

# lecture 08: graphical perception

October 11, 2017

# Announcements

Presentation of the major,  
Monday October 16th  
12:10-1:00 pm

THE STATISTICAL & DATA SCIENCES (SDS)  
DEPARTMENT AT SMITH COLLEGE PRESENTS

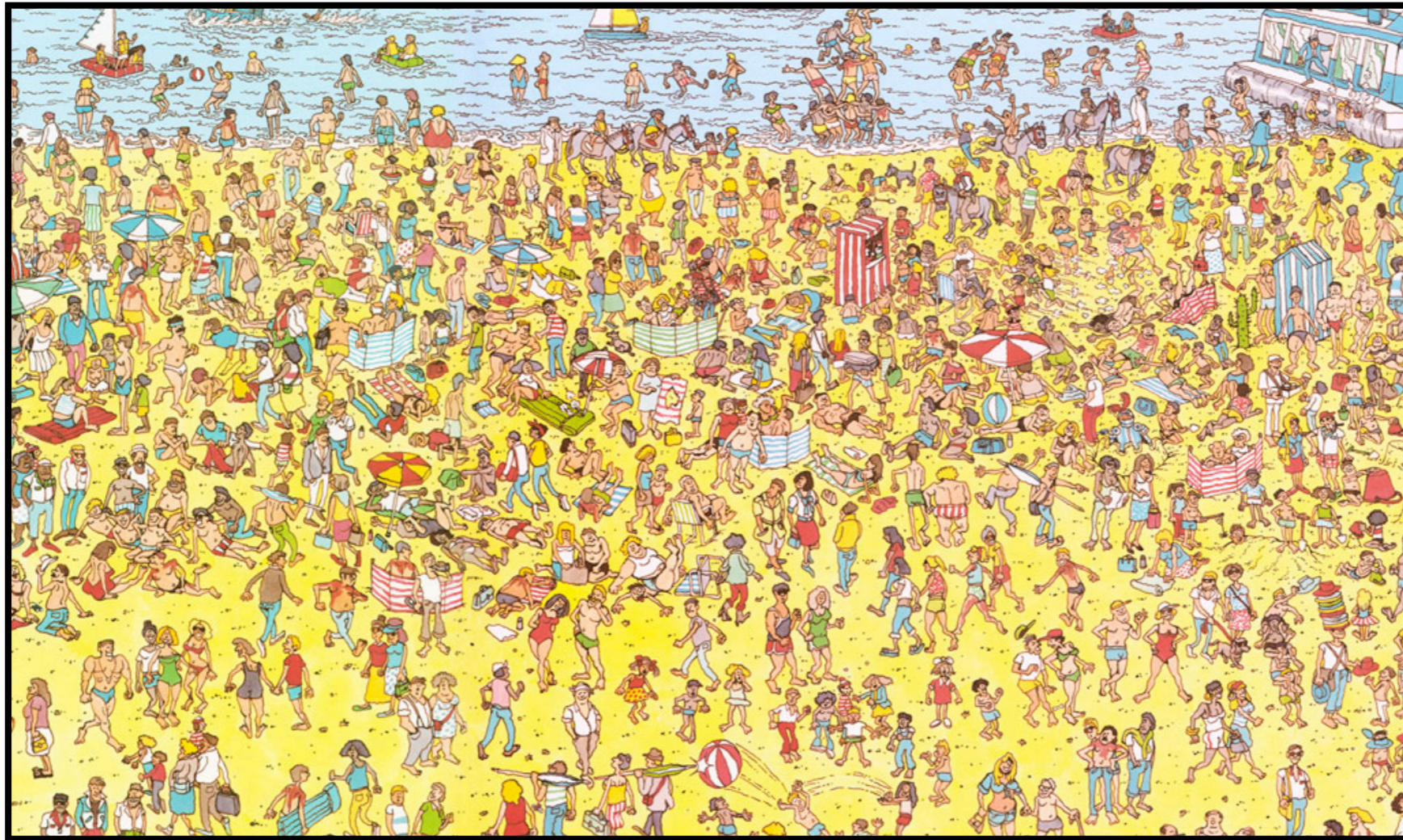
## Presentation of the Major



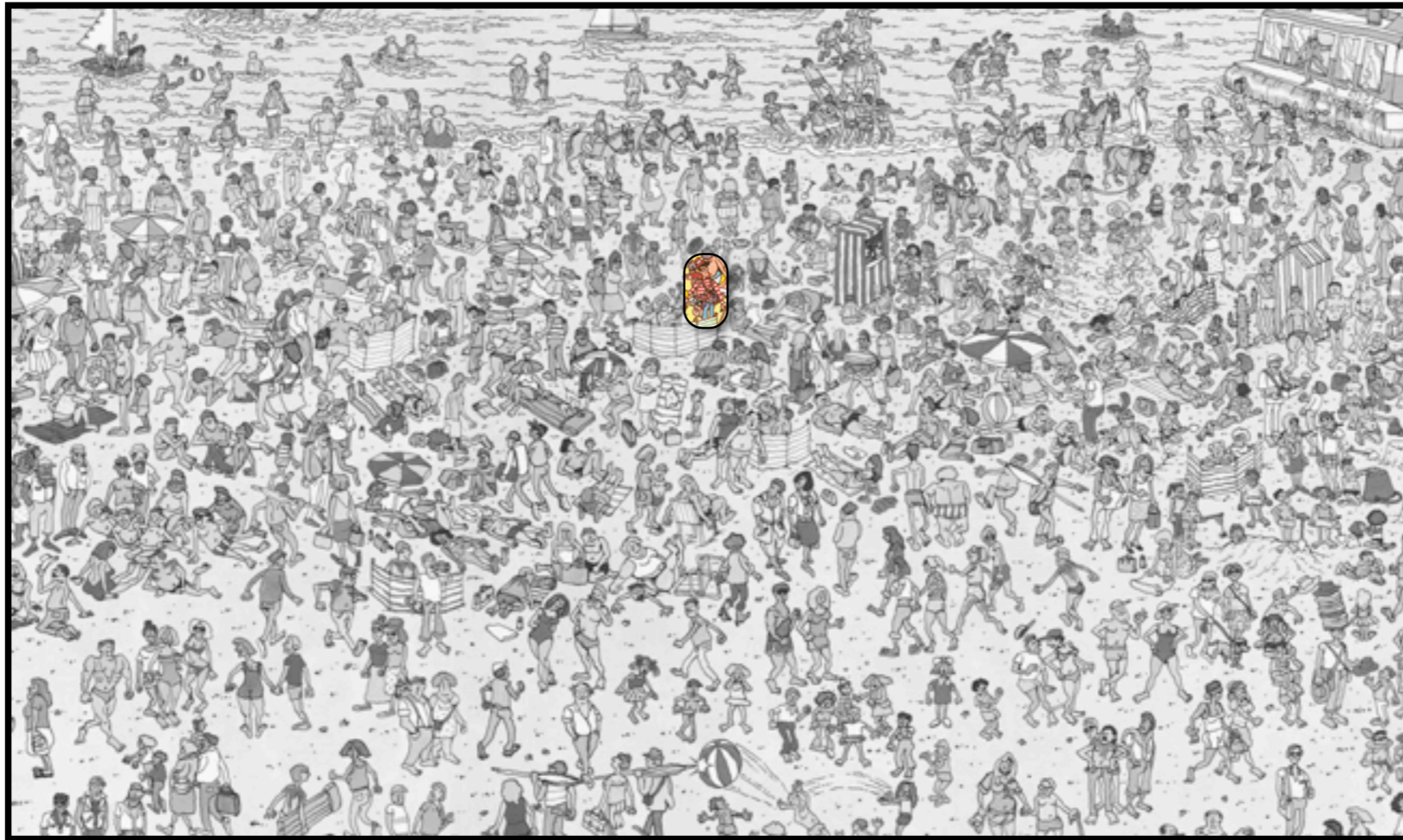
**FORD HALL 240**  
**MONDAY, OCT 16TH, 12:10 - 1:00 PM**

Lunch provided (gluten-free available)

