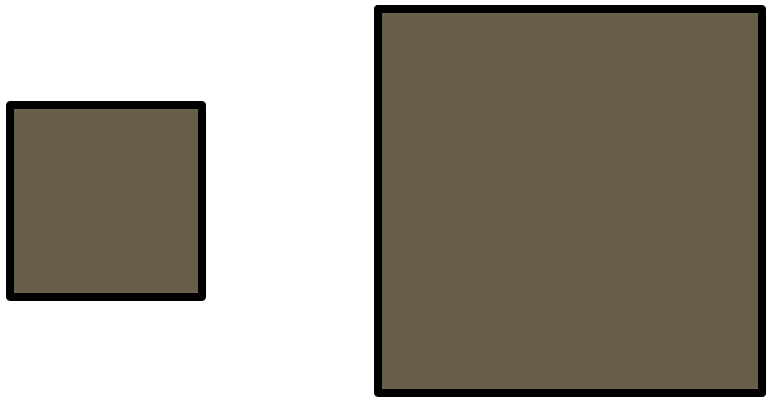


Answer: 2X

Attentive processing

Magnitude estimation

Question: How much **bigger** is the right square?

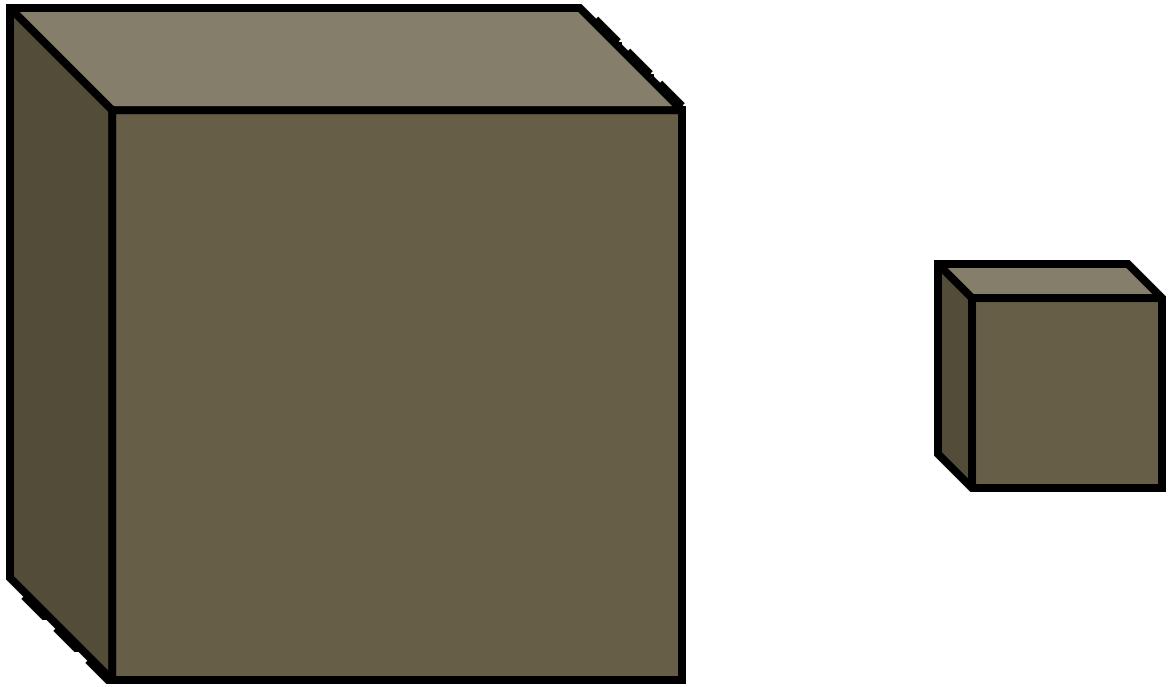


Answer: 4x

Attentive processing

Magnitude estimation

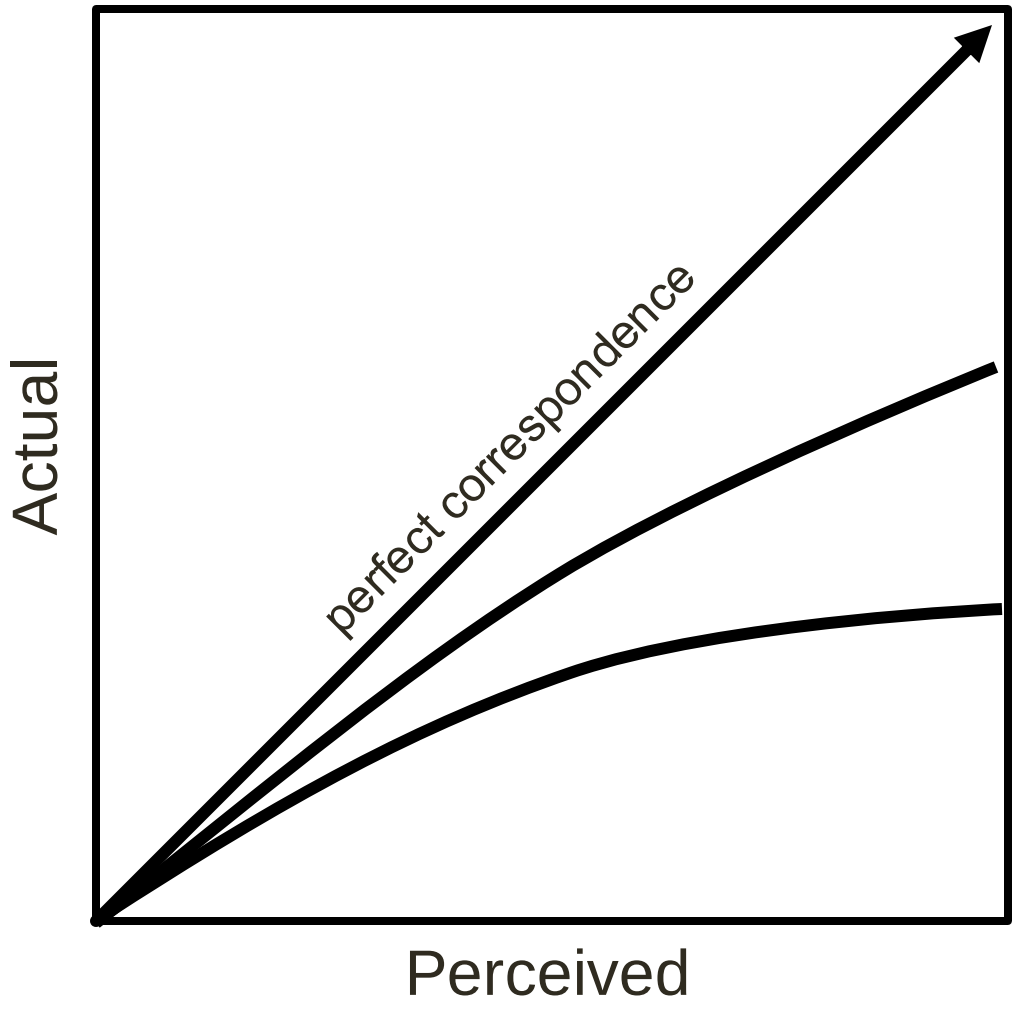
Question: How much **bigger** is the left cube?



