

# MassMutual DSDP 2018: PERCEPTION & COLOR

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# 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



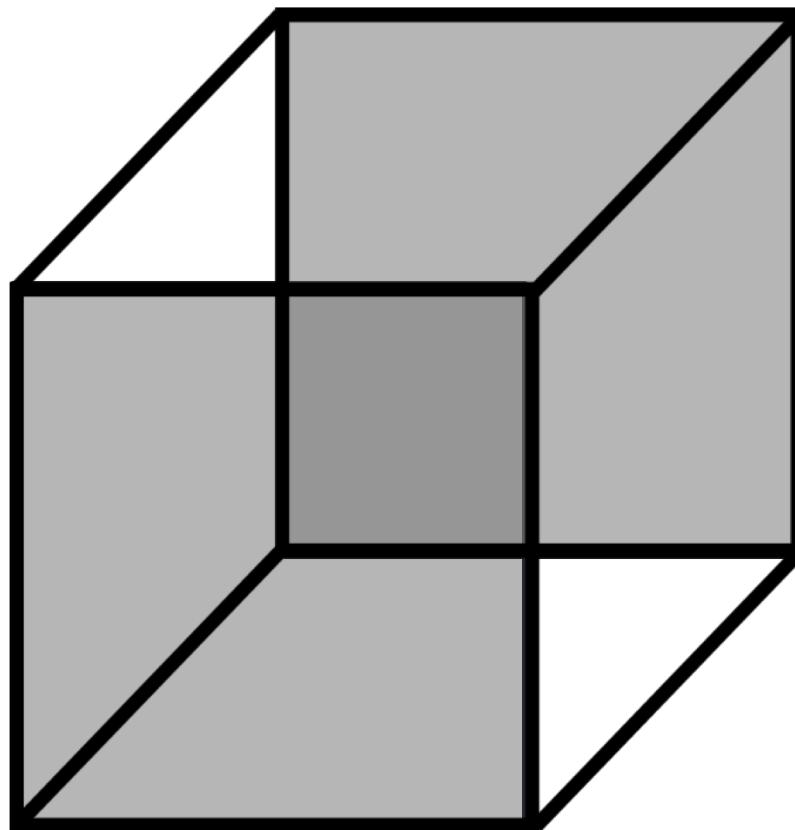
Demonstration of reification in perception from Lehar S. (2003)  
The World In Your Head, Lawrence Erlbaum, Mahwah, NJ. p. 52, Fig. 3.3

## 2. Emergence

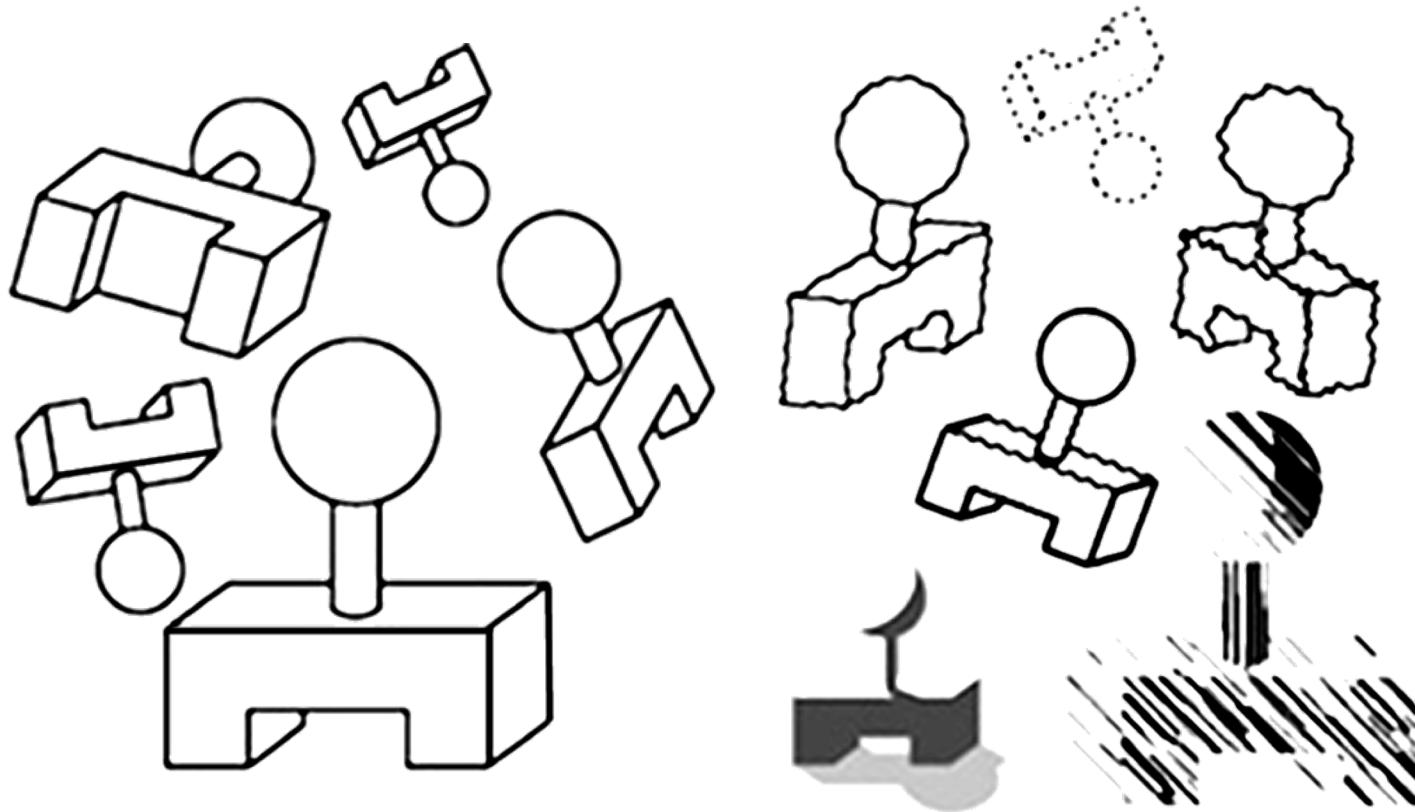


Life Magazine: 58;7 1965-02-19, p 120. Photographer: Ronald C James

### 3. Multistability



## 4. Invariance



Demonstration of invariance in perception from Lehar S. (2003)  
The World In Your Head, Lawrence Erlbaum, Mahwah, NJ. p. 53, Fig. 3.5