# Some things are processed slowly



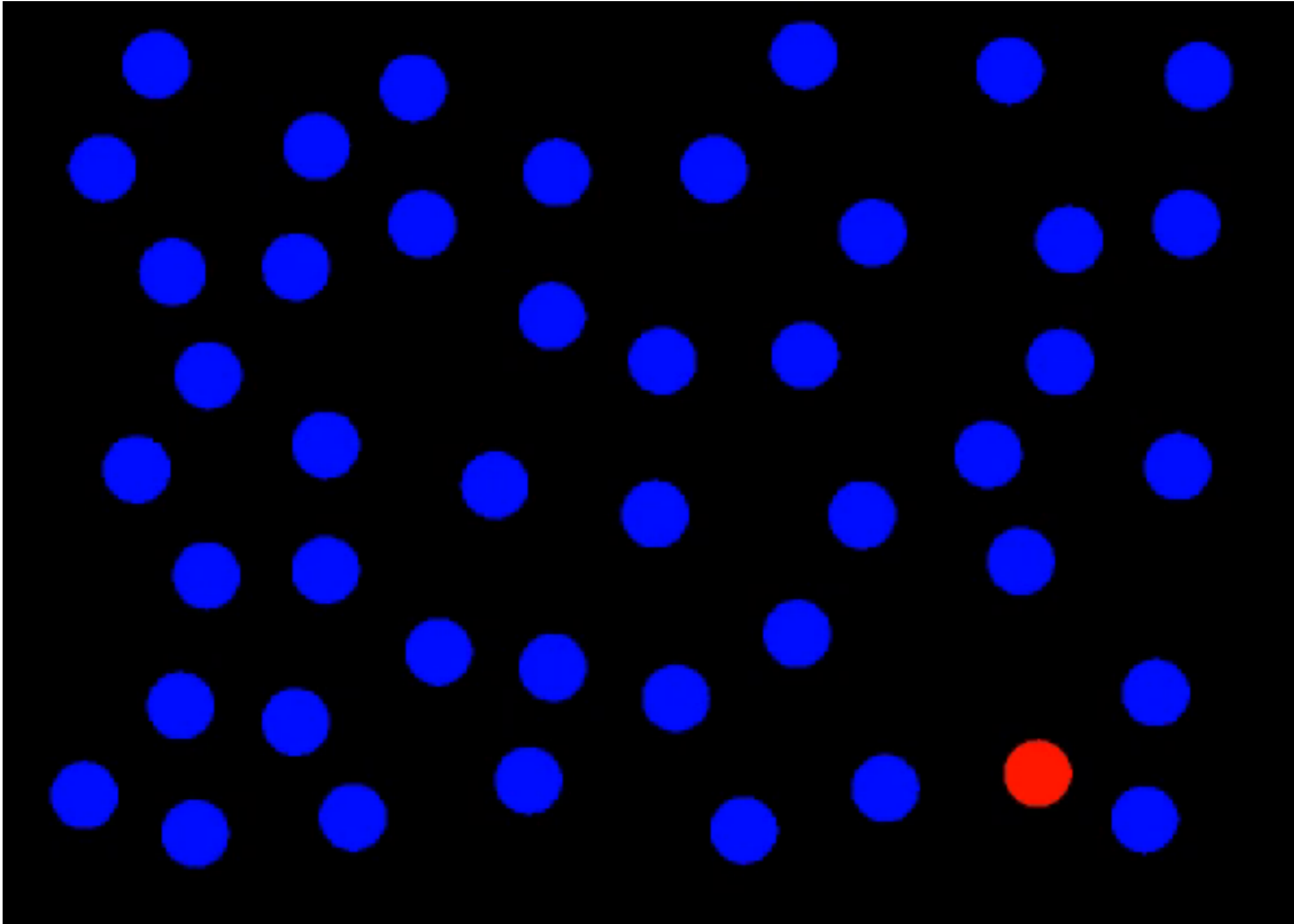
# Others are incredibly fast



Fast = “pre-attentive processing”

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

Get ready



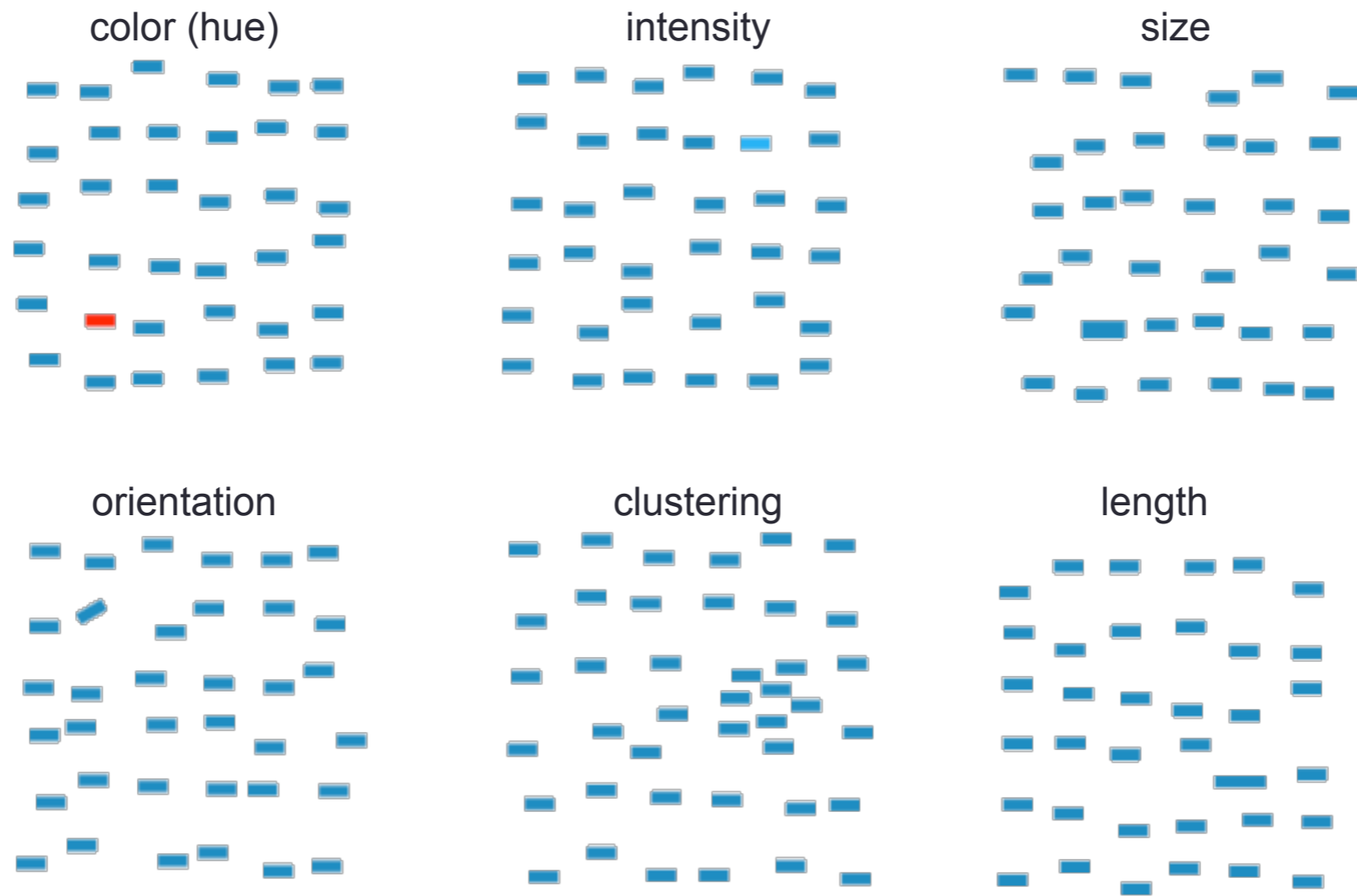
# What did you see?