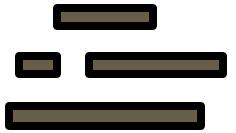
Answer: 27x

Attentive processing

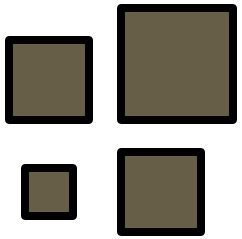
"Apparent" magnitude



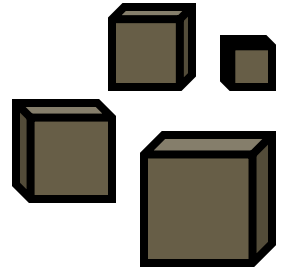
Length
estimate correctly



Area
under-estimate

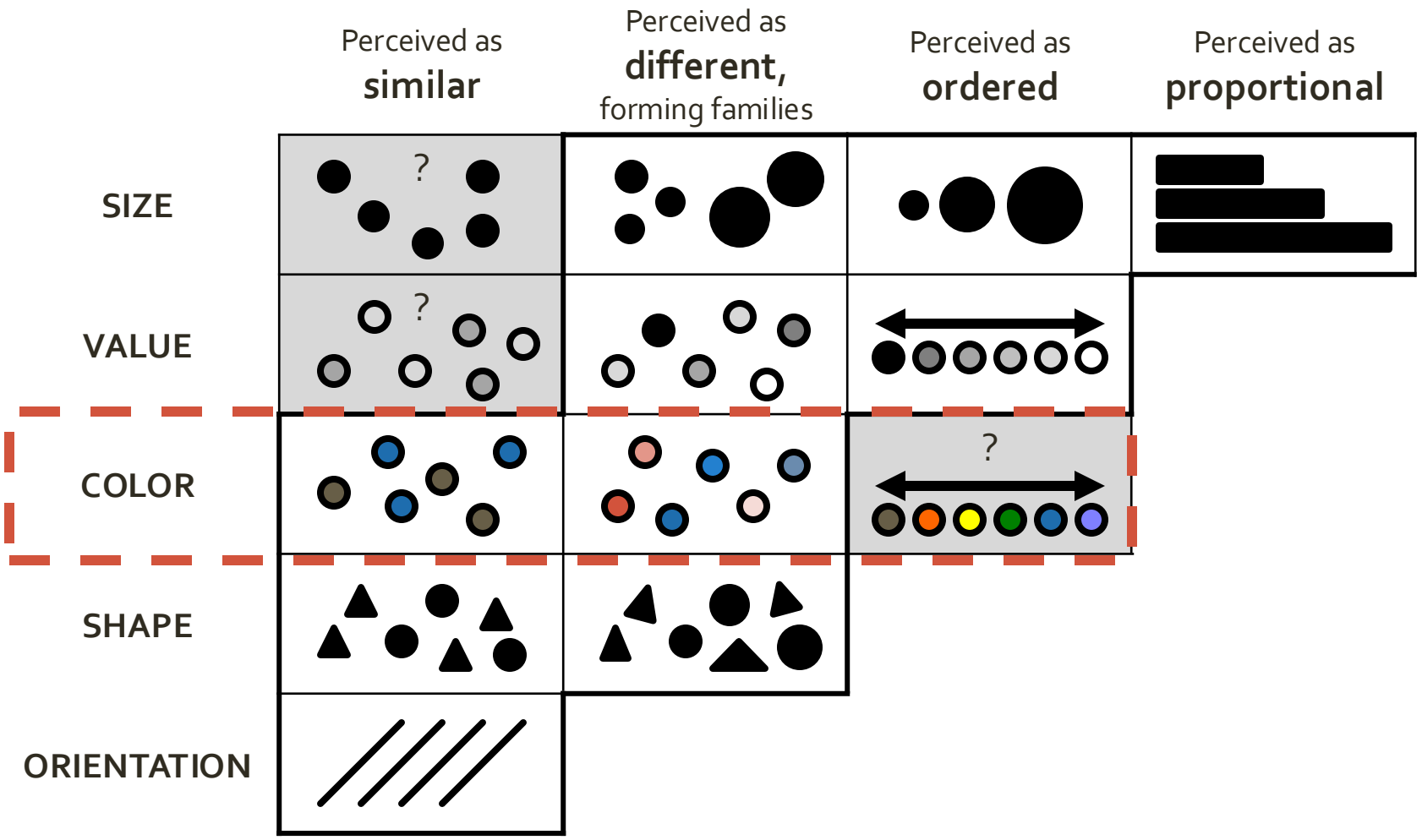


Volume
way under-estimate



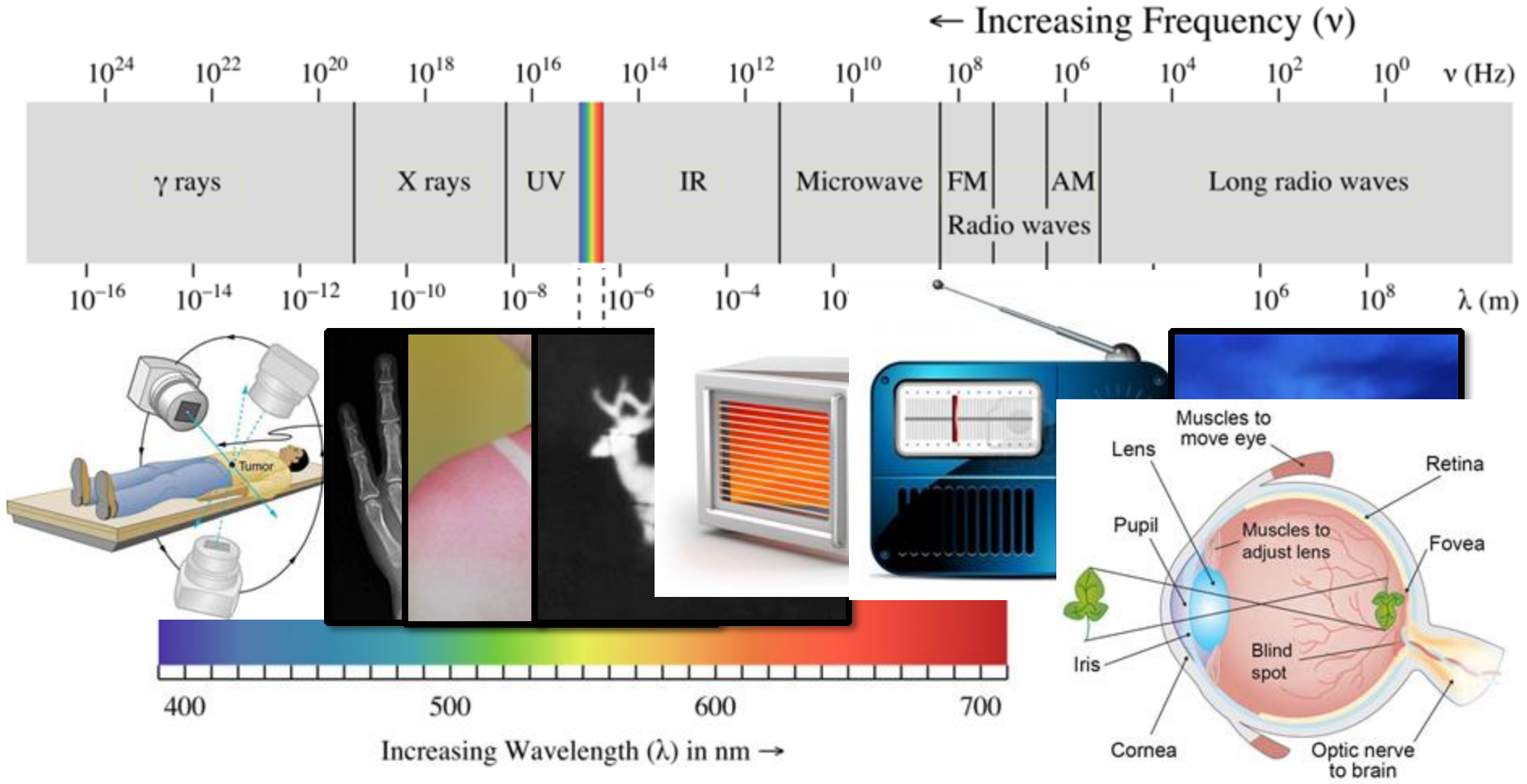
http://makingmaps.net/2007/08/28/perceptual-scaling-of-map-symbols/