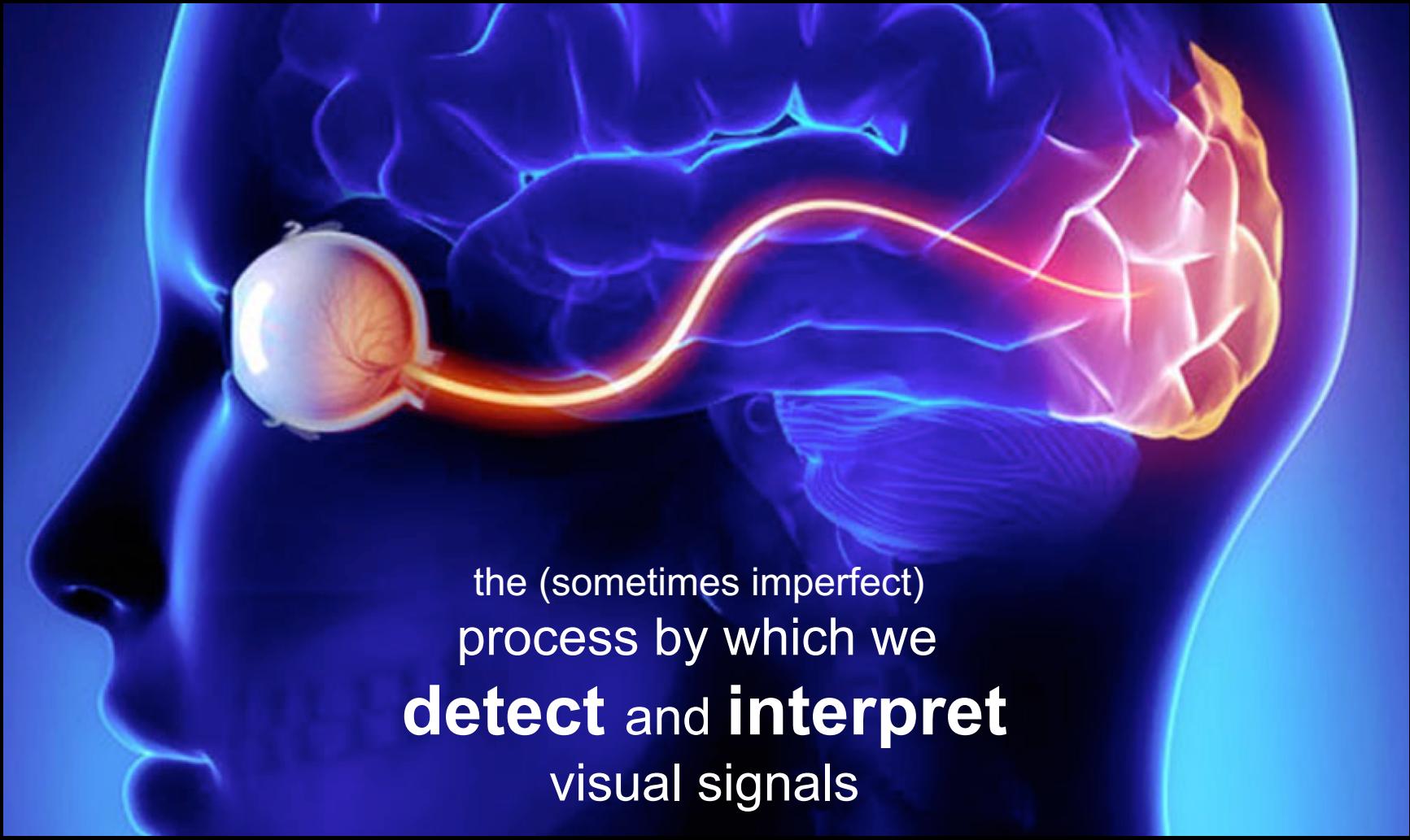
# Hacking the brain

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

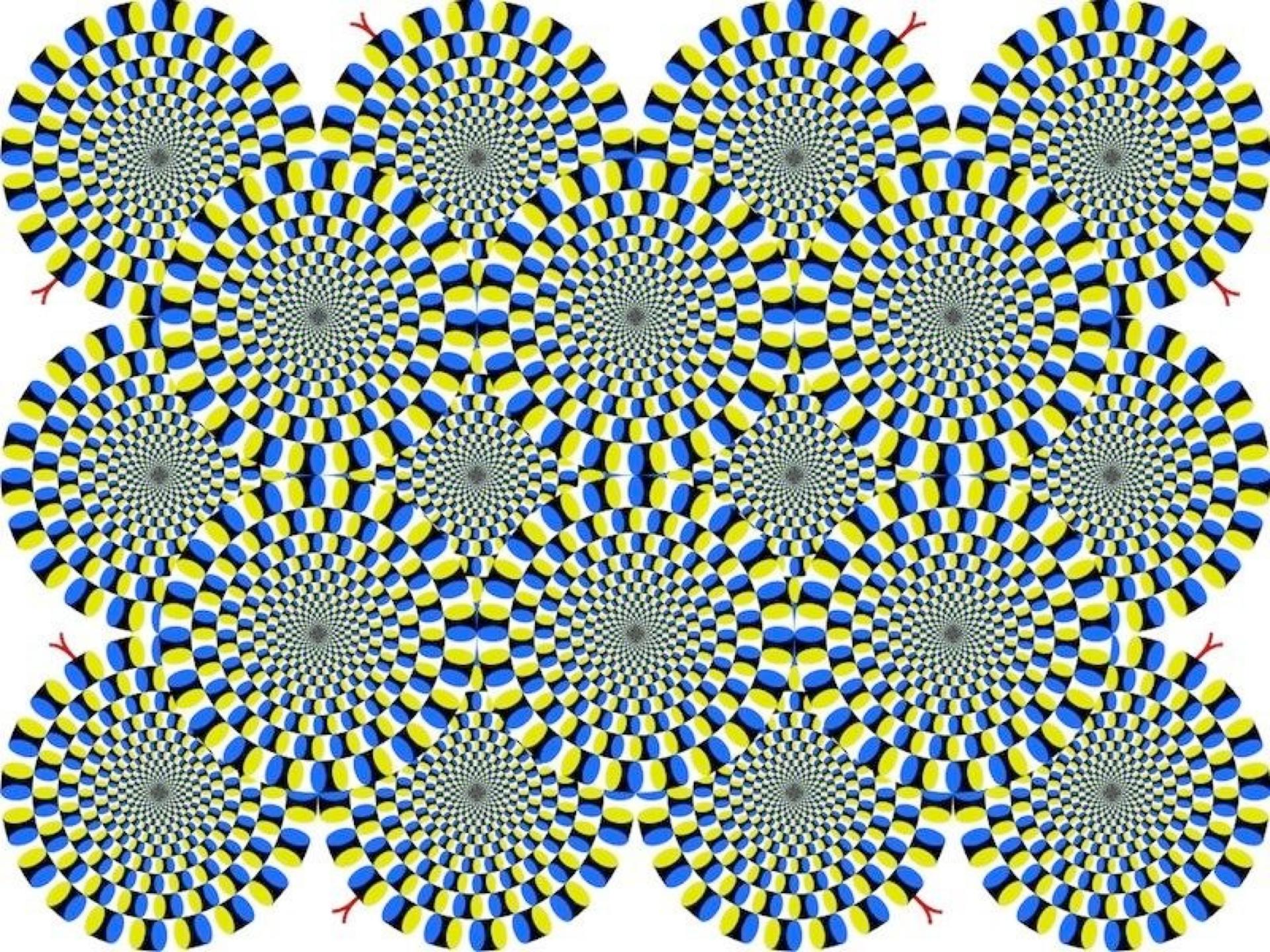
**Answer:** in order to understand how people interpret and make sense of data, we need to know what **cues** they're picking up on – and how to situate those cues within a larger framework

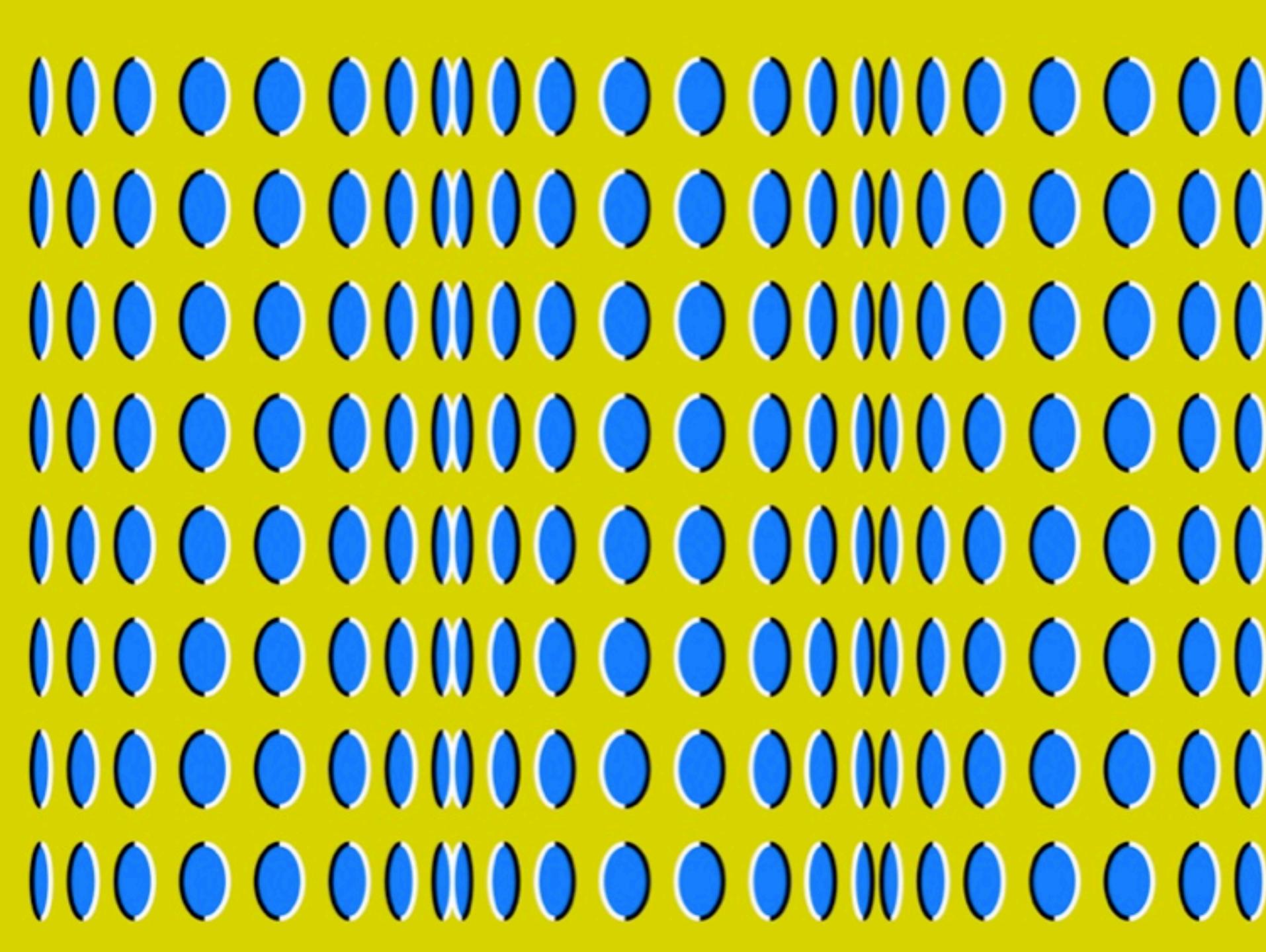


# Visual perception (def.)

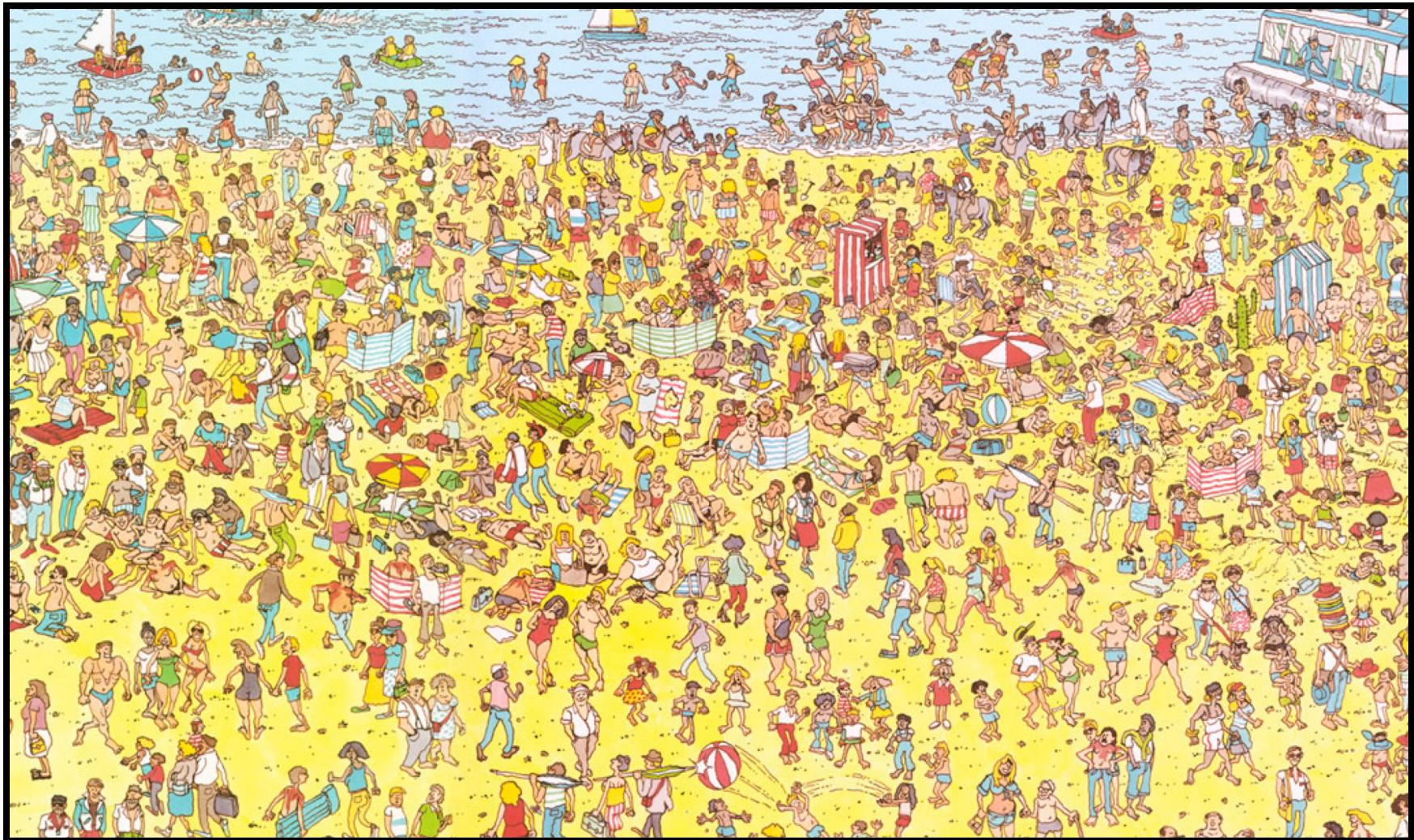


the (sometimes imperfect)  
process by which we  
**detect and interpret**  
visual signals

