



MassMutual DSDP 2017:

PERCEPTION & COLOR

June 9, 2017

R. Jordan Crouser & Amelia McNamara

Statistical & Data Sciences

Smith College

Flashback: mental models



The “gestalt effect”

ge·stalt

/gə'SHtält,-'SHtôlt/

noun PSYCHOLOGY

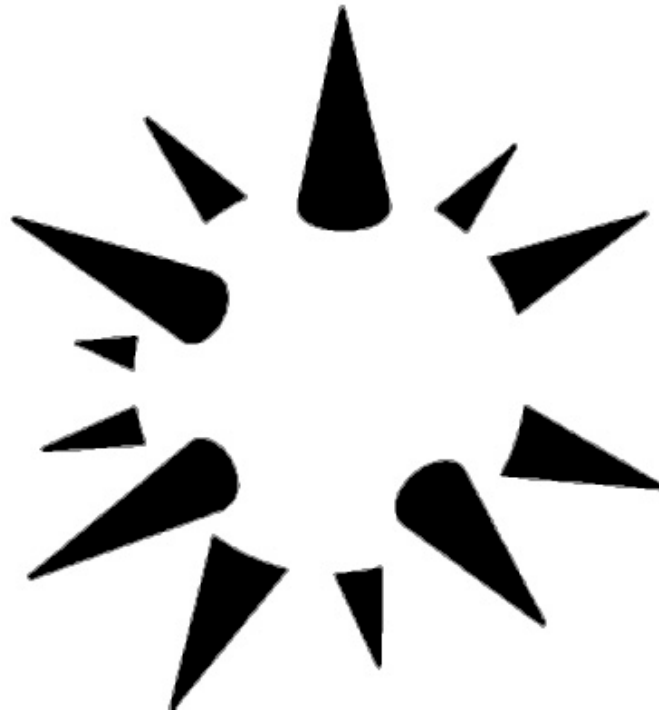
an organized whole that is perceived as more than the sum of its parts.



Translations, word origin, and more definitions

Our brain's ability to generate whole forms, instead of just collections of unrelated elements

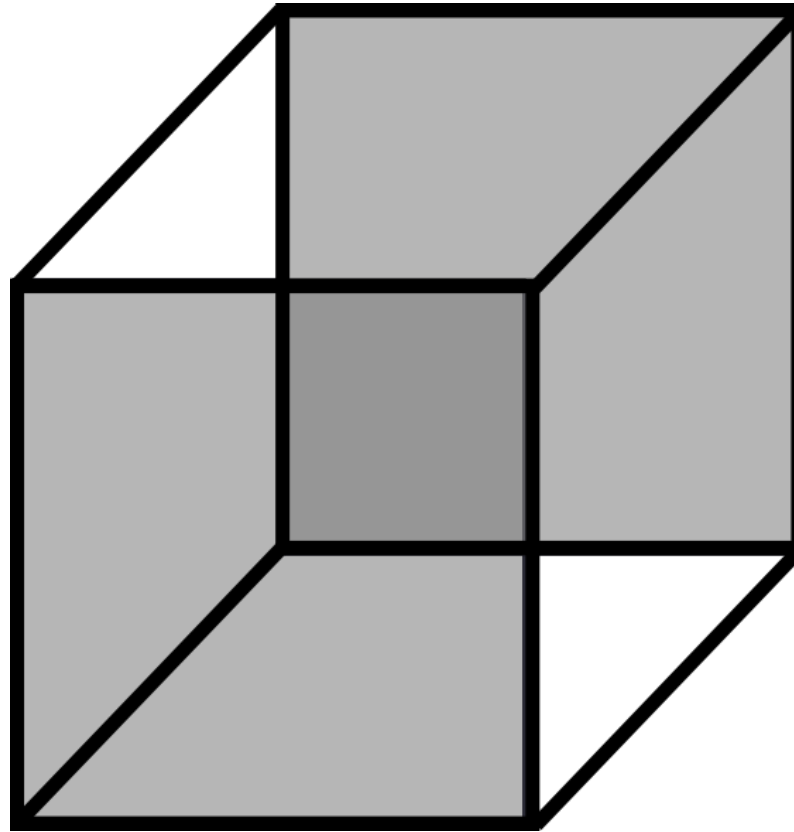
1. Reification



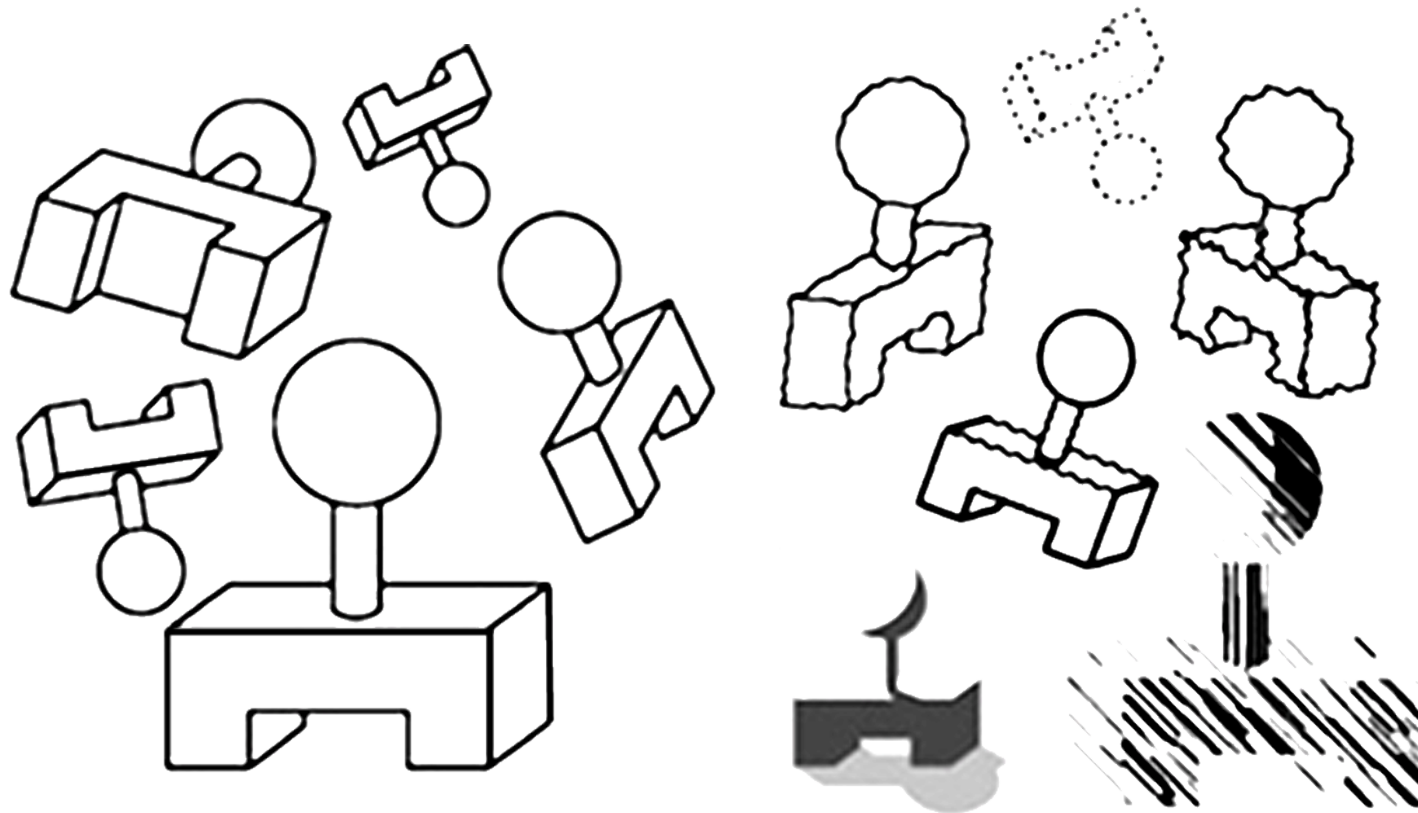
2. Emergence



3. Multistability



4. Invariance



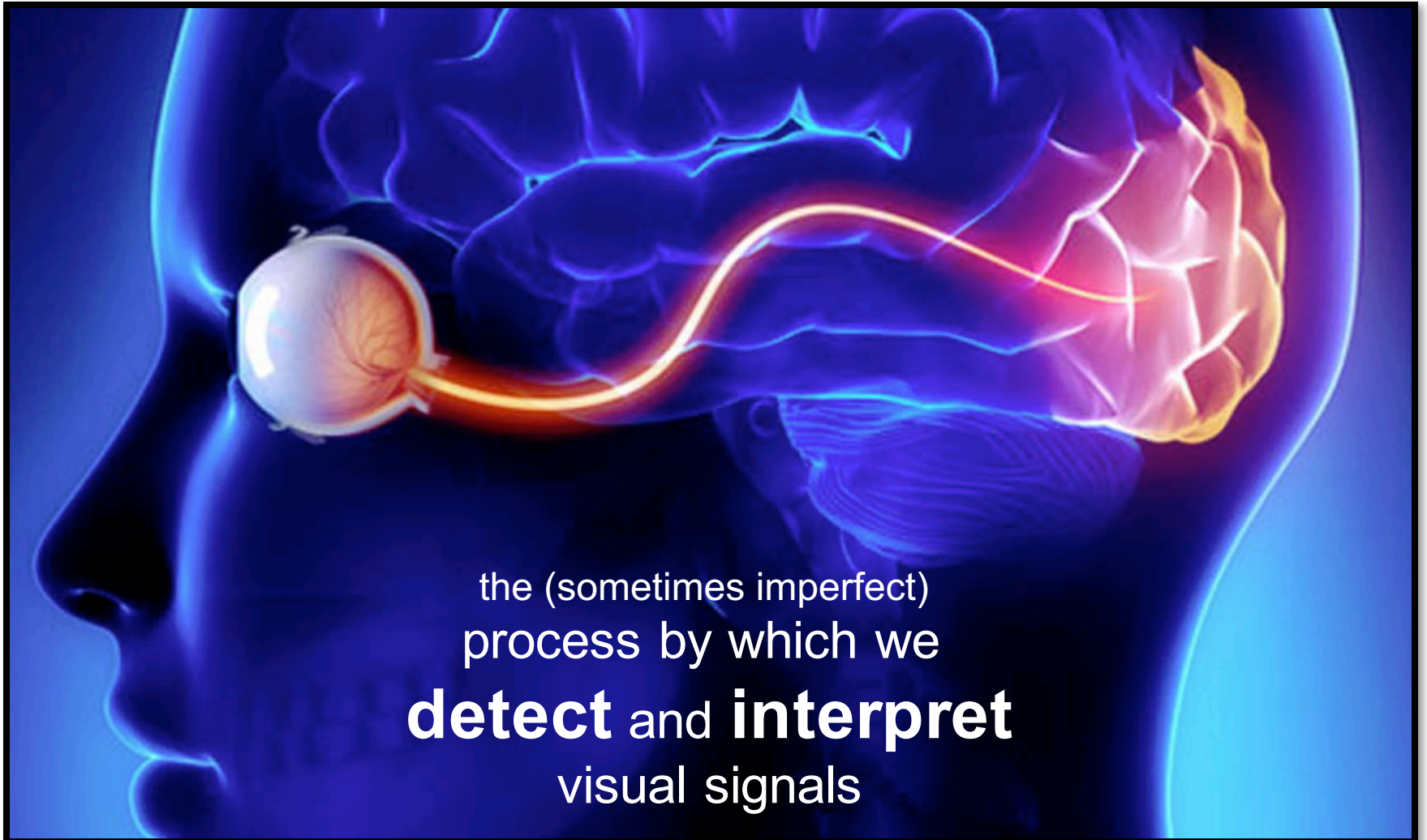
Hacking the brain

Question: what makes all this mental model stuff useful to us (designers and readers of data)?