Mapping to visual dimensions



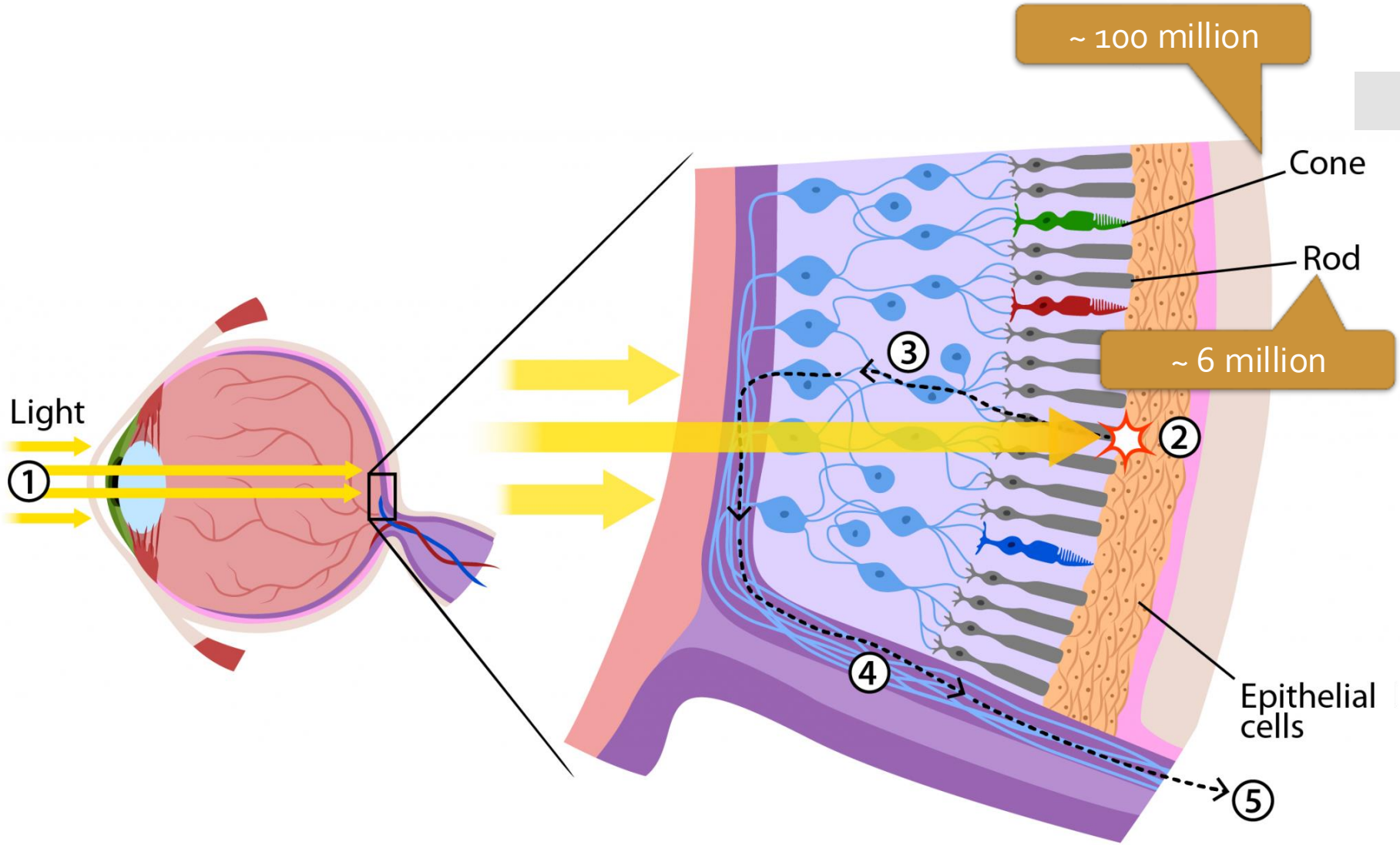
Color 101

Kinds of light



Eye diagram courtesy ASU

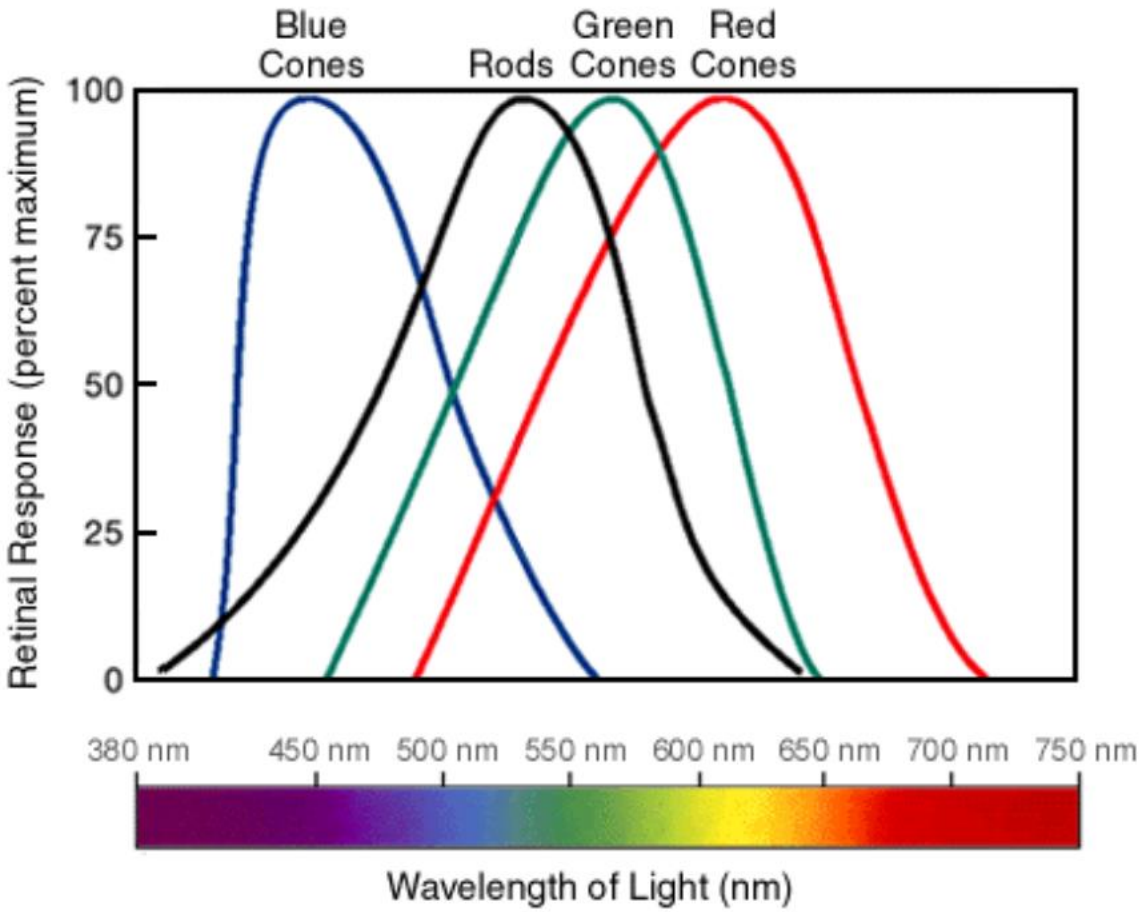
How we see color