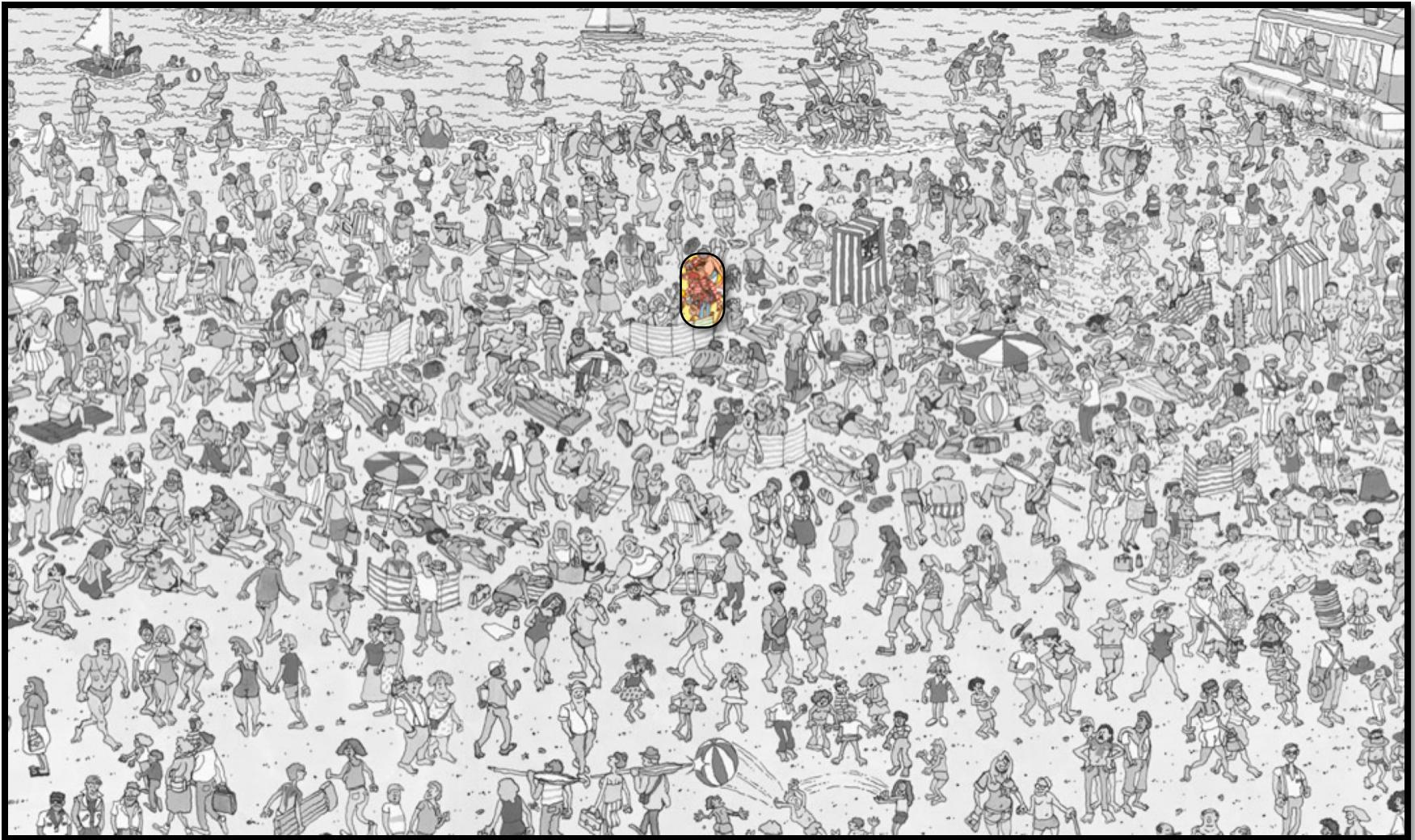




# Some things are processed slowly

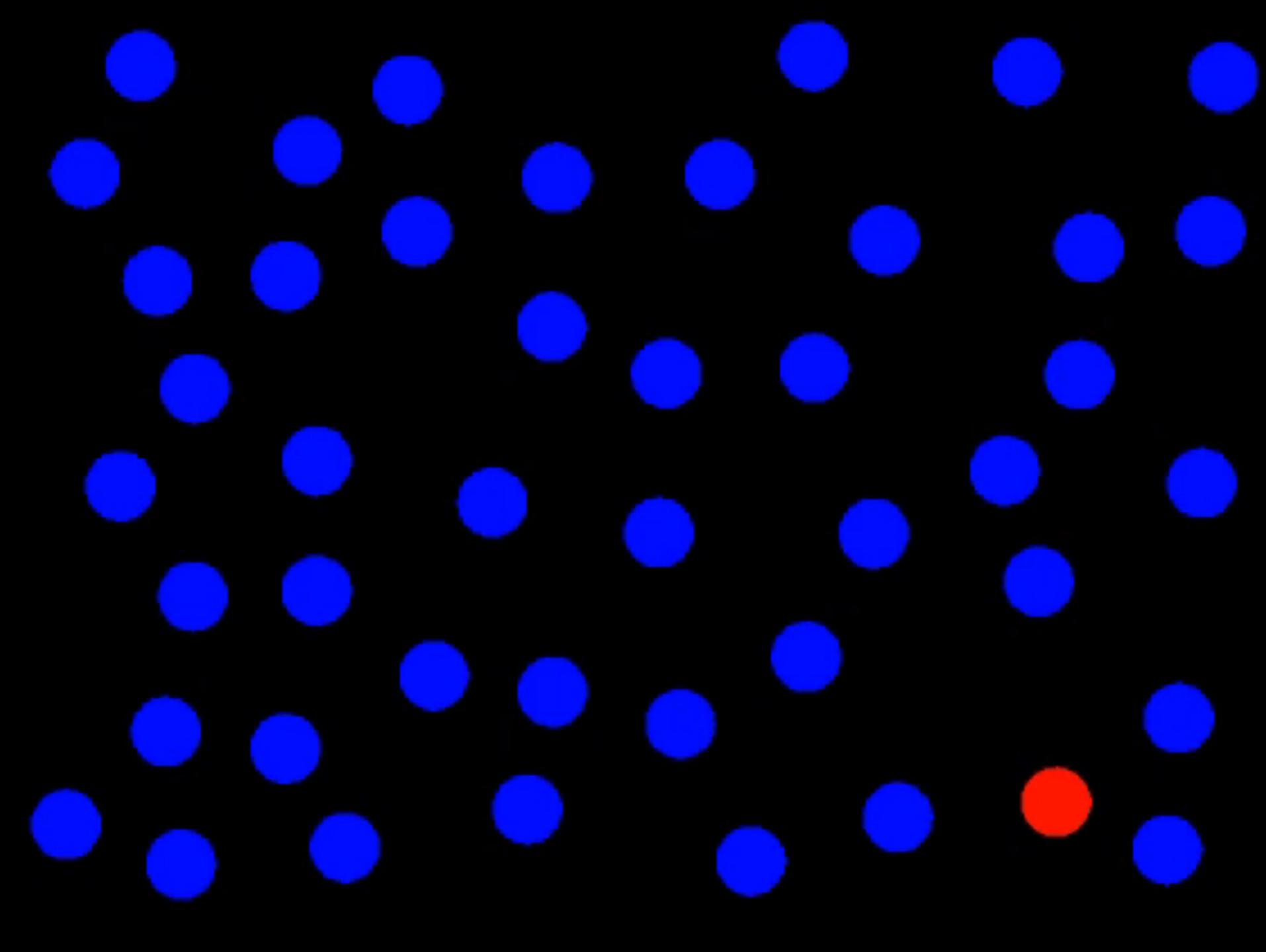


# Others are incredibly fast



# 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

1281768756138976546984506985604982826762

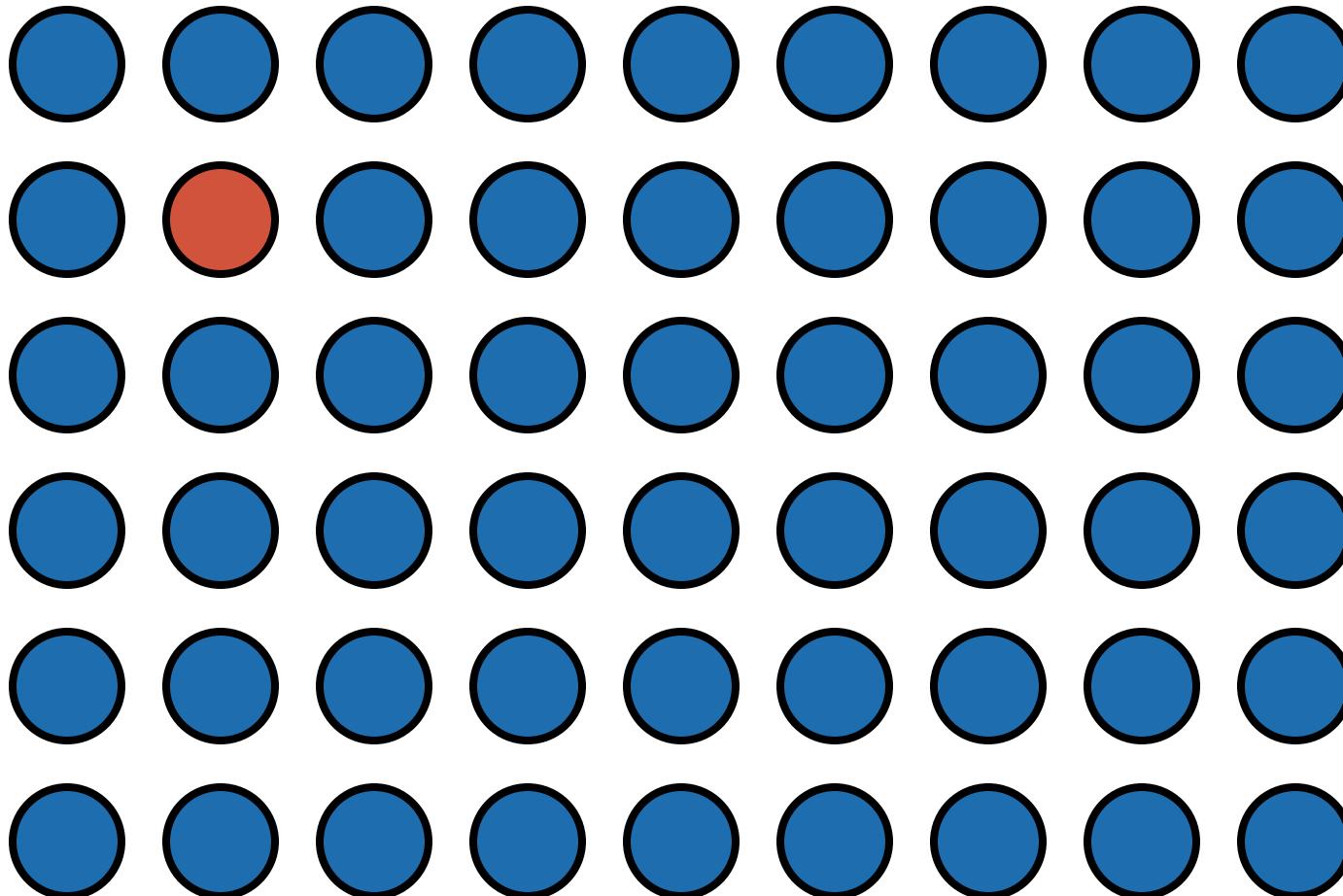
9809858458224509856458945098450980943585