Answer: in order to understand how people interpret and make sense of data, we need to know what **cues** they're picking up on – and how to situate those cues within a larger framework

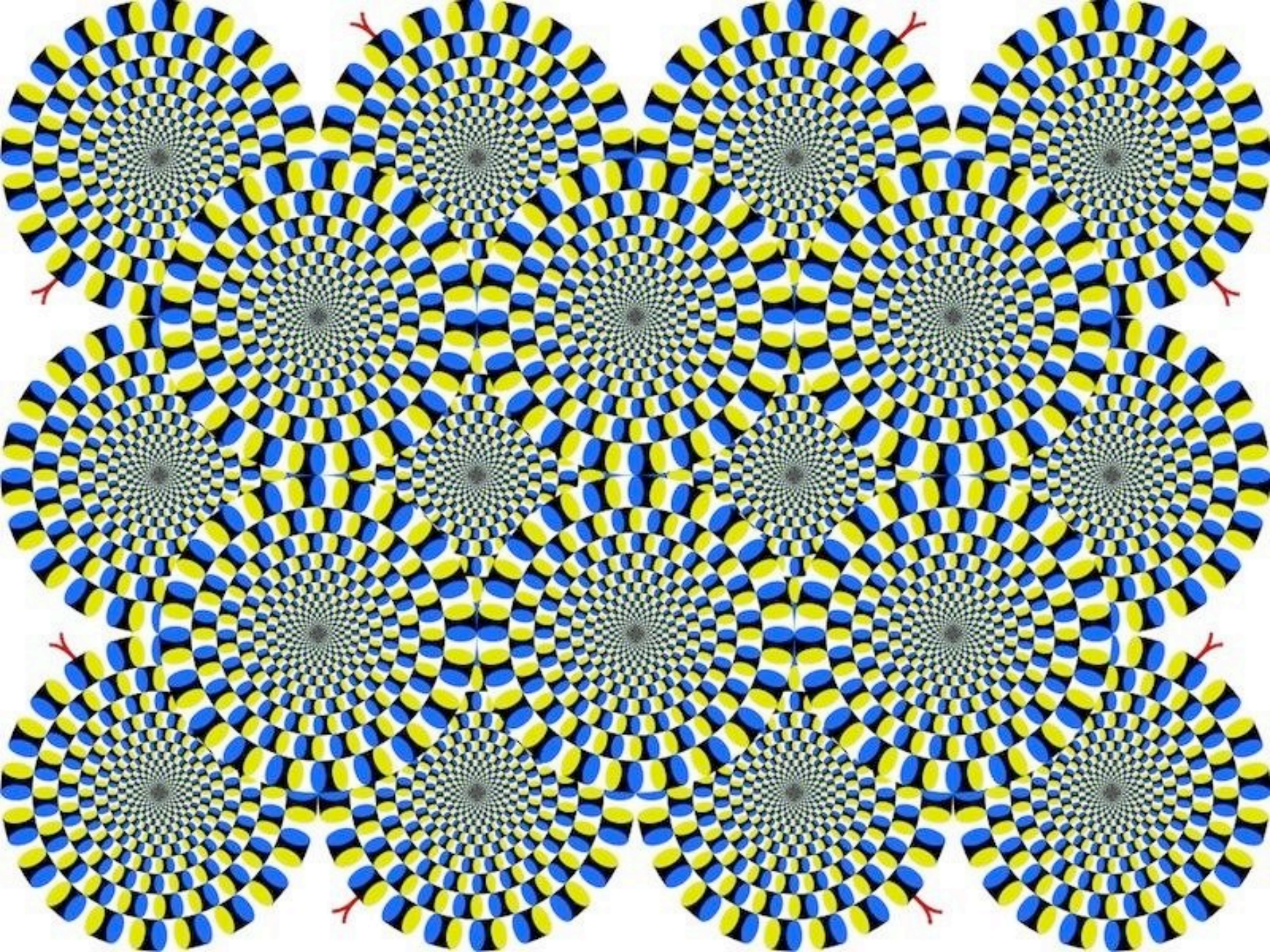


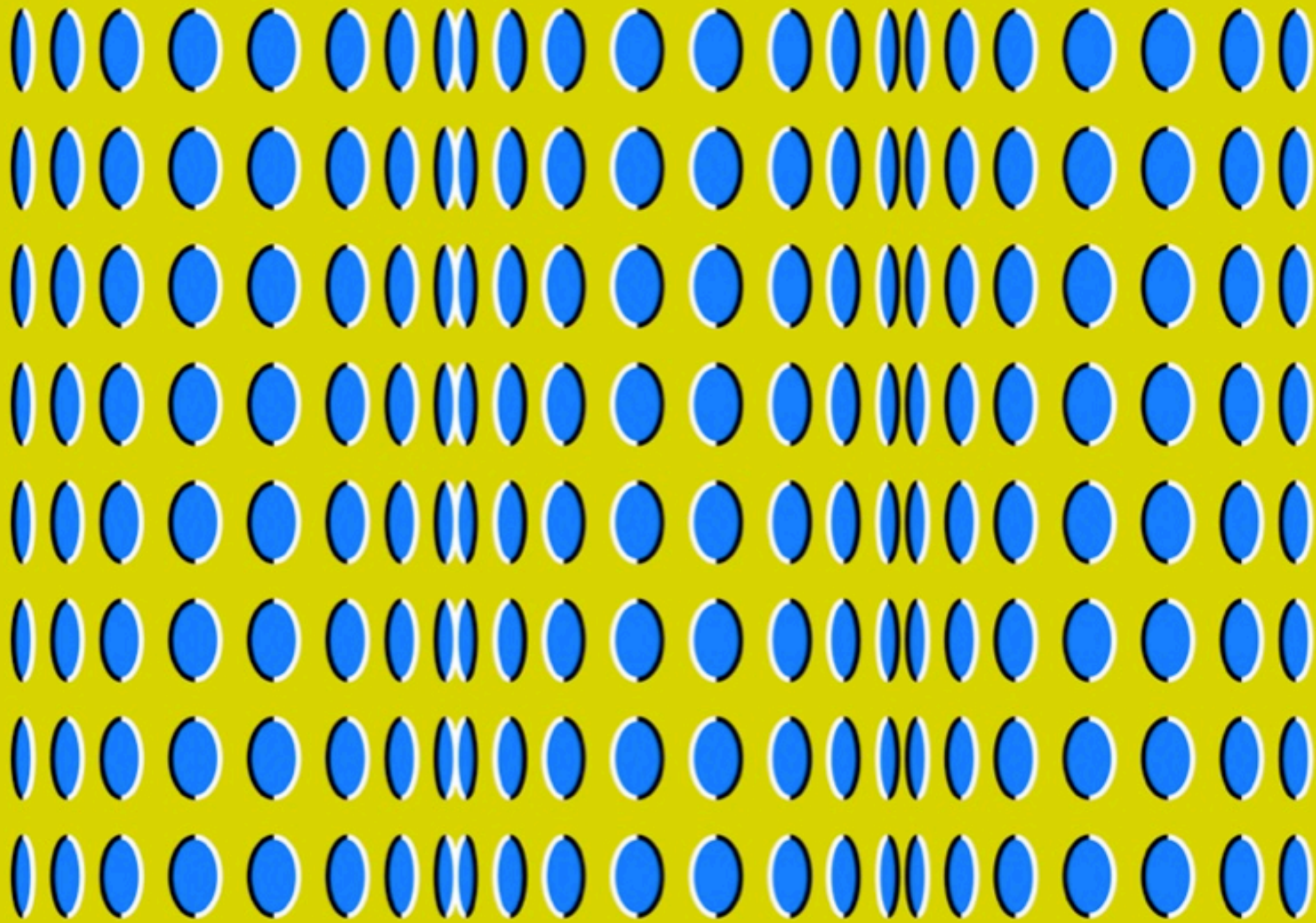
Visual perception (def.)



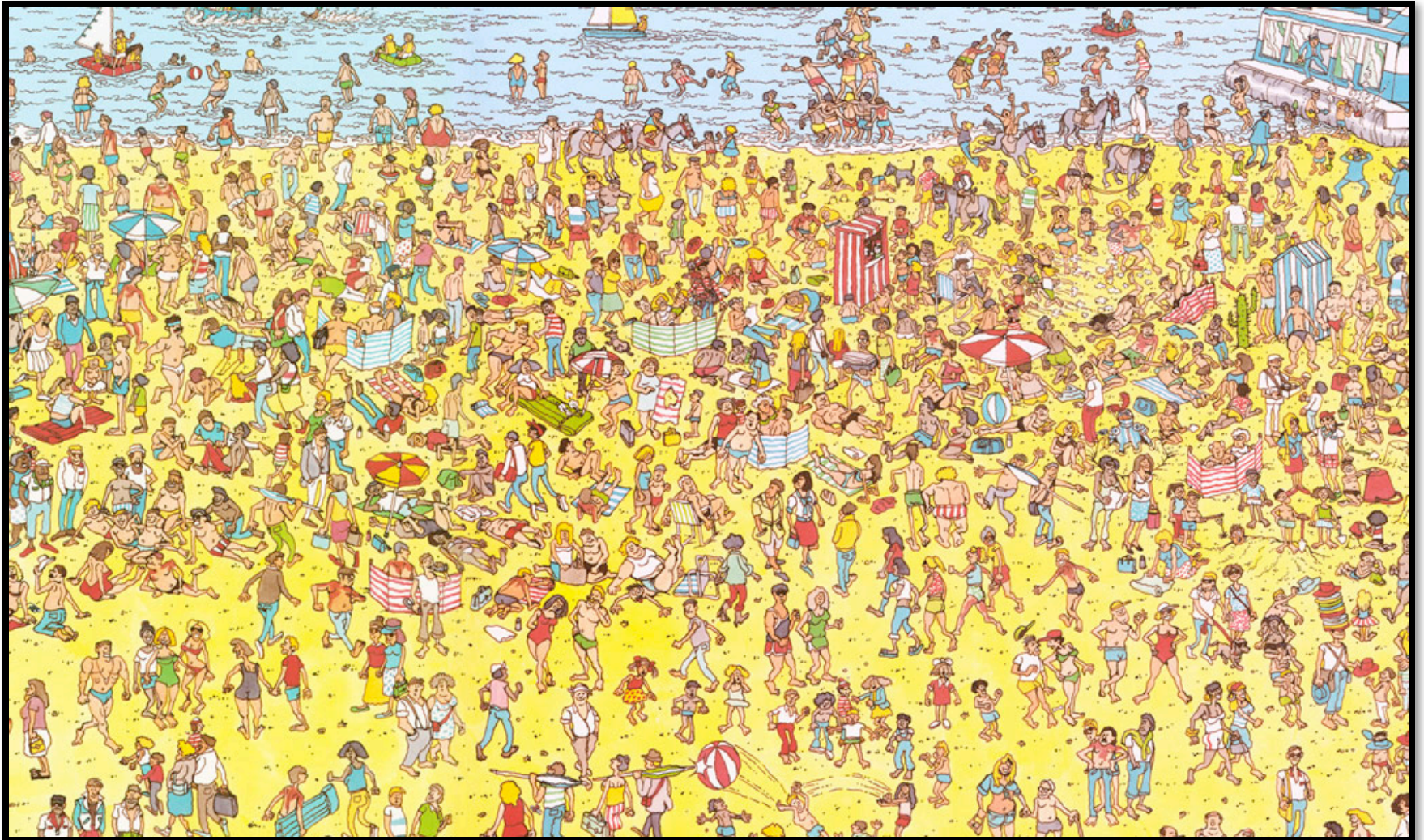
the (sometimes imperfect)
process by which we