https://askabiologist.asu.edu/rods-and-cones

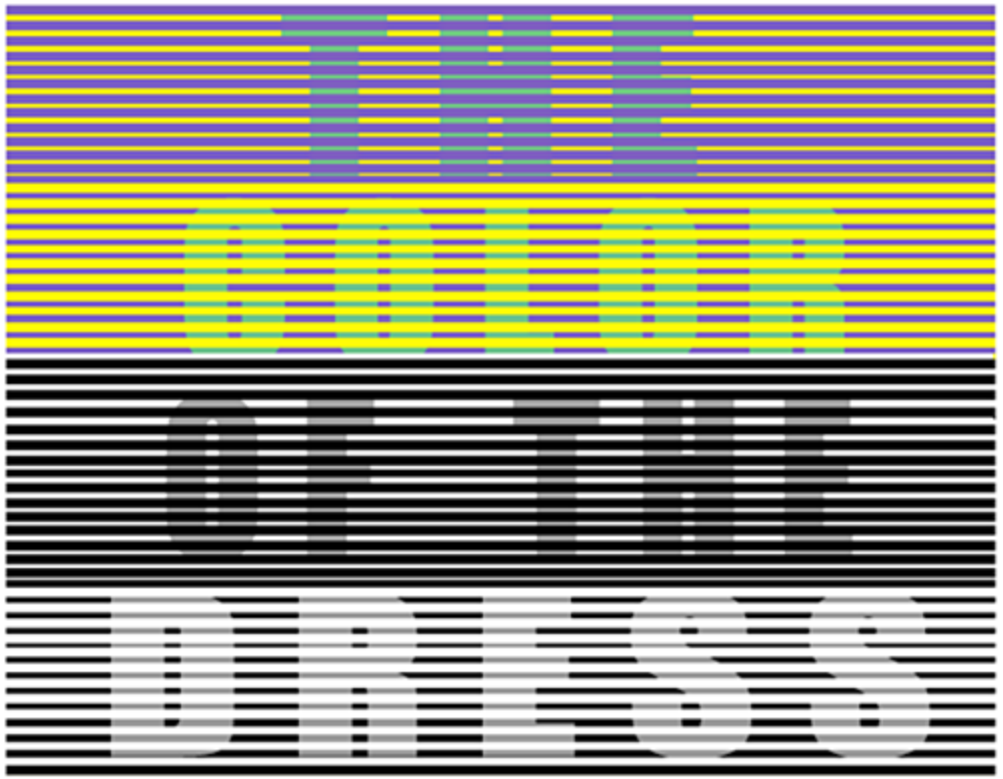
How we see color

What do you notice here?



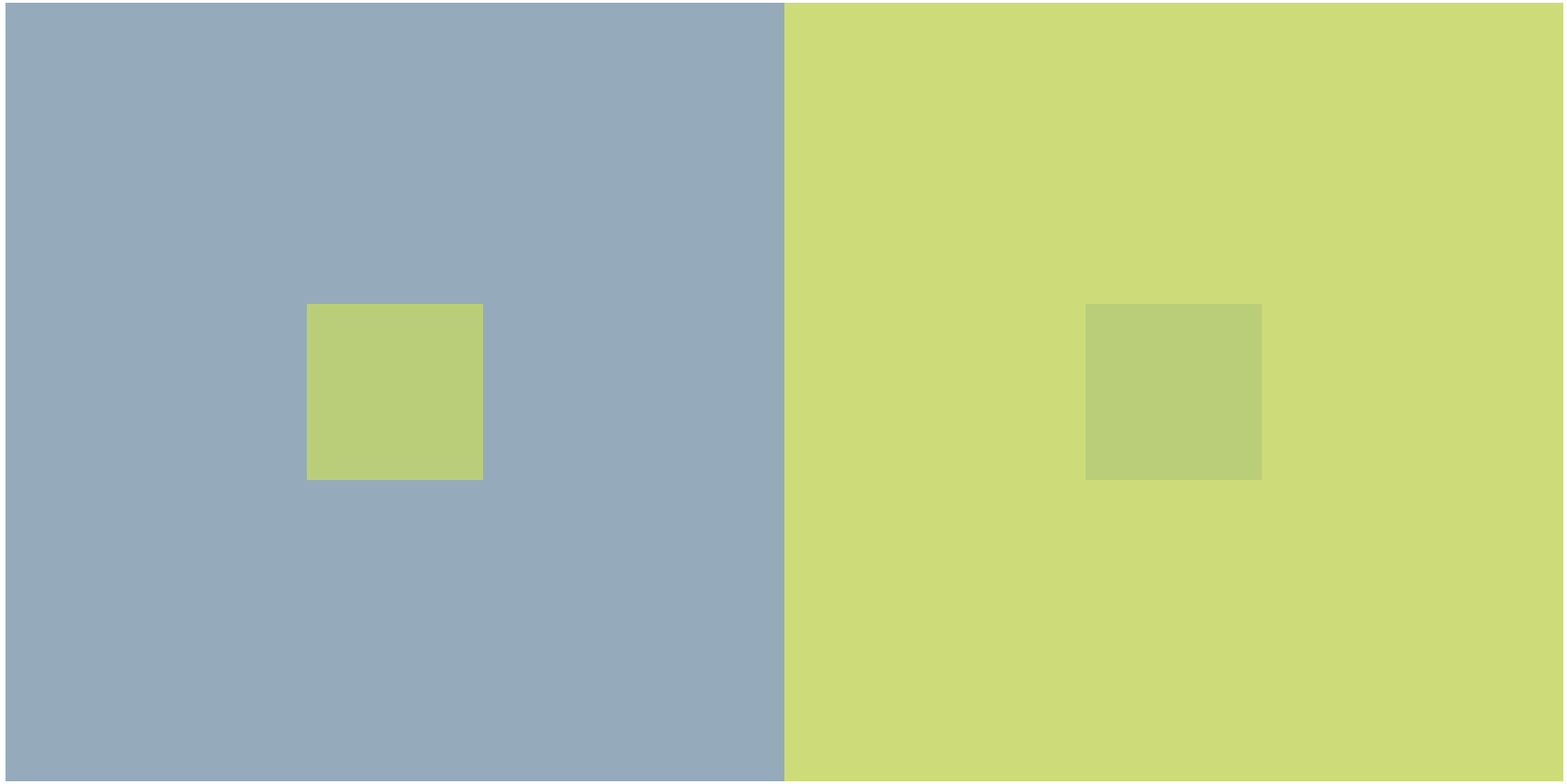
https://askabiologist.asu.edu/rods-and-cones