9091030209905959595772564675050678904567

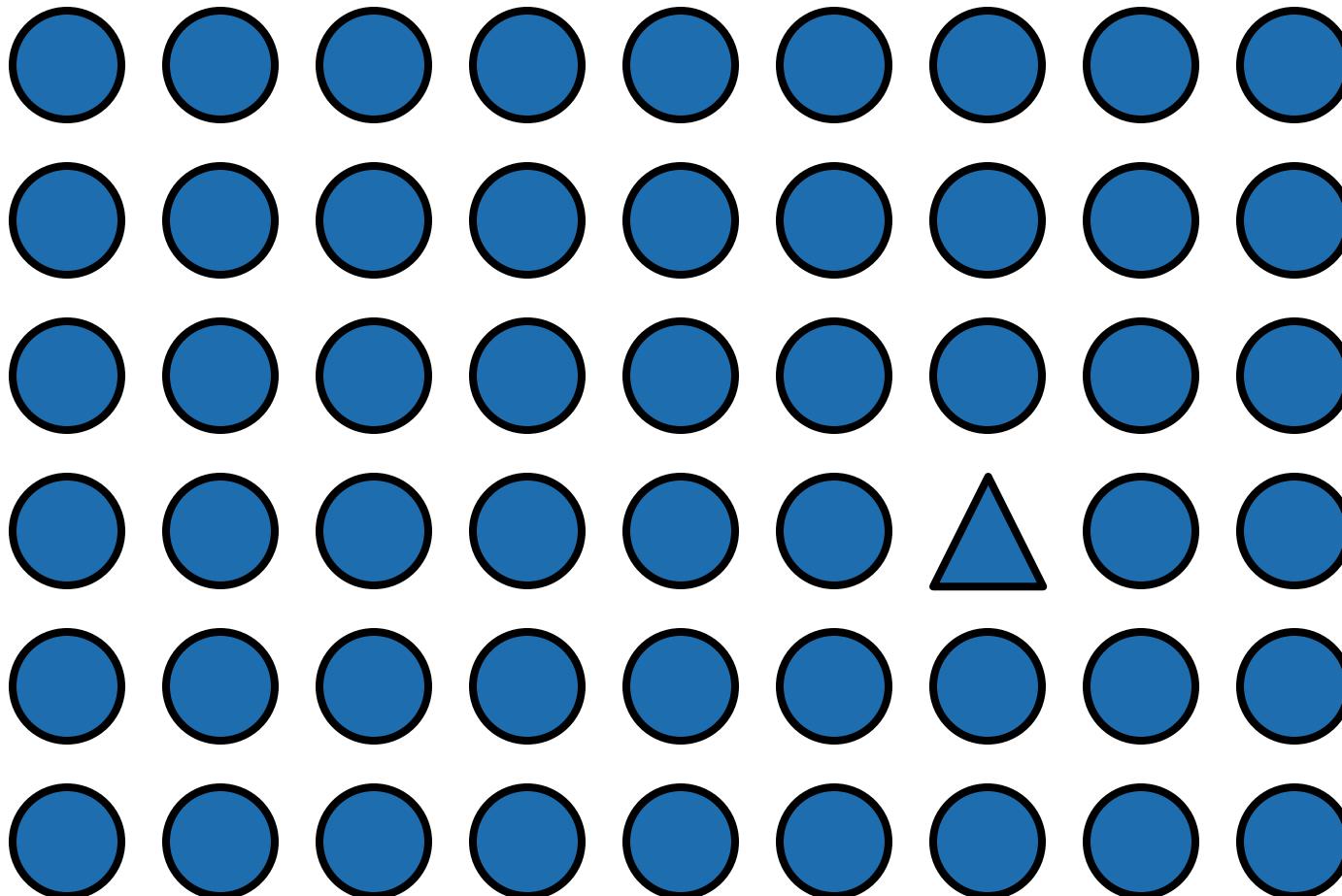
8845789809821677654876364908560912949686

**How many threes are there?**

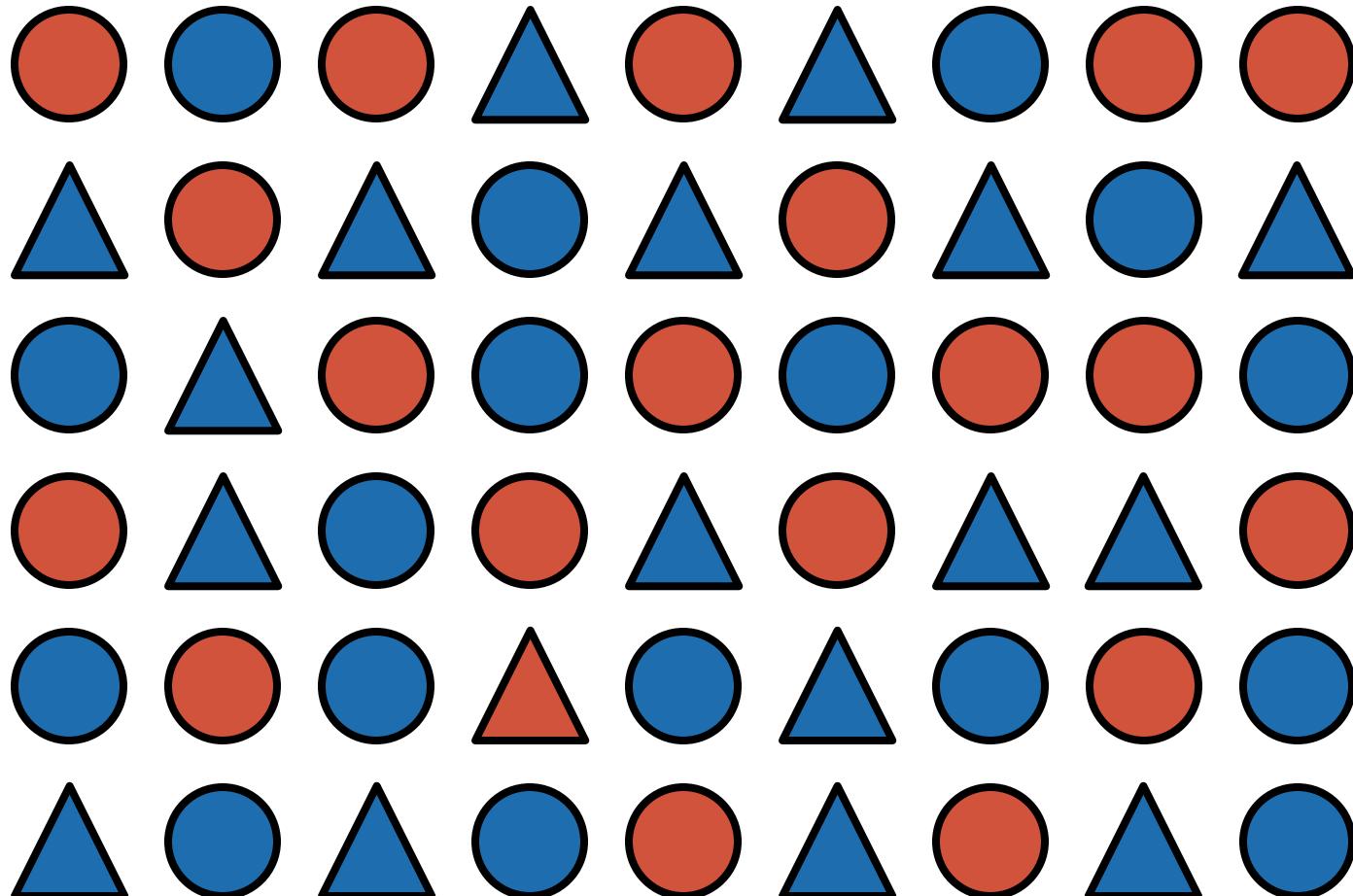
# Pre-attentive processing: color (hue)



# 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:

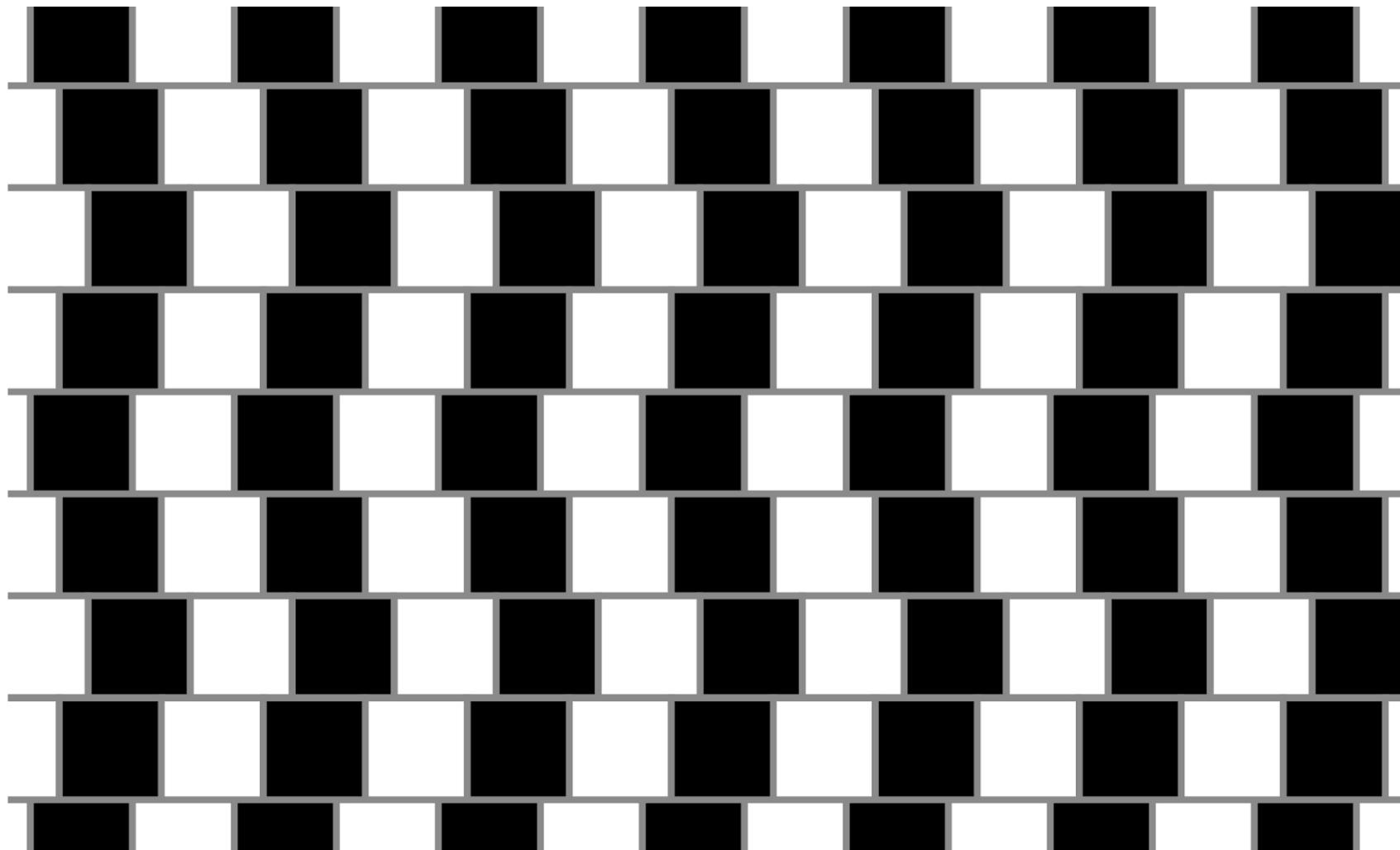
# Ex. flicker can cause change blindness



# Can you see it now?



# Sometimes gestalt & pre-attention compete



# Sometimes gestalt & pre-attention compete



# Magnitude estimation

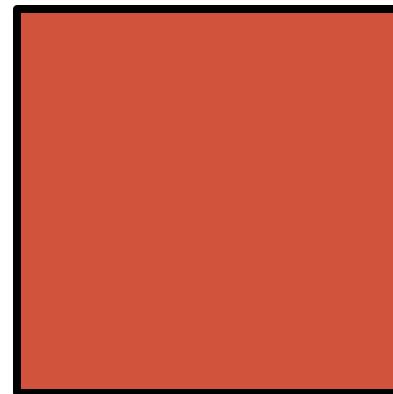
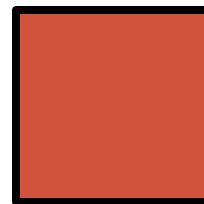
**Question:** How much **bigger** is the lower bar?