detect and **interpret**
visual signals

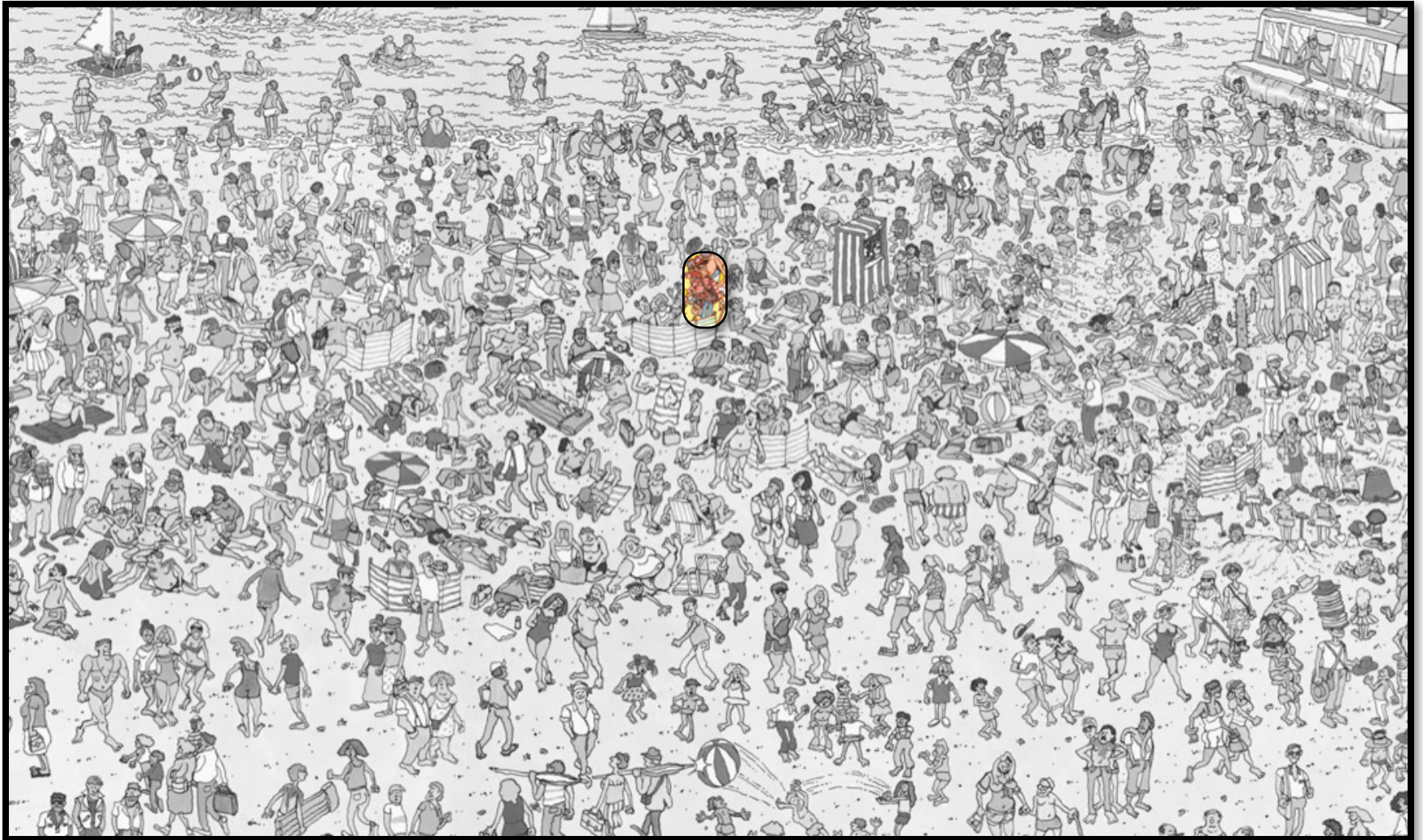




Some things are processed slowly

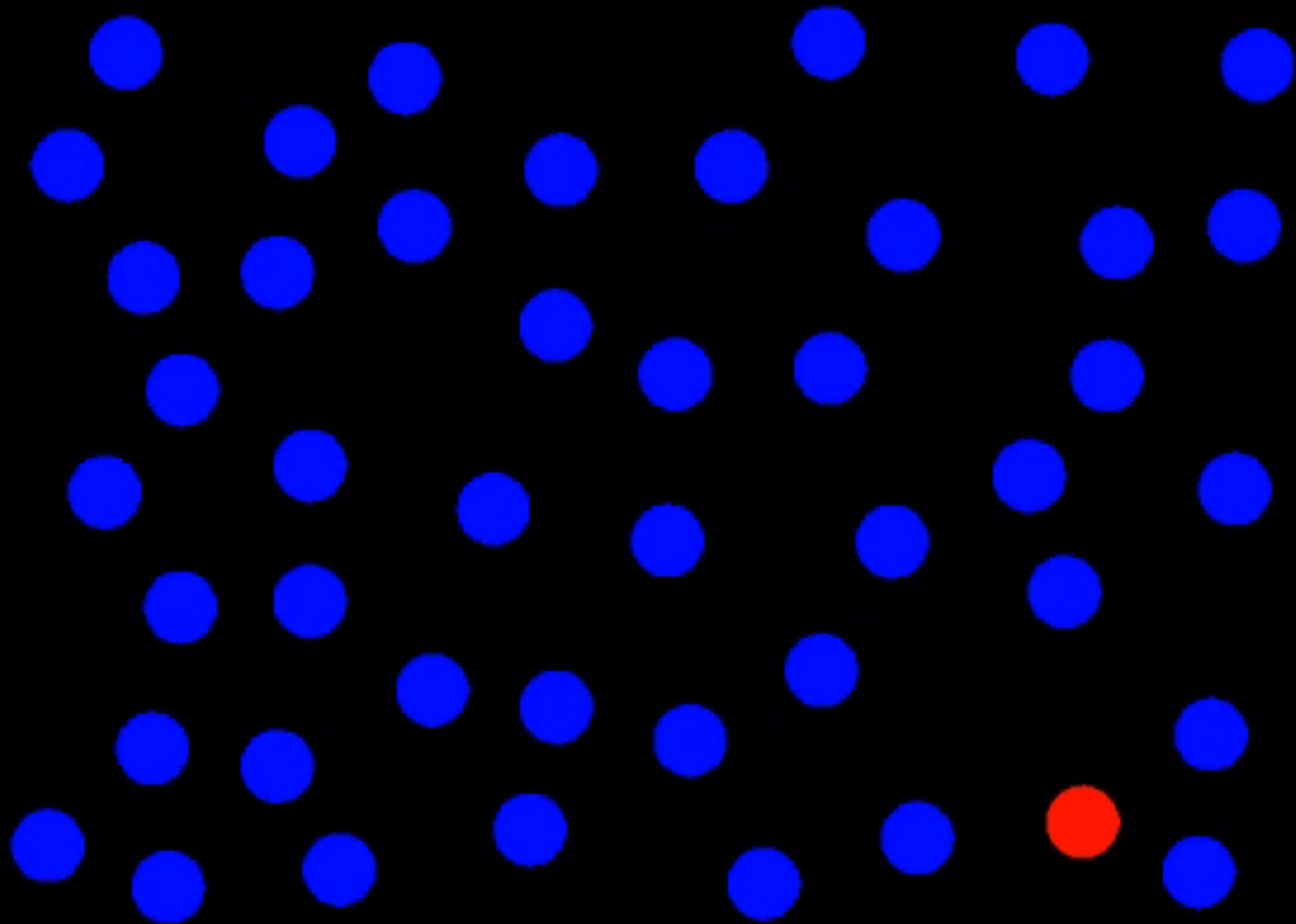


Others are incredibly fast



Fast = “pre-attentive processing”

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



What did you see?



Pre-attentive processing facilitates:

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

Attentive counting

1281768756138976546984506985604982826762
9809858458224509856458945098450980943585
9091030209905959595772564675050678904567
8845789809821677654876364908560912949686

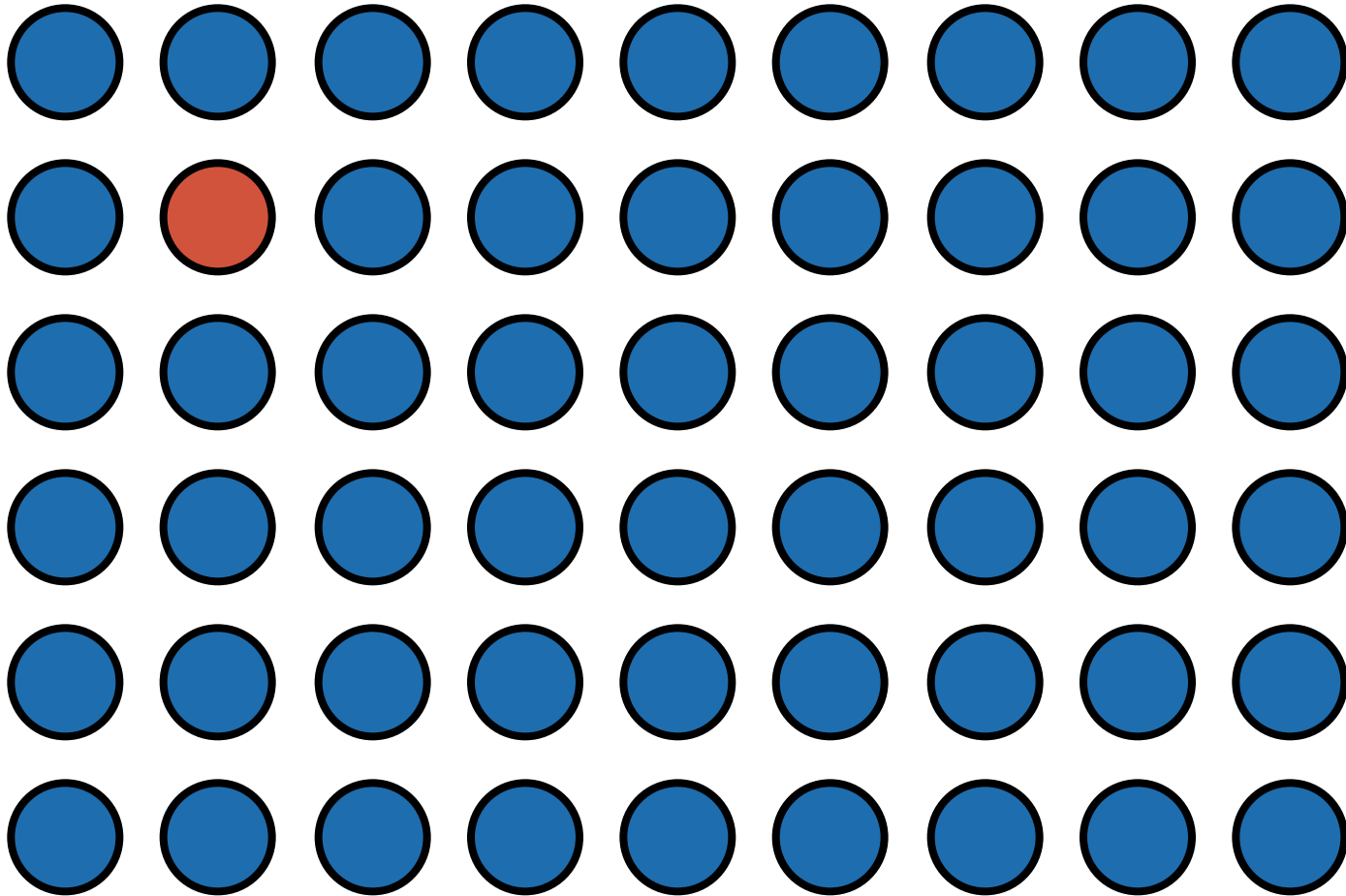
How many threes are there?