Color phenomena



Color phenomena

Caveat 1: color is perceived in context



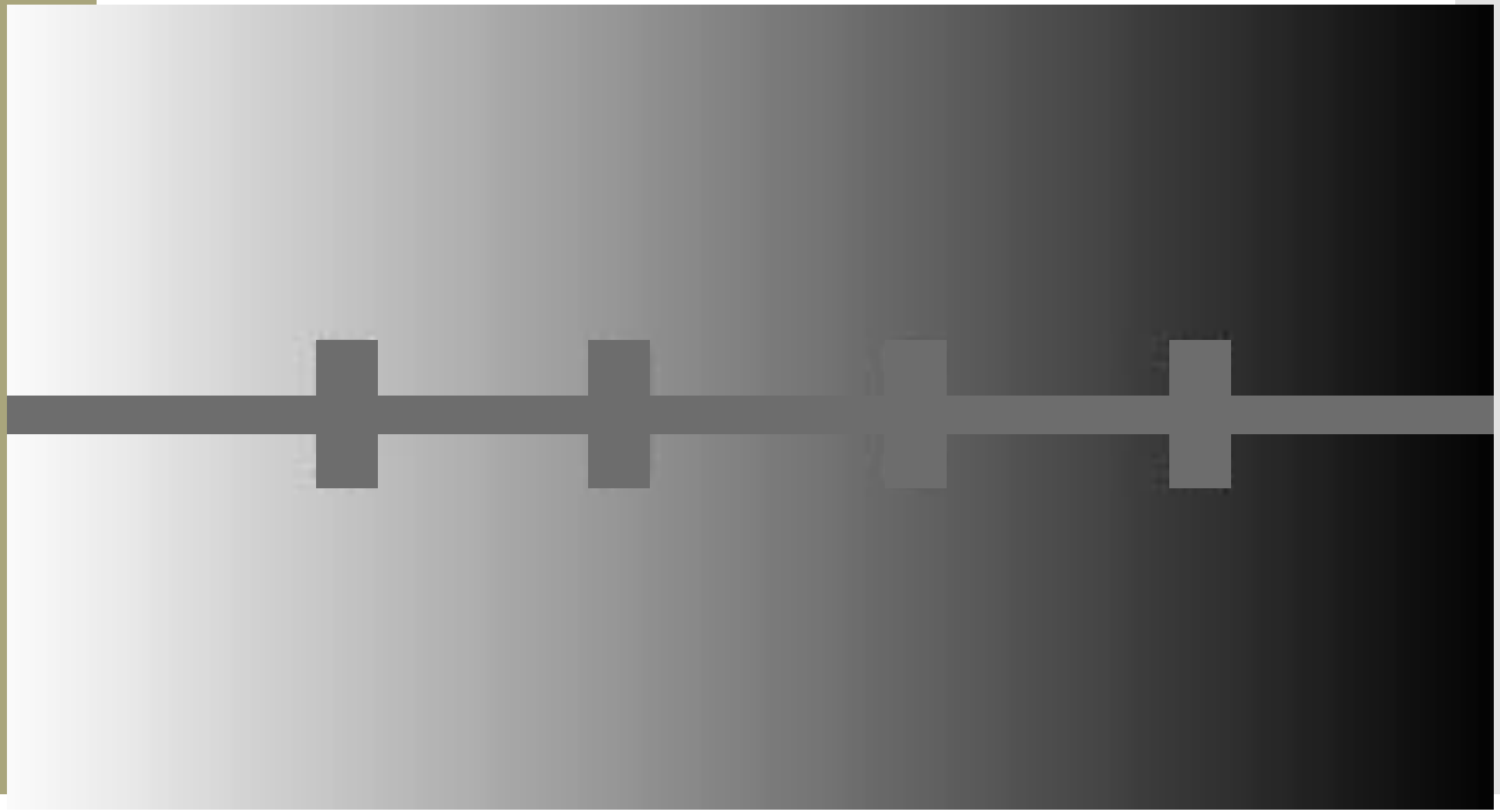
Which small square is **darker green**?