**Answer:** 2x

# Magnitude estimation

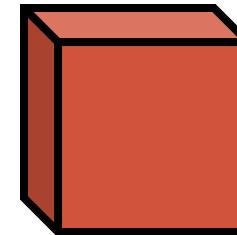
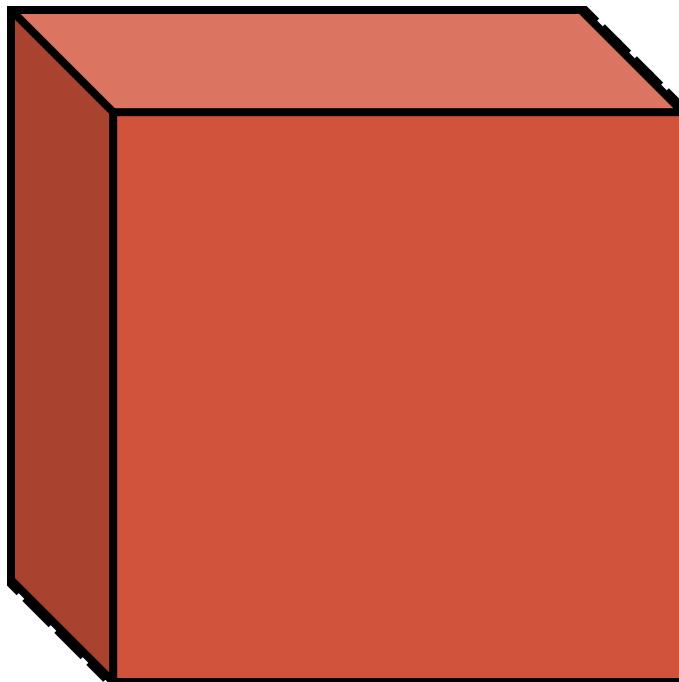
**Question:** How much **bigger** is the right square?



**Answer:** 4x

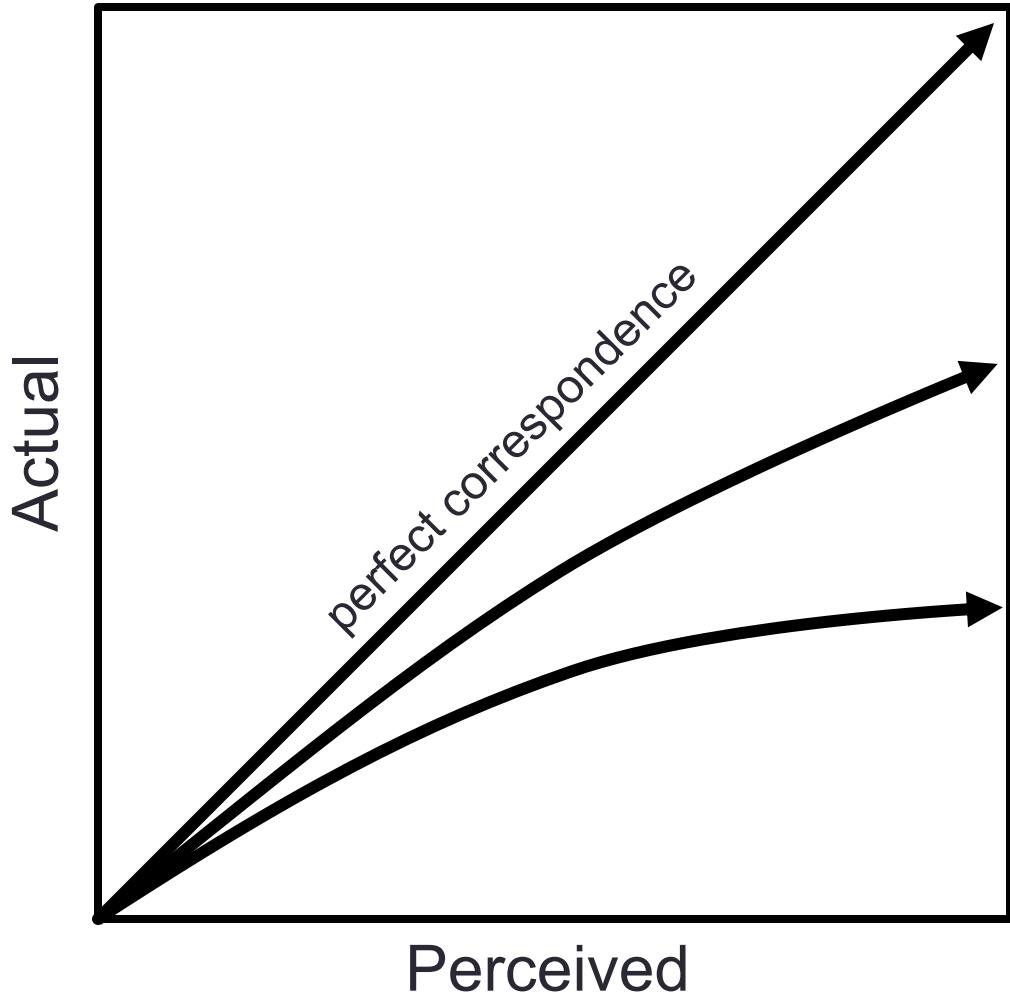
# Magnitude estimation

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



**Answer:** 27x

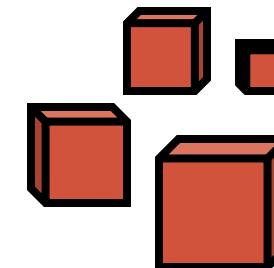
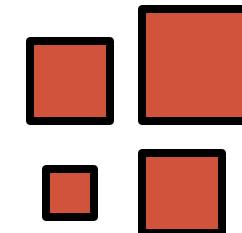
# “Apparent” magnitude