Pre-attentive counting

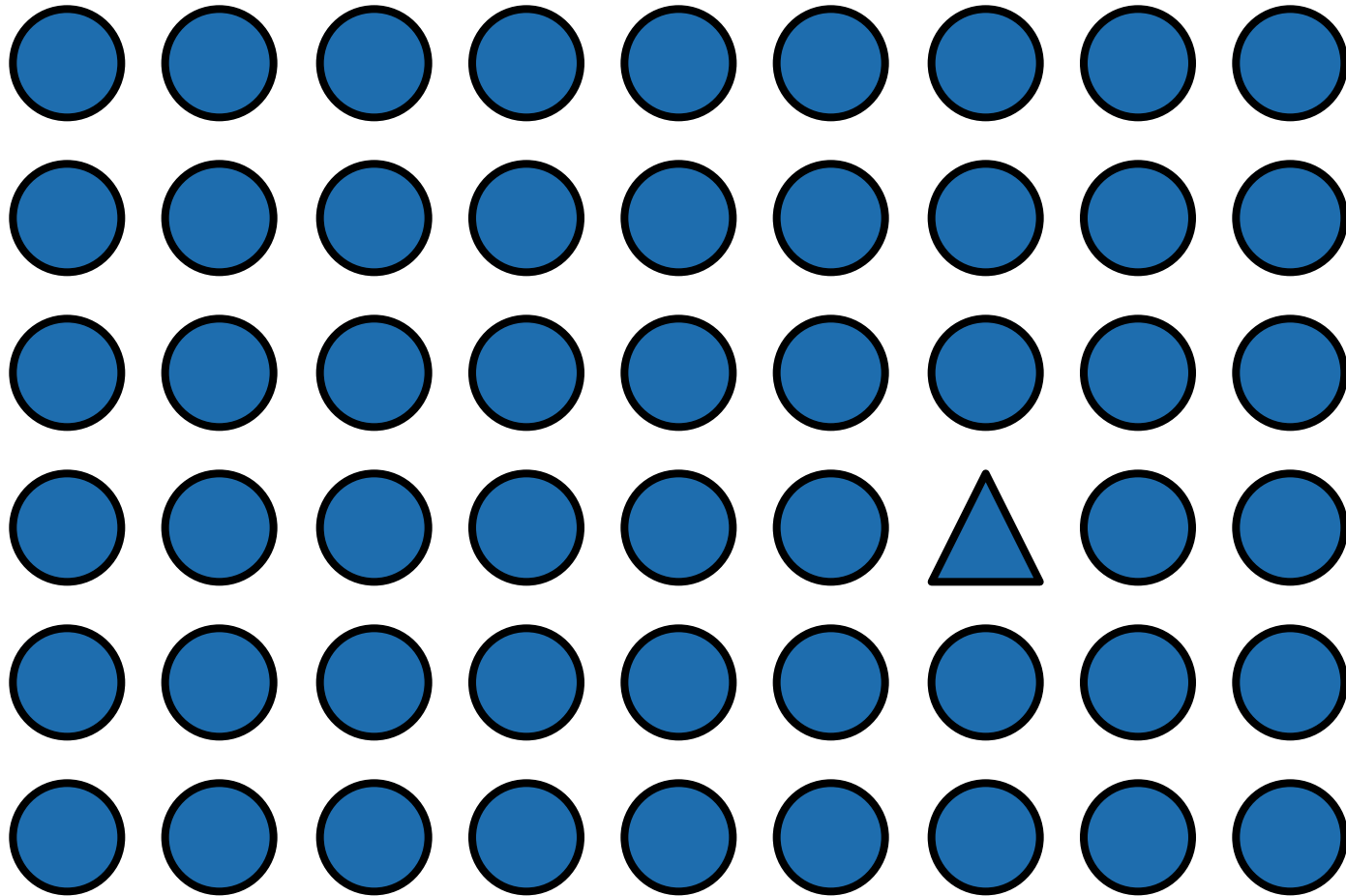
12817687561**3**8976546984506985604982826762
980985845822450985645894509845098094**3**585
90910**3**0209905959595772564675050678904567
8845789809821677654876**3**64908560912949686

How many threes are there?

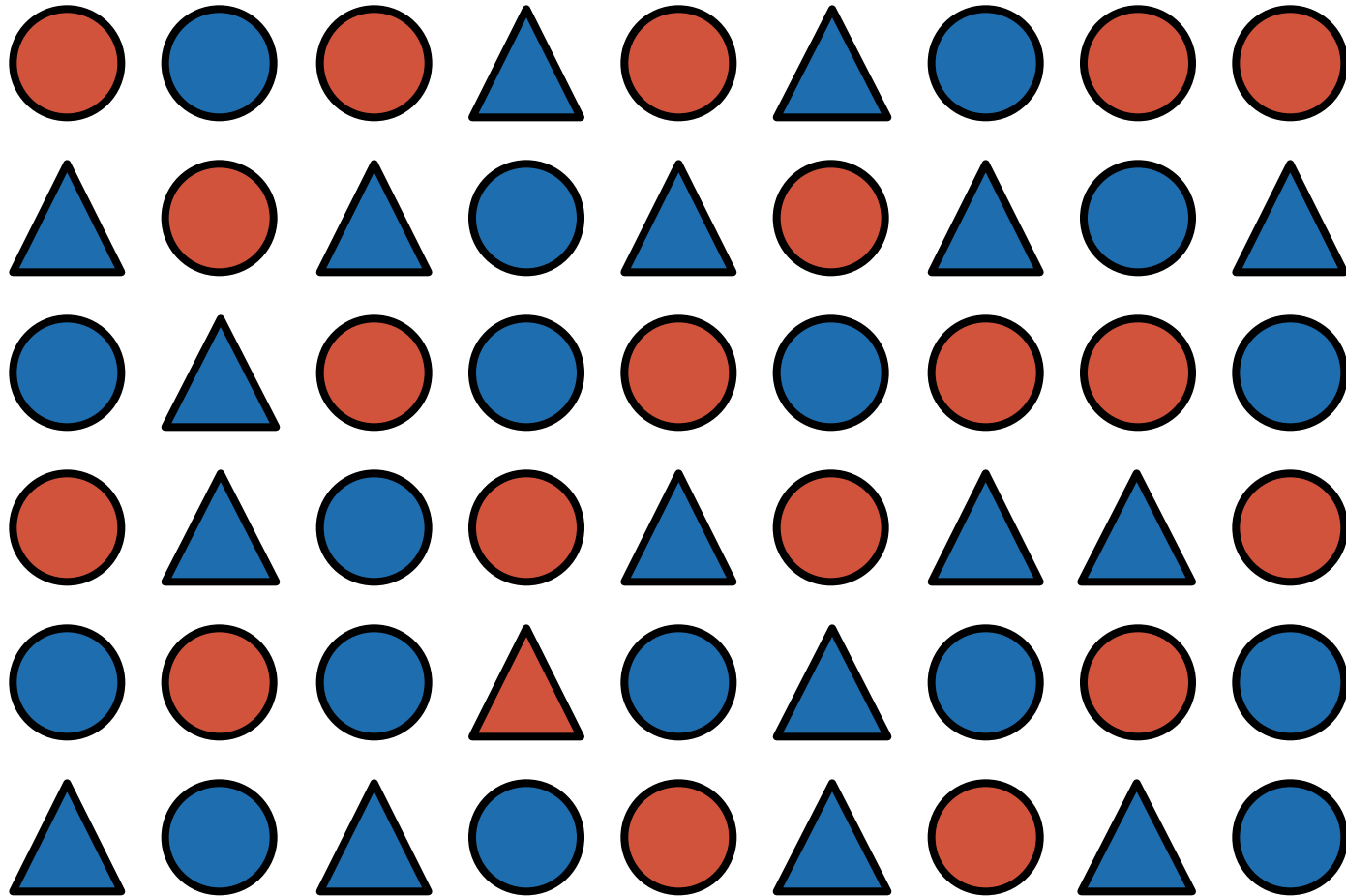
Pre-attentive processing: color (hue)



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 **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:

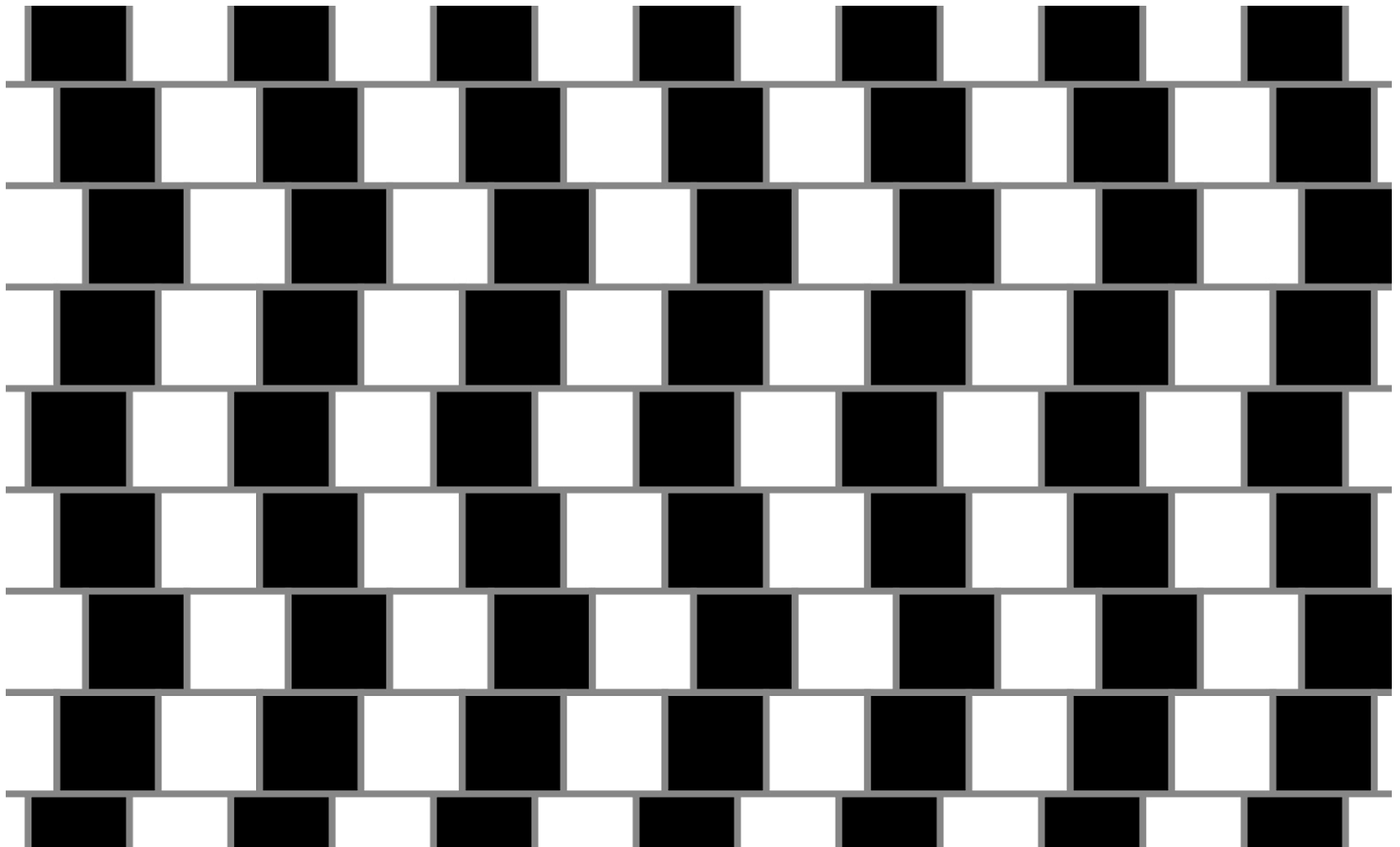
Ex. flicker can cause change blindness



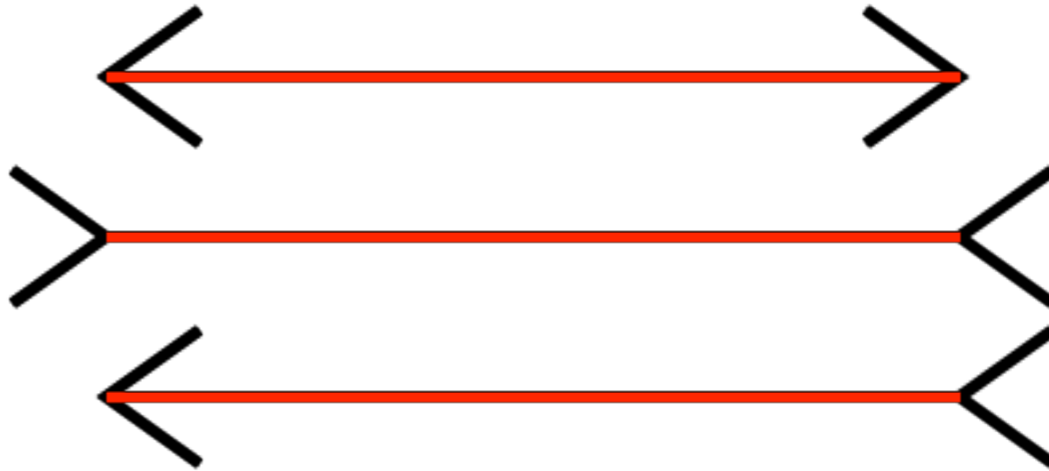
Can you see it now?



Sometimes gestalt & pre-attention compete



Sometimes gestalt & pre-attention compete



Magnitude estimation

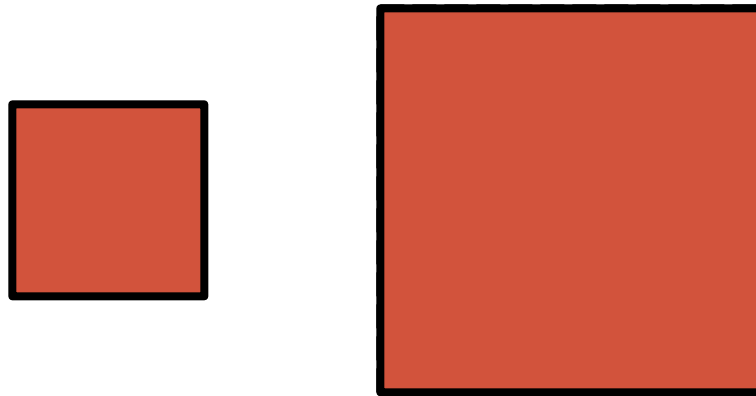
Question: How much **bigger** is the lower bar?



Answer: 2x

Magnitude estimation

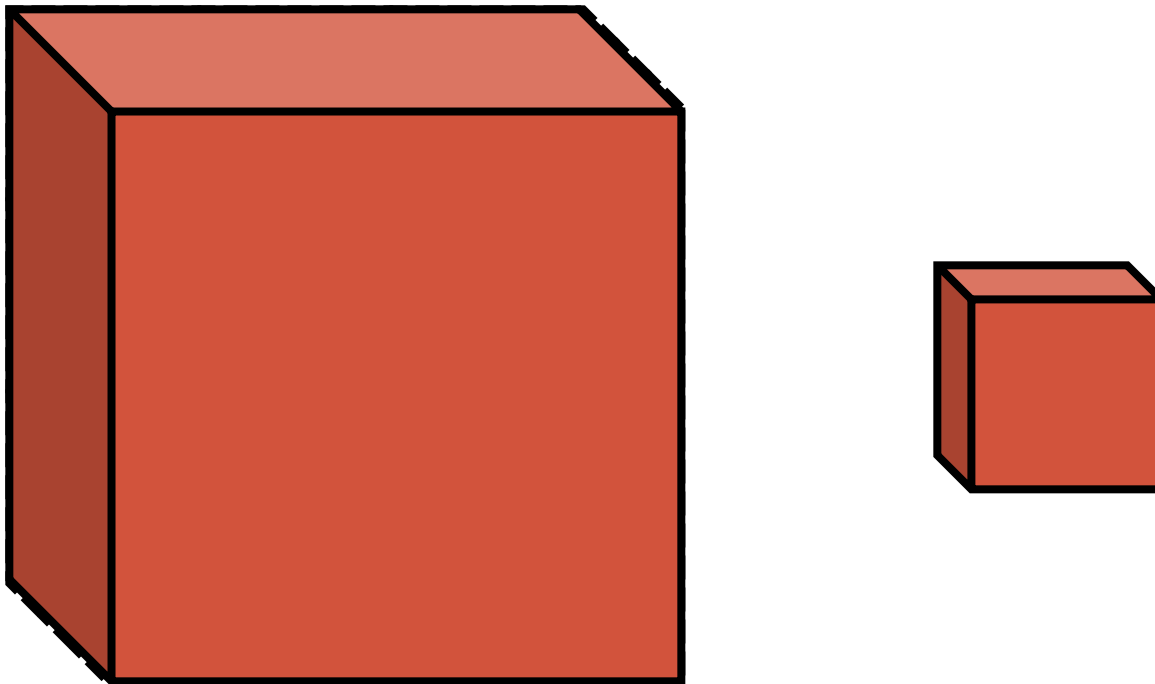
Question: How much **bigger** is the right square?



Answer: 4x

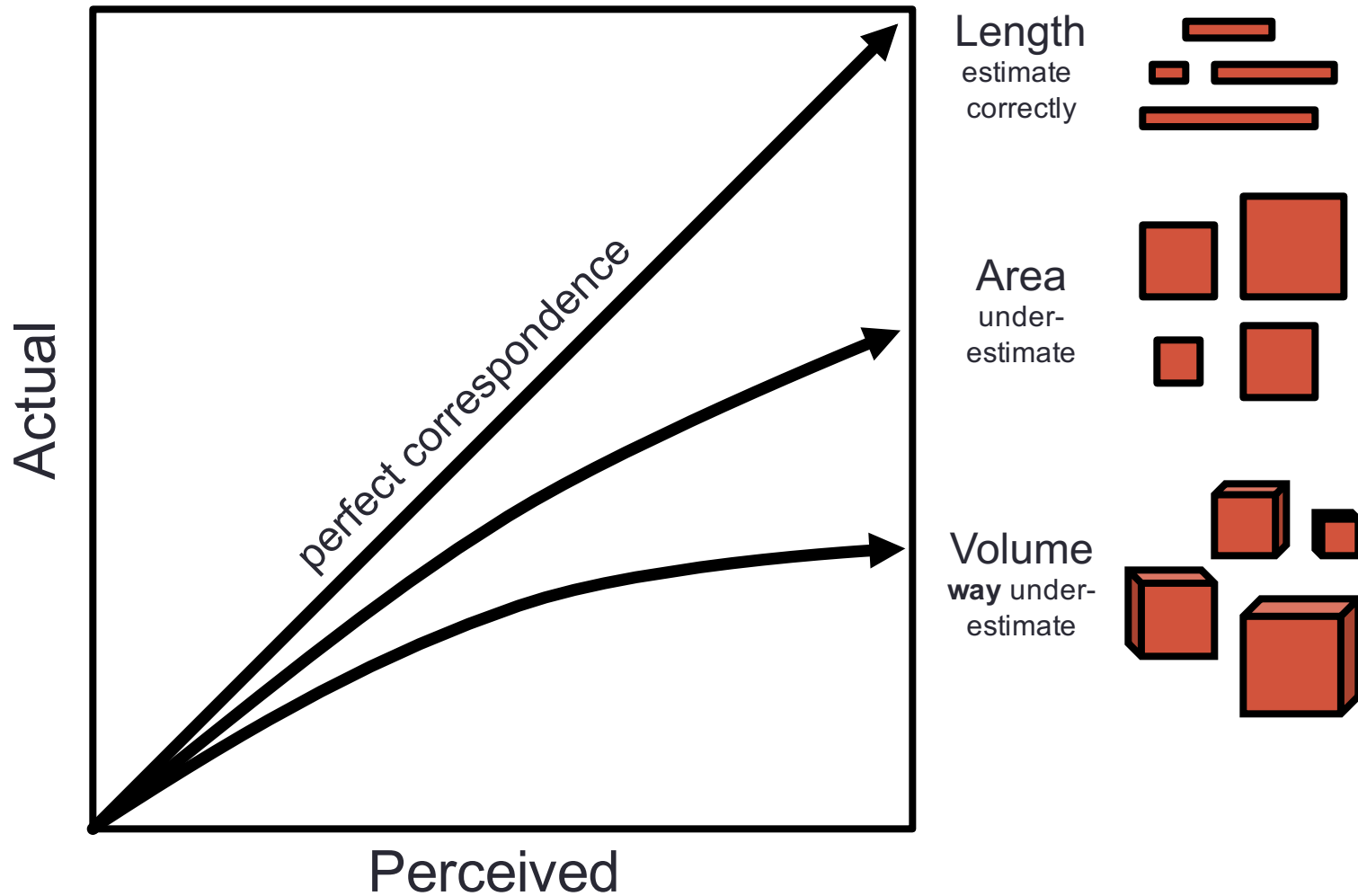
Magnitude estimation

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

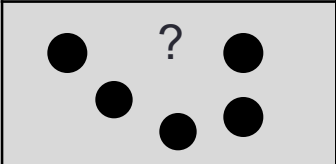
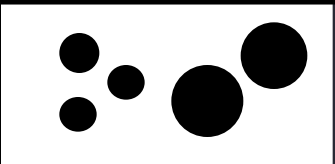
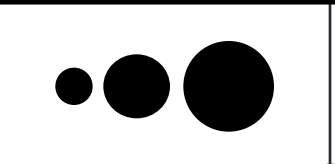

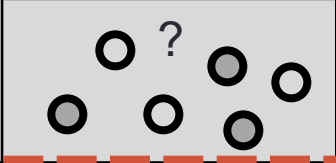
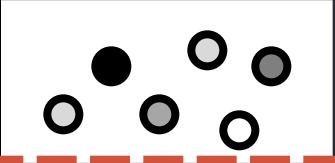
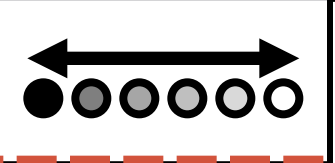
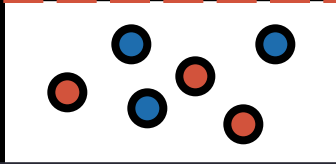
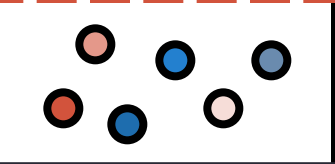
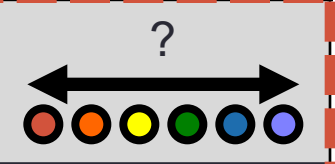
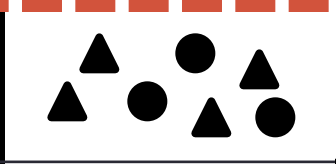
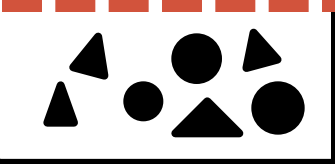
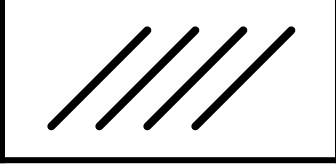