Color phenomena

Caveat 2: difference is relative

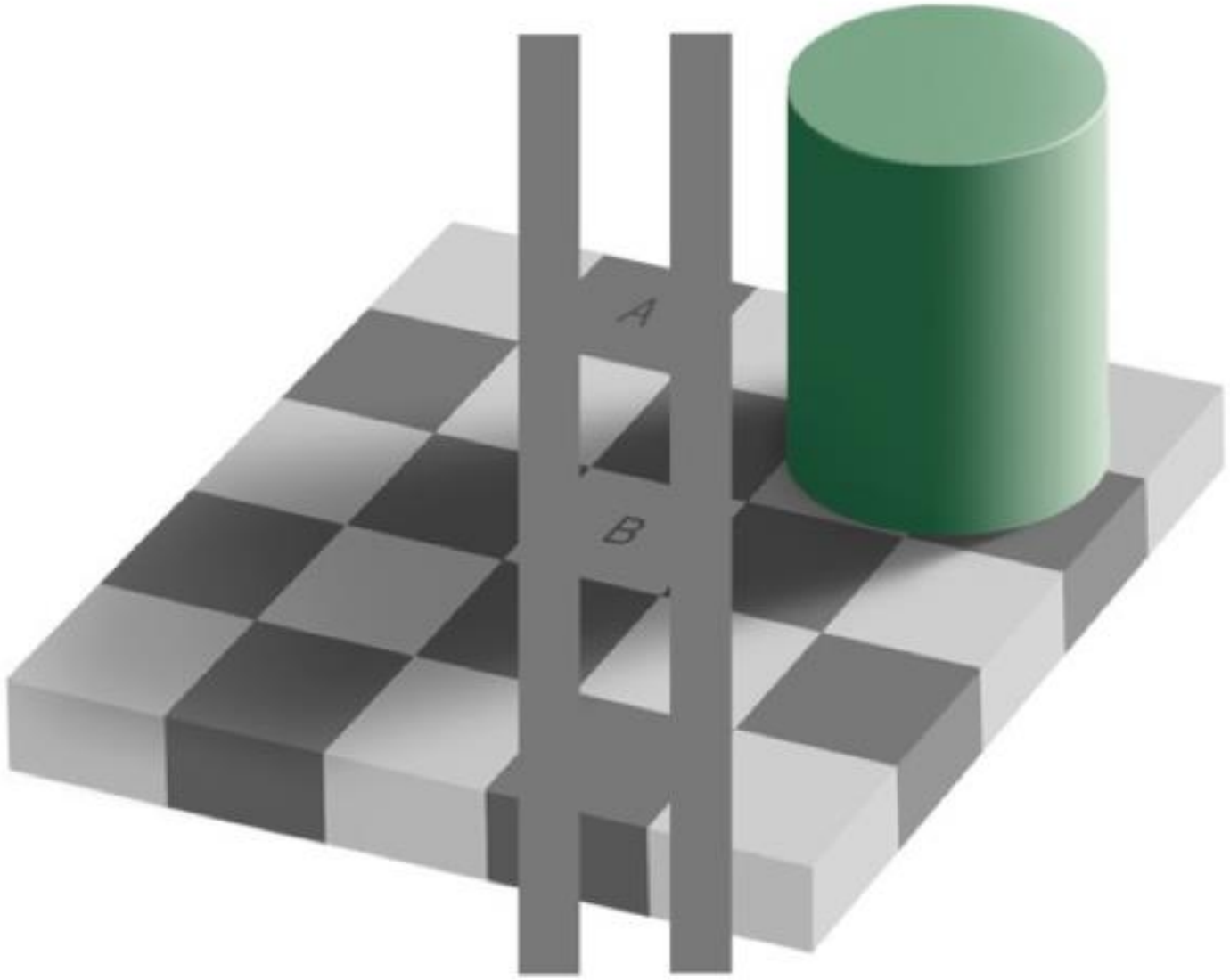
Caveat 2a: so are brightness and contrast

Color phenomena



Color phenomena

Caveat 3: mental models > perception

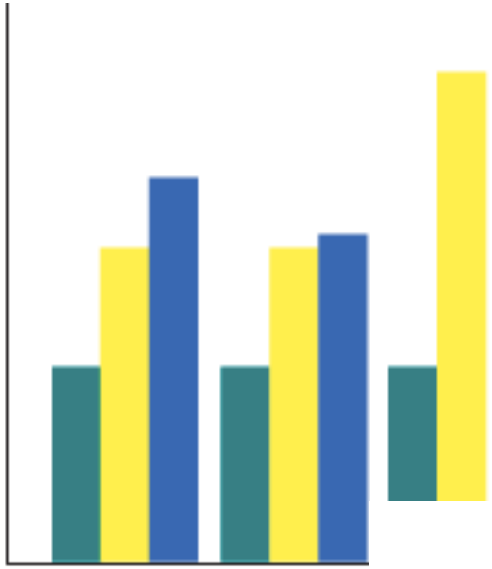


Color palettes

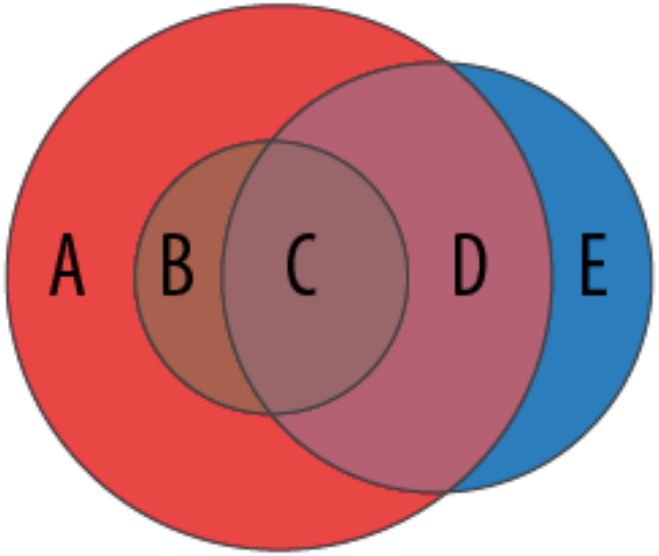
- Using a poor color scheme can also cause issues with your visualization