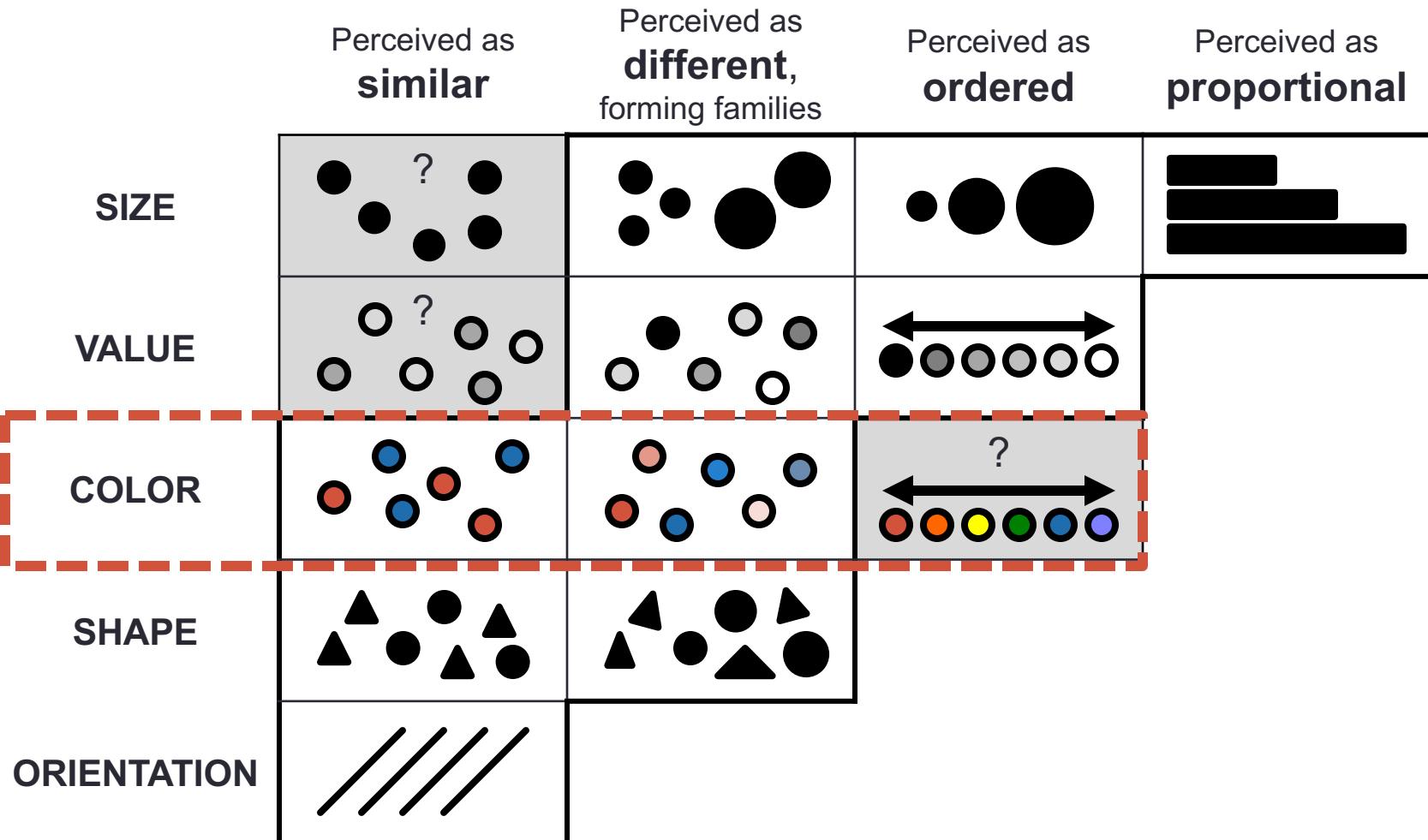
Length  
estimate  
correctly

Area  
under-  
estimate

Volume  
way under-  
estimate



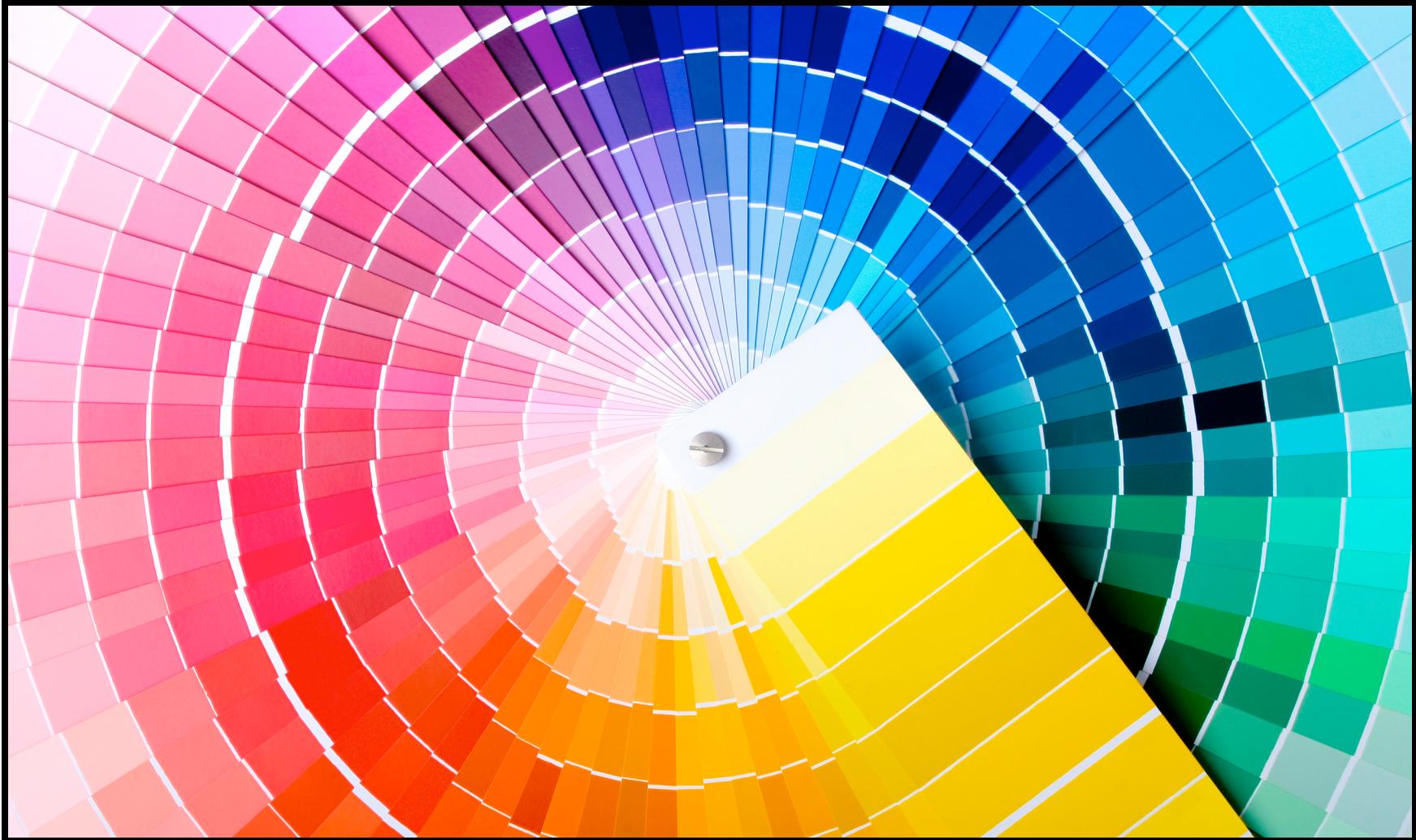
# Mapping to visual dimensions



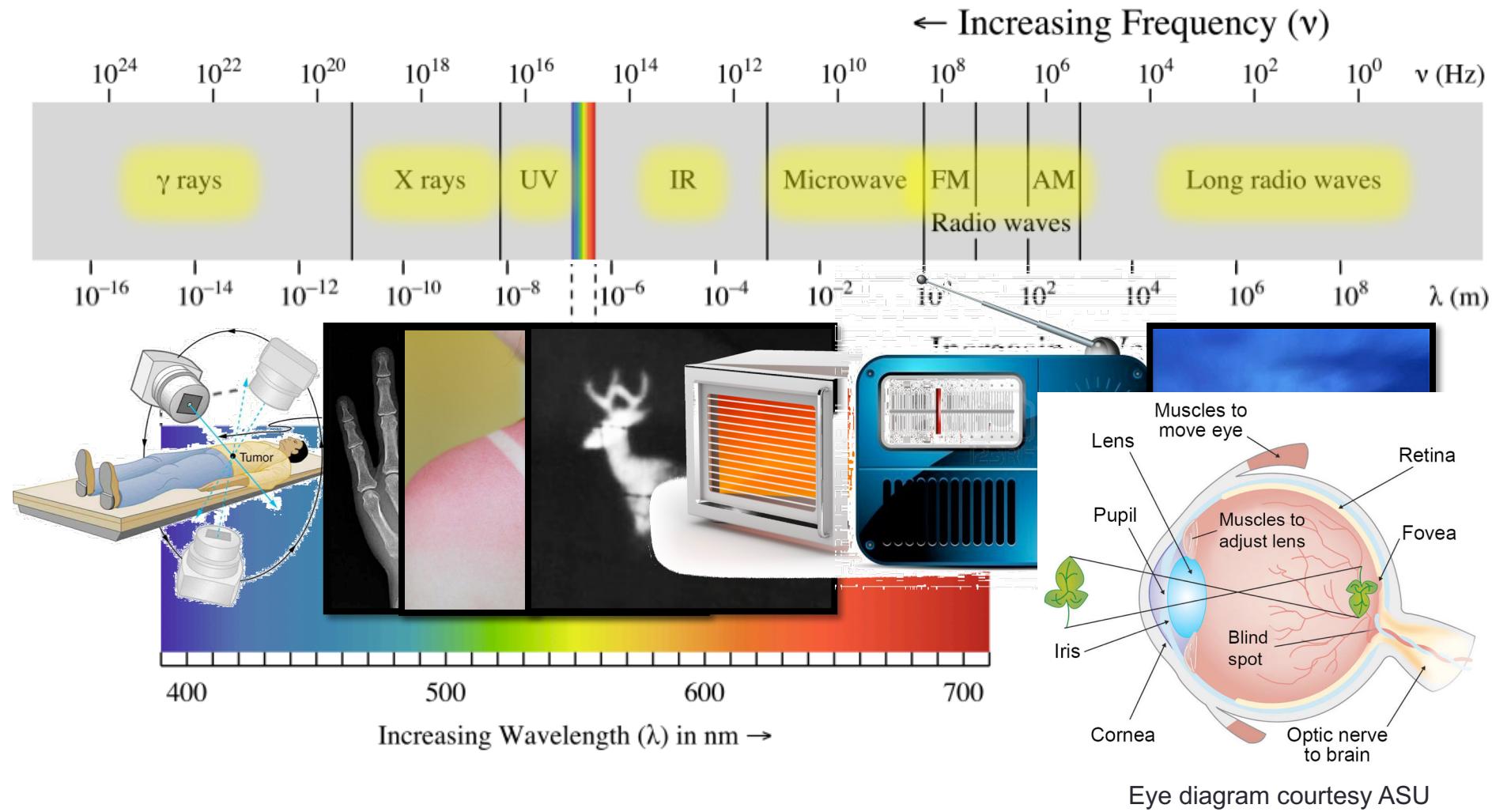
Back in 10 minutes



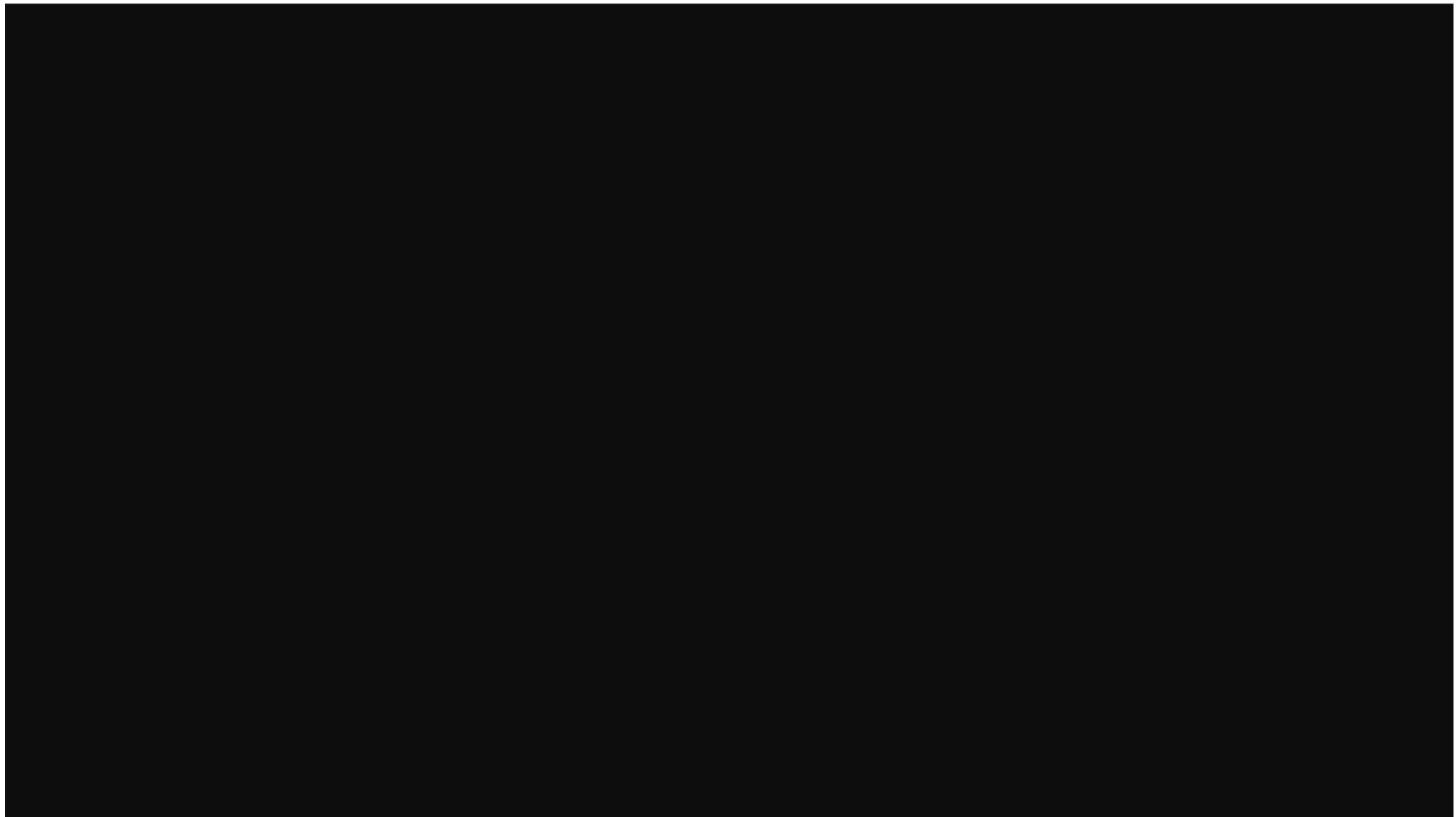