Answer: $27x$

“Apparent” magnitude



Mapping to visual dimensions

	Perceived as similar	Perceived as different , forming families	Perceived as ordered	Perceived as proportional
SIZE				
VALUE				
COLOR				
SHAPE				
ORIENTATION				

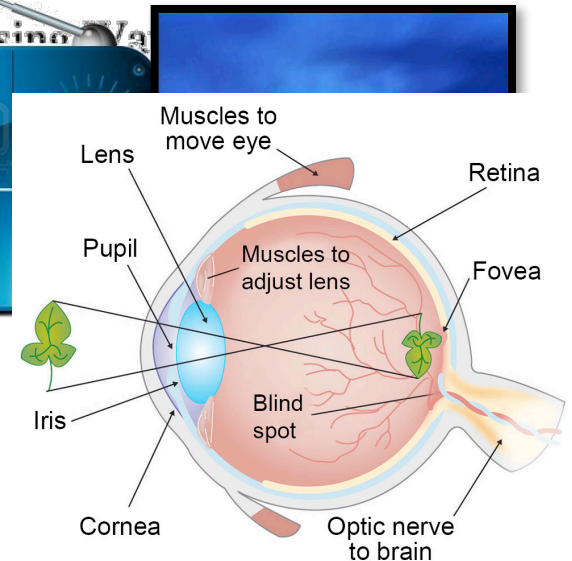
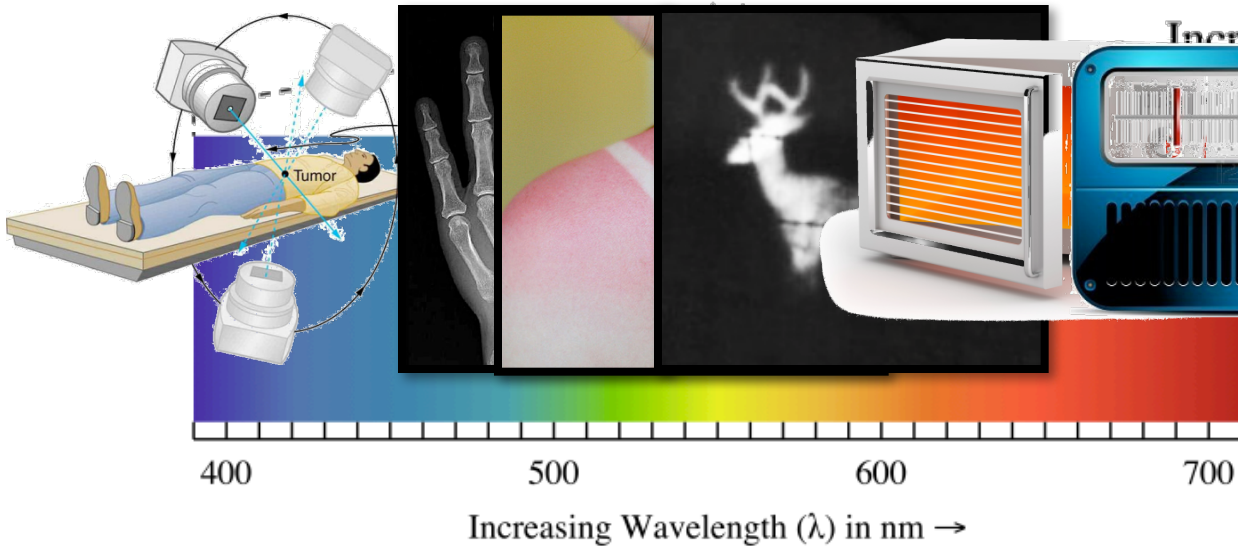
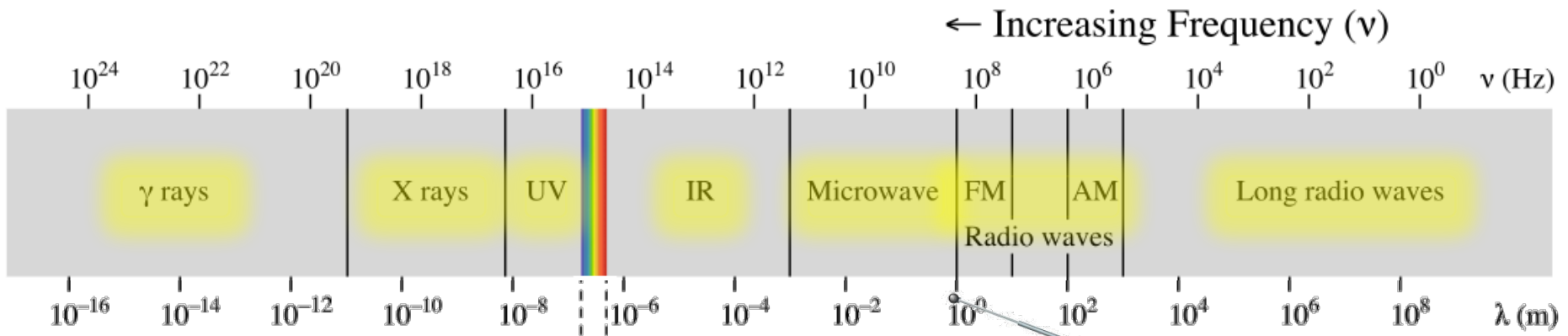
Back in 10 minutes