Color Problems

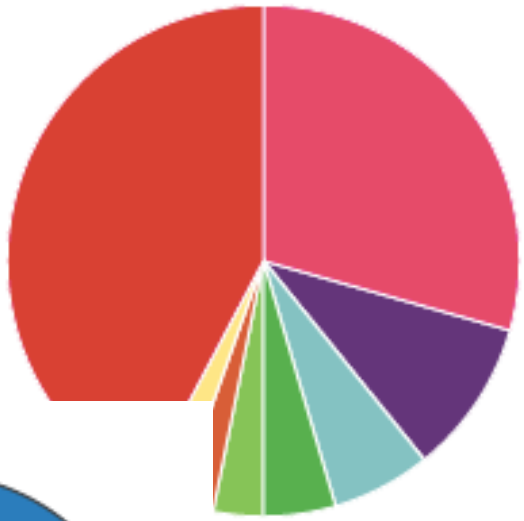
One color dominates



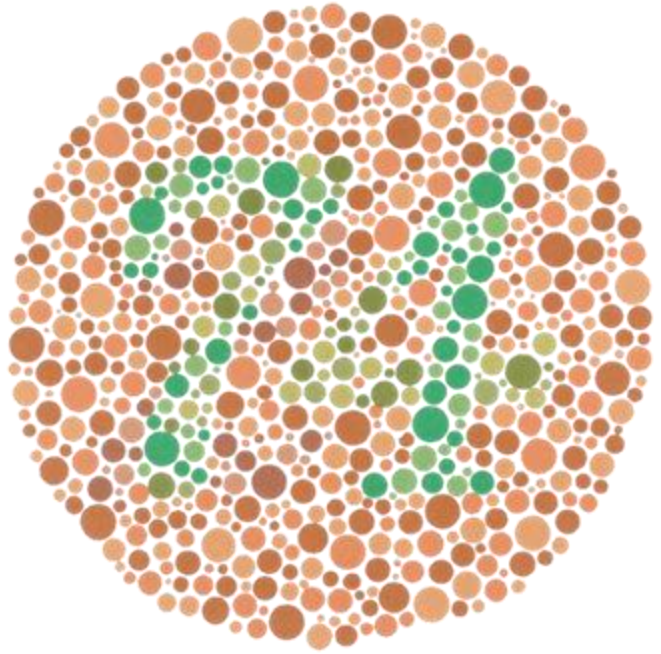
Murky



Difficult to distinguish



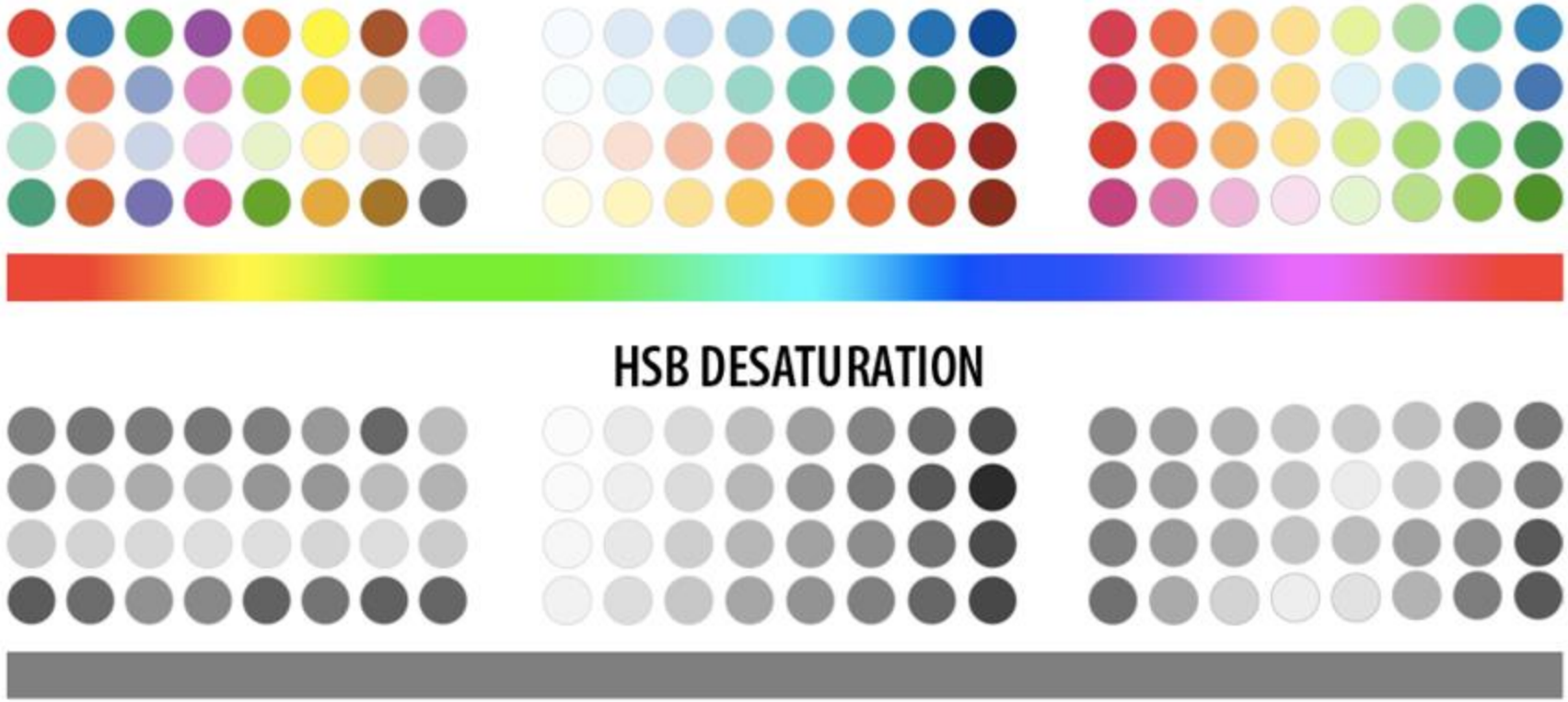
Fun fact: "colorblindness"



1 out of every 8 people has just 2 types of color receptors (rather than 3)

What happens when you print?

- Need color scheme that converts well to grey scale



Colorbrewer palettes

- colorbrewer.org provides a whole bunch of palettes that can help us avoid these issues
- This makes life a lot easier for us!

When should we use each type of color palette?

Takeaways: Perception

- Visualization is about more than just aesthetics
- There are compelling **cognitive reasons** why some visualization techniques are helpful and others aren't
- The choices we make about **visual mappings** can have a significant effect on performance

Mid Semester Assessment

- Please watch this (9os) video: https://smith.zoom.us/rec/share/VMw2HG9S7iKXiB9iIPUSP55brD_6y0hor5aB2IJ2G-5GK9EmTIpt8TT2-CRrovRF.swJJ83M3CzpcJCEK?startTime=1675788468000
- Please fille out this survey: https://smithcollege.qualtrics.com/jfe/form/SV_1YzLF4QVTzJLRKS

Mini-lab: perceptual tricks

- Find a partner and open Tableau
- Open a dataset of your choosing
- Build two visualizations on this dataset
  - One that tells the "real" story in the data (as you understand it)
  - One that uses color, size, or other cues in an intentionally misleading way

Discussion

- What did you try?
- What did you learn about the data?
- Can you imagine a scenario that might incline someone to choose your “bad” visualization instead of a better one?