# Color 101



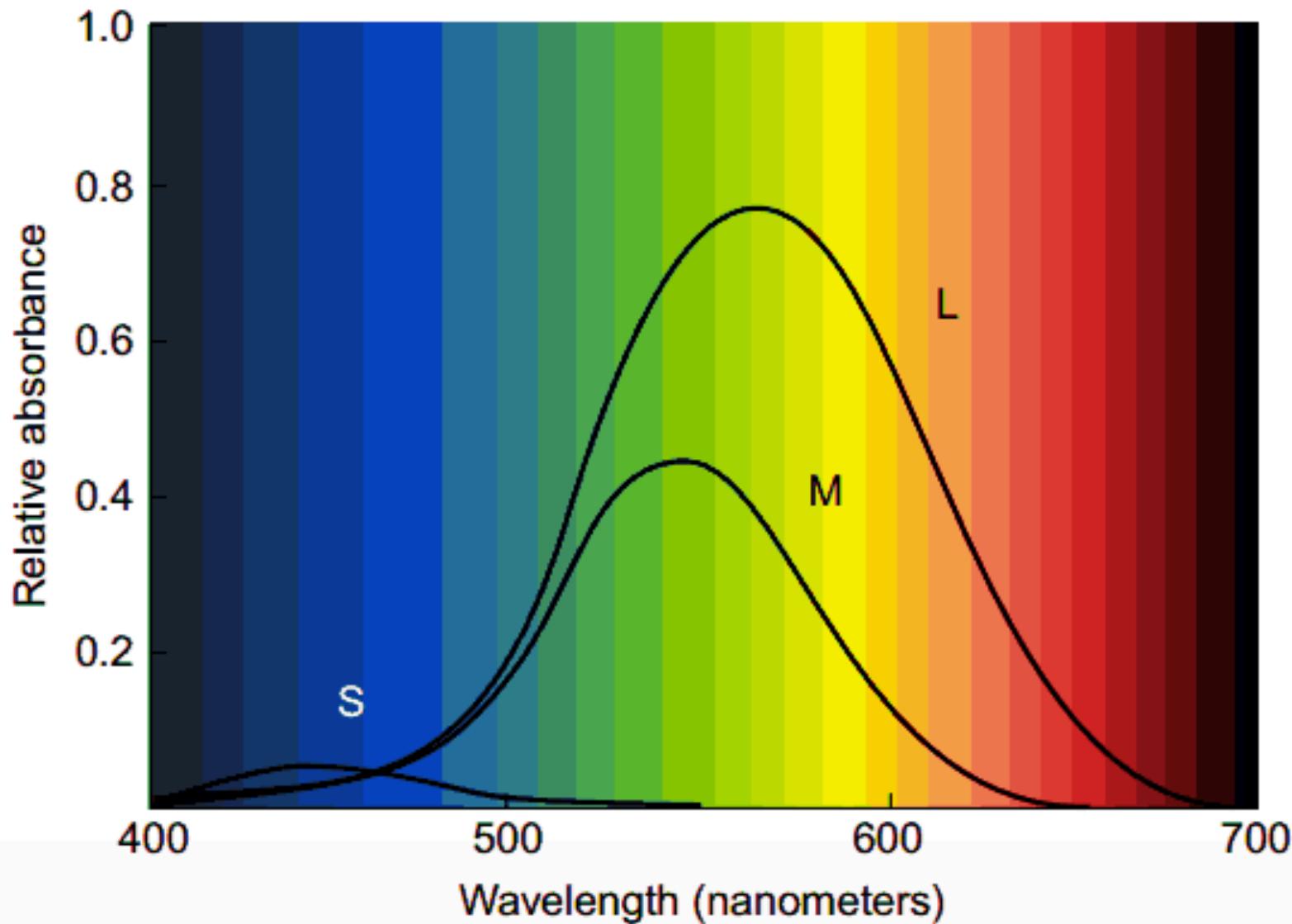
# Kinds of light



# How we see color



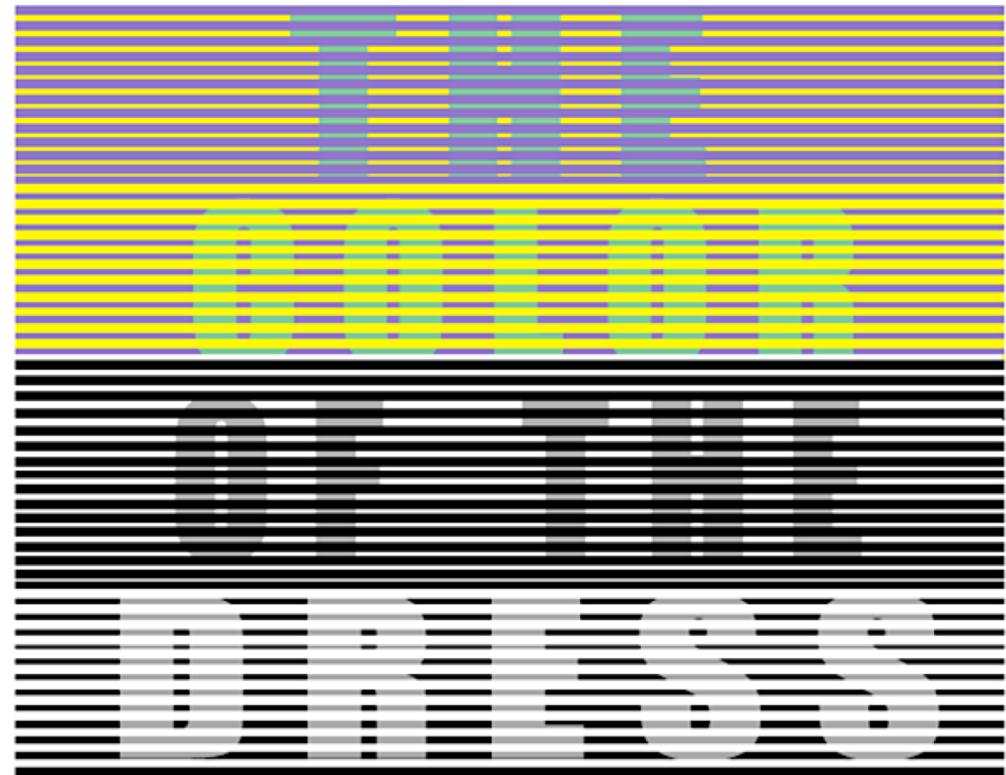
# 3 kinds of color sensors



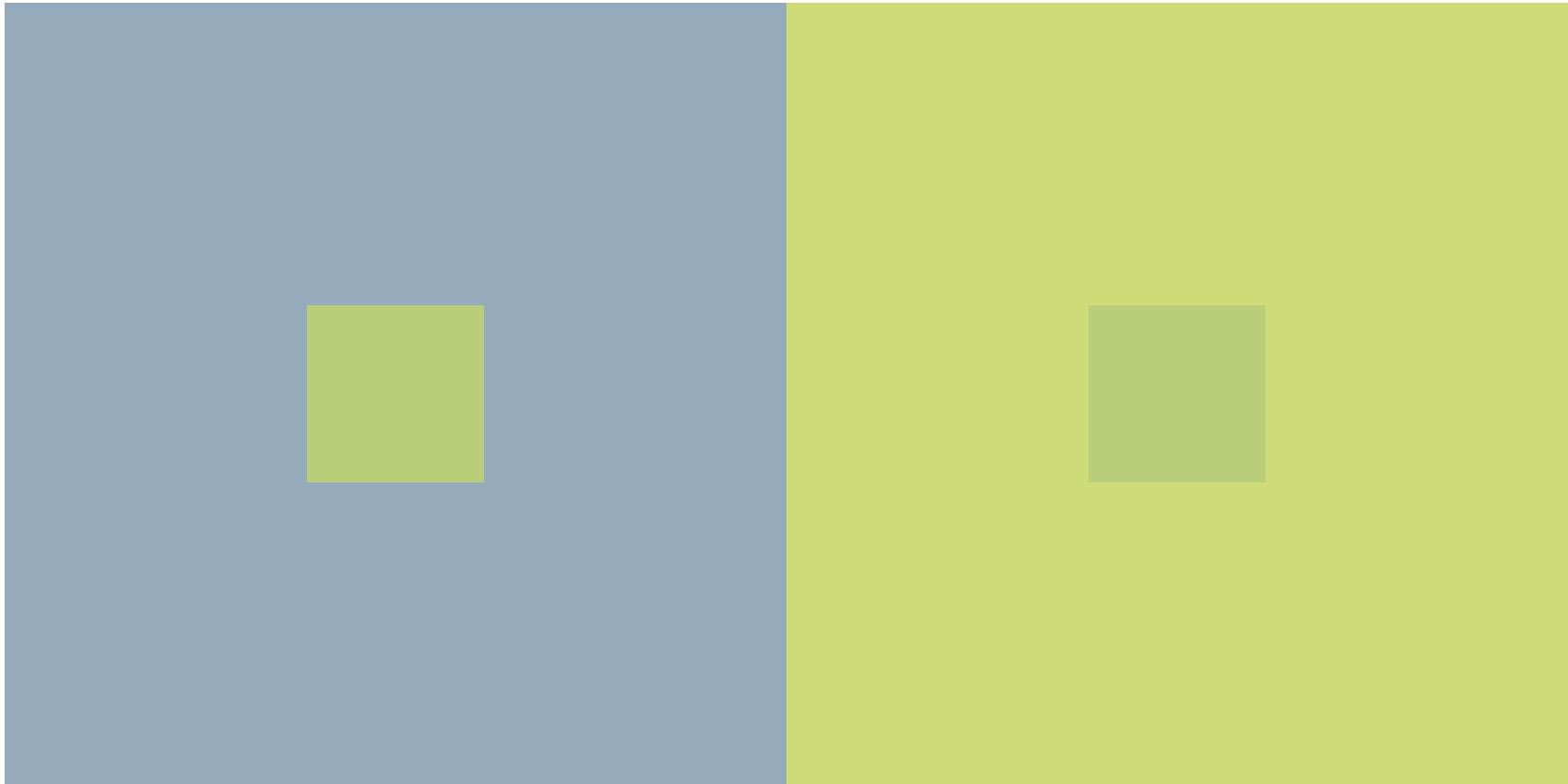
# Discussion: what do you notice?



# Color phenomena



# Caveat 1: color is perceived in context



Which small square is **darker green**?