Color 101



Kinds of light

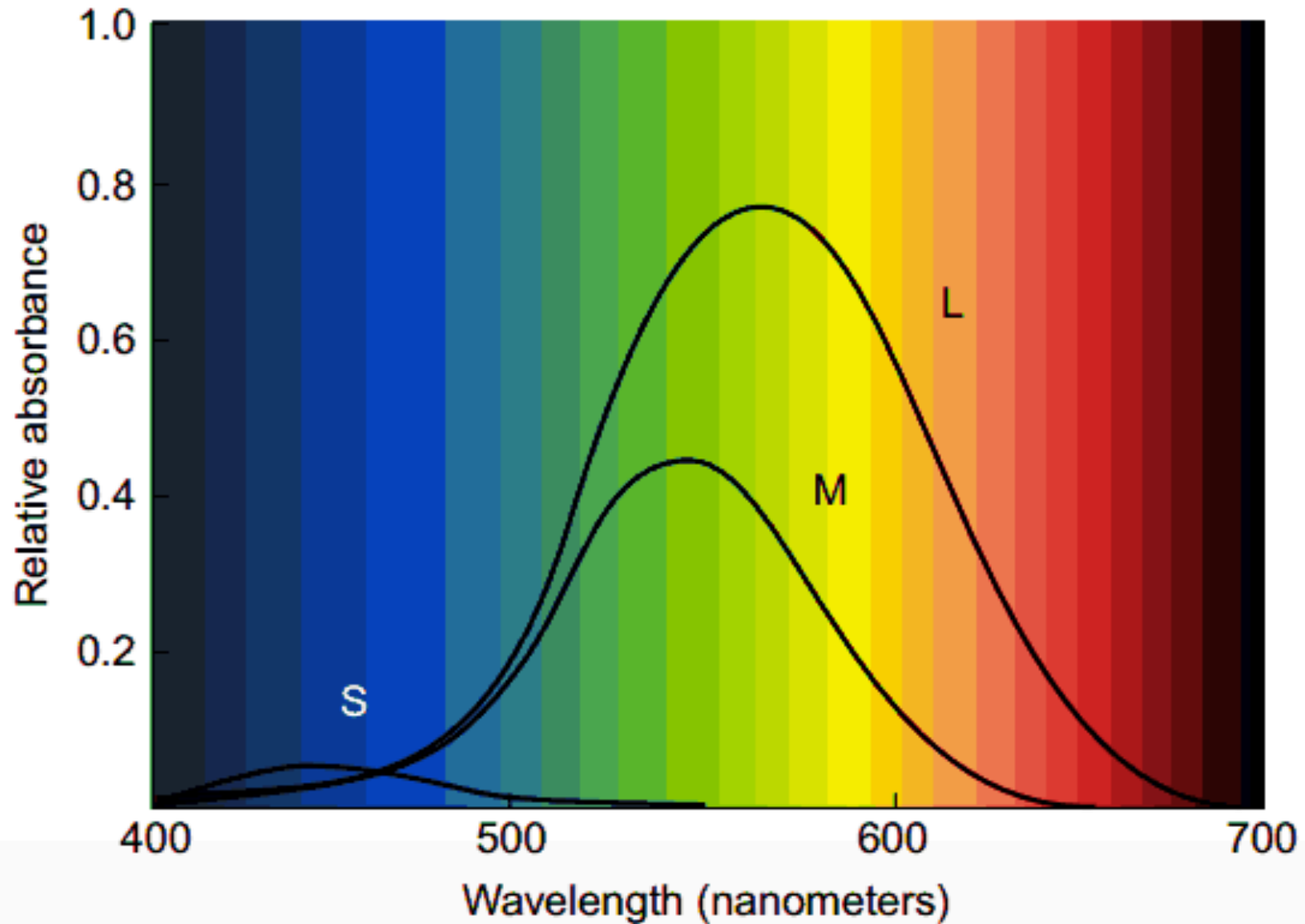


Eye diagram courtesy ASU

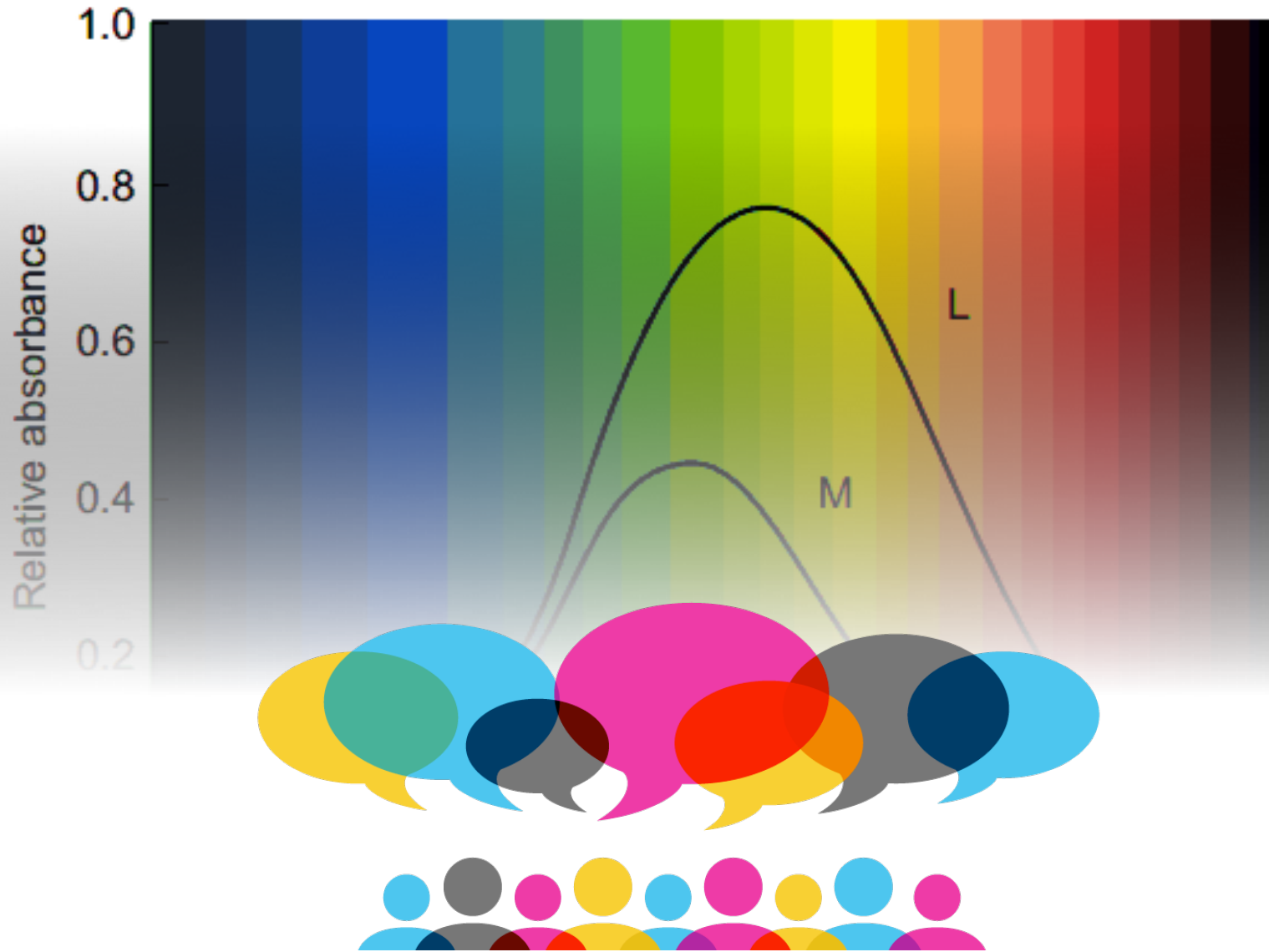
How we see color



3 kinds of color sensors



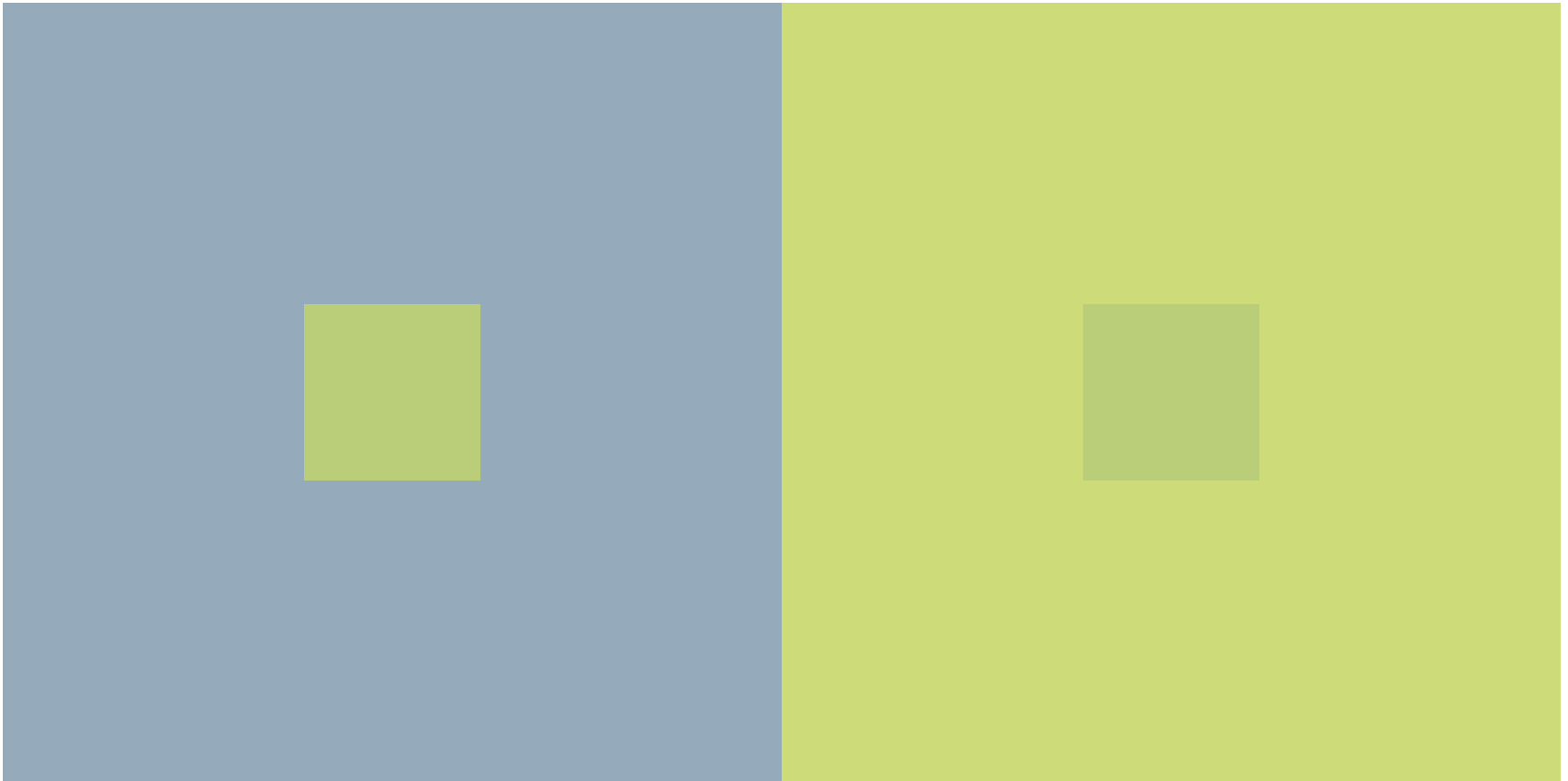
Discussion: what do you notice?



Color phenomena



Caveat 1: color is perceived in context

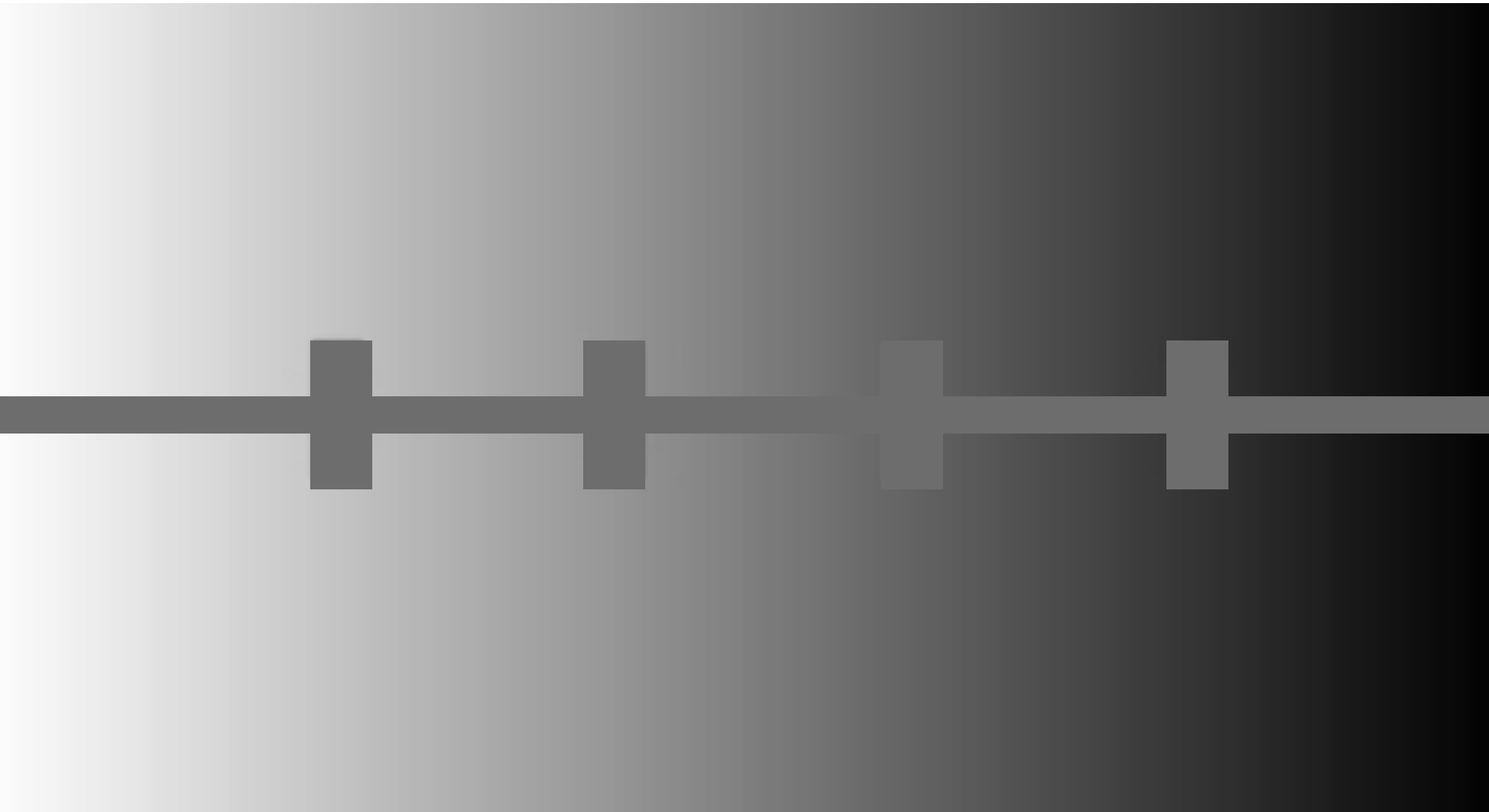


Which small square is **darker green**?