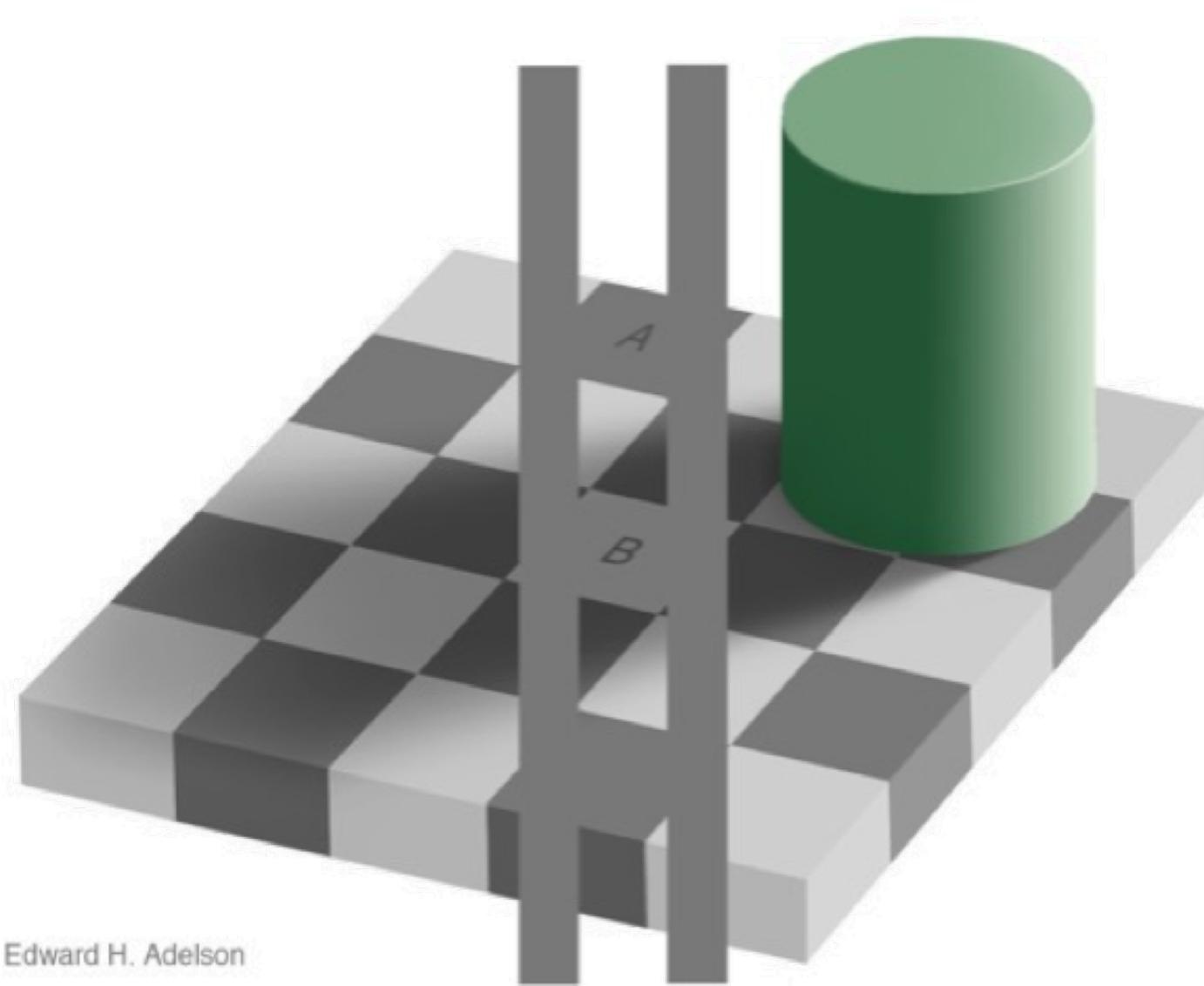
## Caveat 2: difference is relative



# Caveat 2a: so are brightness and contrast



# Caveat 3: mental models > perception

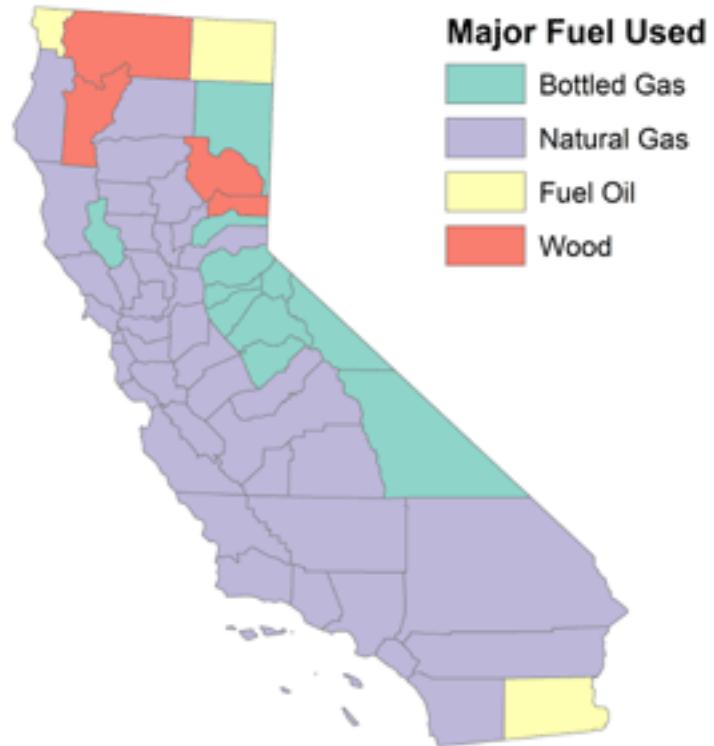


# Takeaways: Perception

- 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

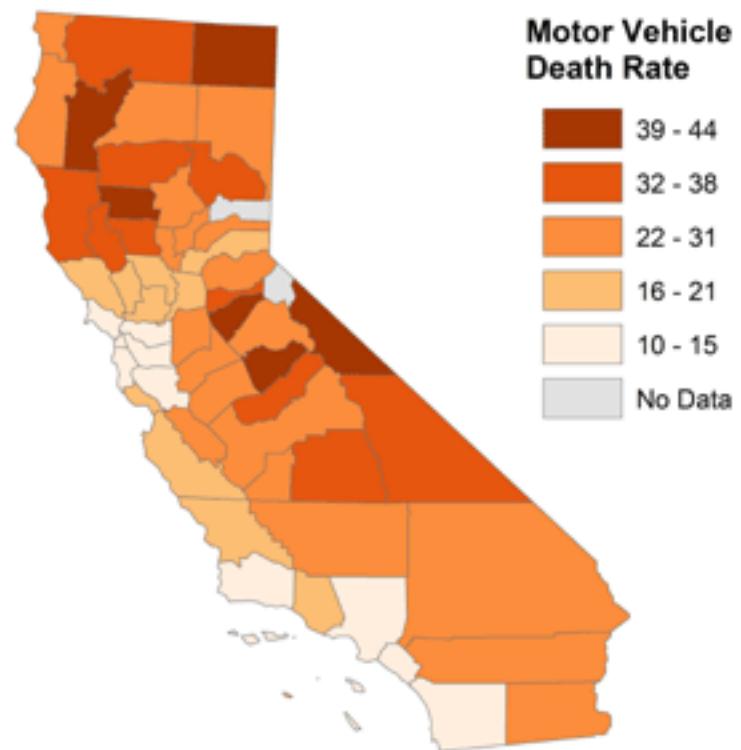
# Categorical color schemes

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



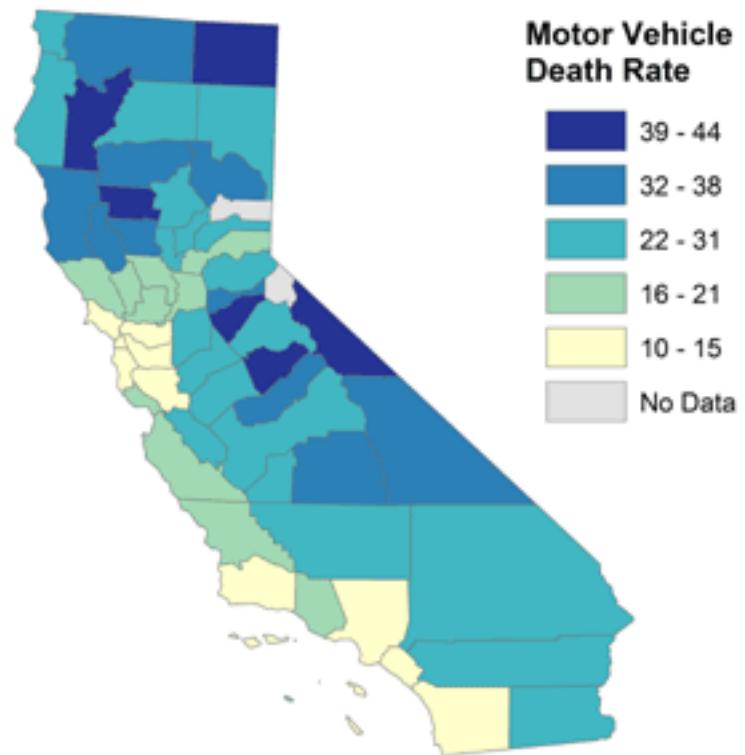
# Sequential color schemes: one hue

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



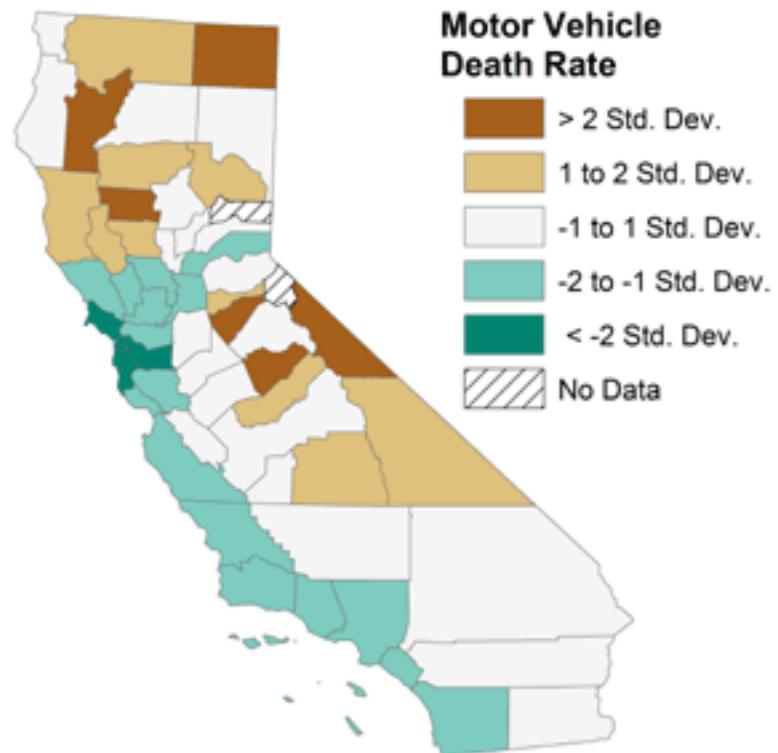
# Sequential color schemes: multi-hue

- 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

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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.