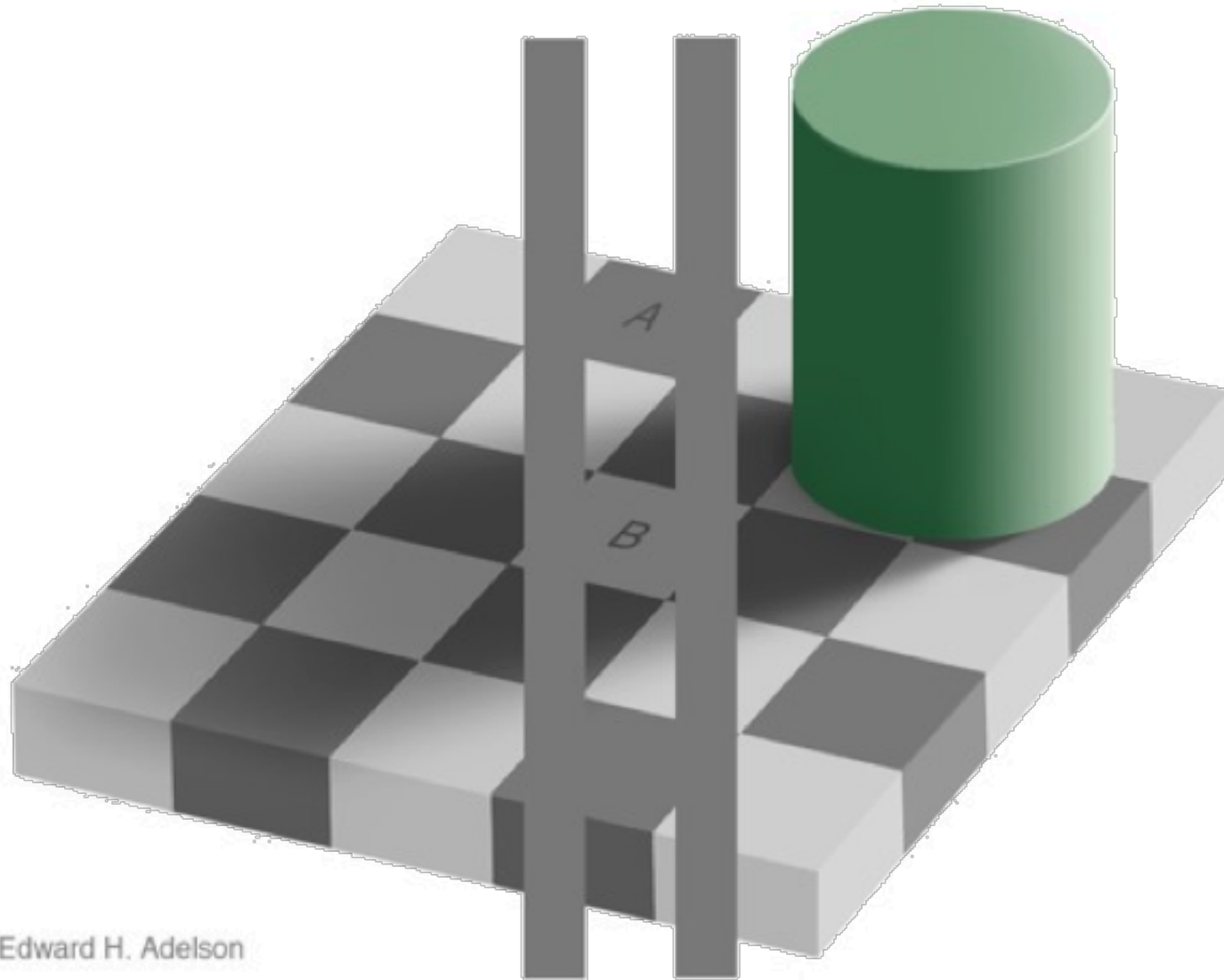
Caveat 2: difference is relative



Caveat 2a: so are brightness and contrast



Caveat 3: mental models > perception



Edward H. Adelson

Takeaways: Perception

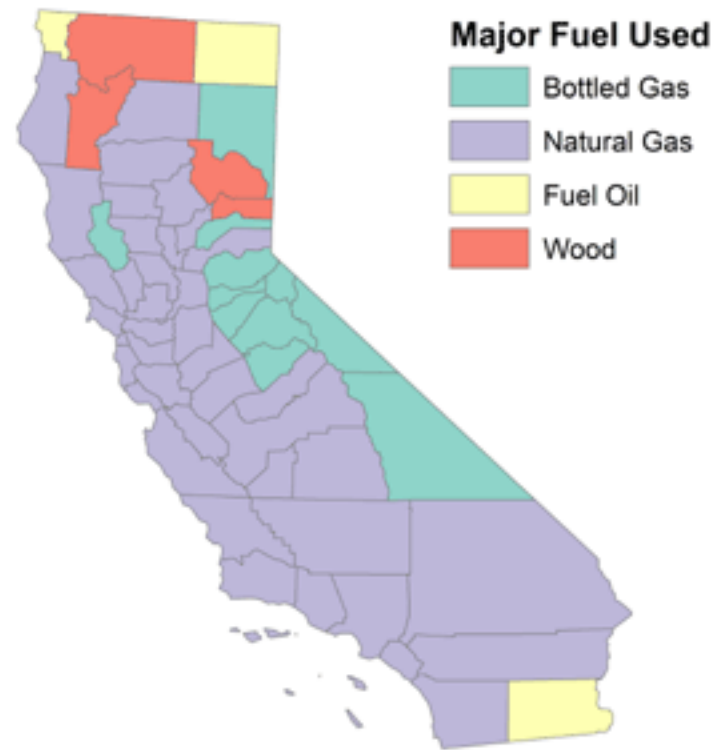
- Visualization is about more than just aesthetics
- There are compelling **cognitive reasons** why some visualization techniques are helpful and others aren't
- The choices we make about **visual mappings** can have a significant effect on performance

Color schemes: 3 types

- Categorical
- Sequential
 - Single hue
 - Multi-hue
- Diverging

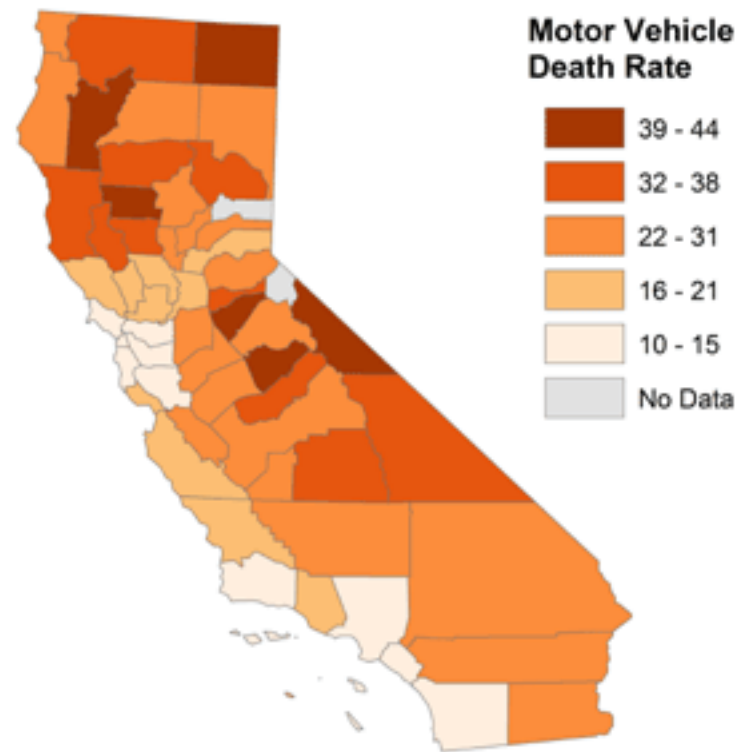
Categorical color schemes

- Different color = different category
- **Protip #1:** choose colors that are *perceptually distant*
- **Protip #2:** choose colors that are roughly the same saturation and value



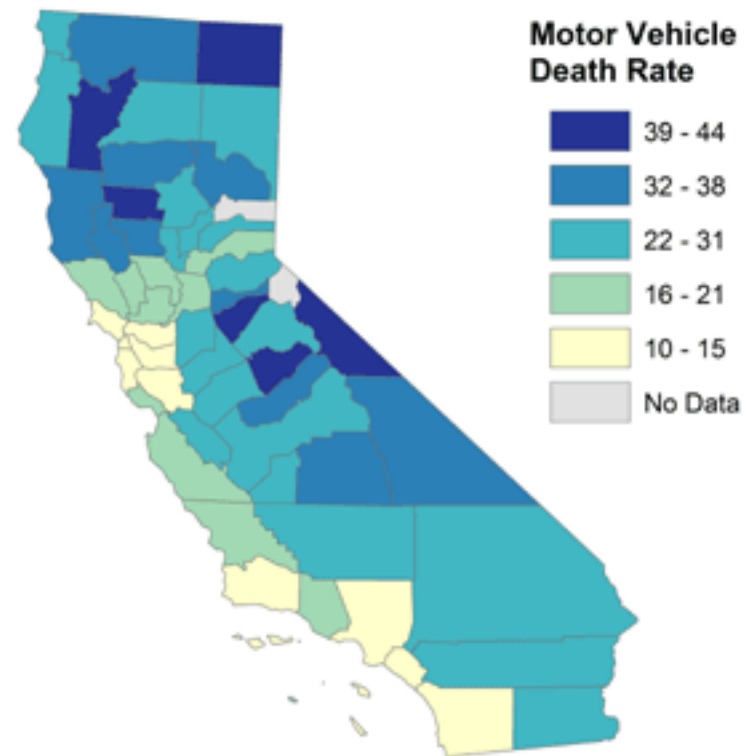
Sequential color schemes: one hue

- **Saturation** indicates difference in the amount of the phenomenon
- **Protip #1**: no more than 5-6 levels
- **Protip #2**: people interpret darker = more



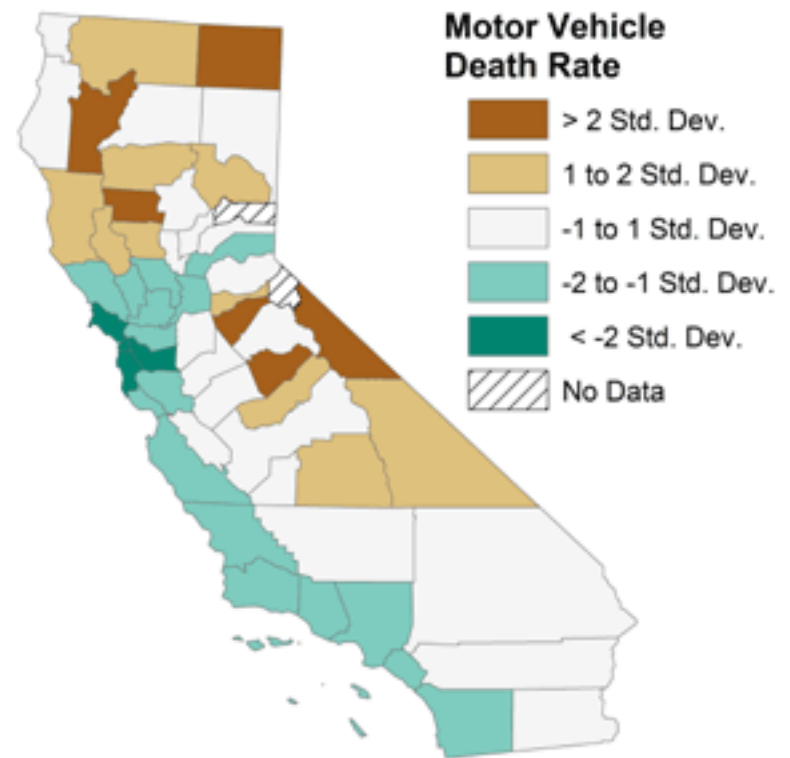
Sequential color schemes: multi-hue

- **Hue** indicates difference in the amount of the phenomenon
- **Protip #1**: no more than 2 anchor colors
- **Protip #2**: people interpret high saturation = more



Diverging color schemes

- **Two colors** used to indicate extremes of a range
- **Protip #1:** neutral color in the middle
- **Protip #2:** differentiate between “average” and “no data”



Lab 3: colorbrewer and ggthemes

ColorBrewer and ggthemes

Secure <https://jcrouser.github.io/datavis/lab-colorbrewer-ggthemes.html>

MassMutual DSDP - DataVis Workshop 2017

Home Schedule Resources Labs

Introduction

- Setting up
- Drawing a ggplot
- Changing colors manually
- Changing colors with RColorBrewer
- Styling using ggthemes
- Putting it all together

ColorBrewer and ggthemes

Introduction

Goal: by the end of this lab, you will be able to use `colorbrewer` and `ggthemes` to customize the look of your visualization.

Setting up

For this lab, we're going to be using the `ToothGrowth` dataset, which is one of the example datasets included in `R`. It contains data on how fast guinea pigs' teeth grow if you give them vitamin C supplements in various forms and at various doses. You can learn more about this dataset by typing `?ToothGrowth` at the console.