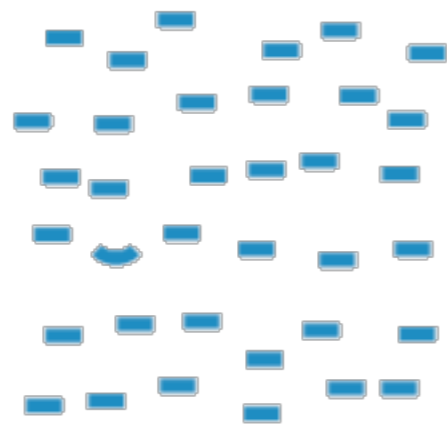
“An understanding of what is processed pre-attentively is probably the most important contribution that visual science can make to data visualization” (Ware, 2004, p. 19)

# Pre-attentive features

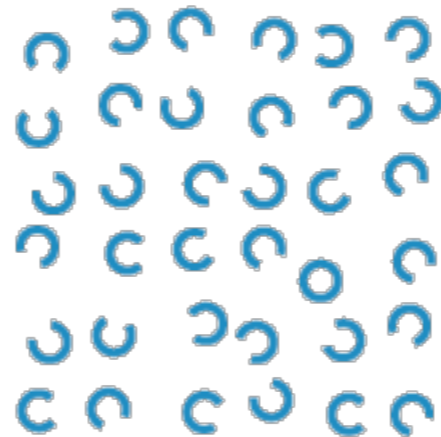


# Pre-attentive features

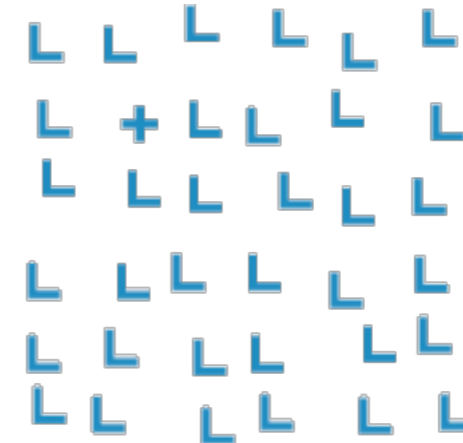
curvature



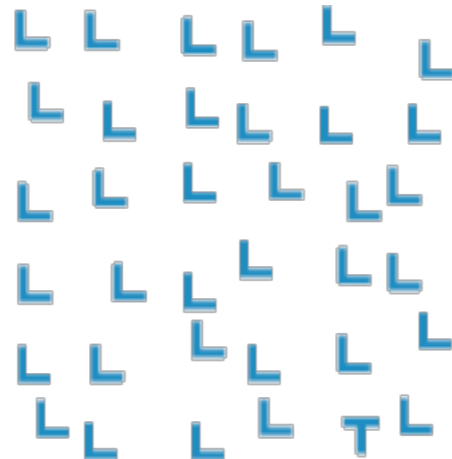
closure



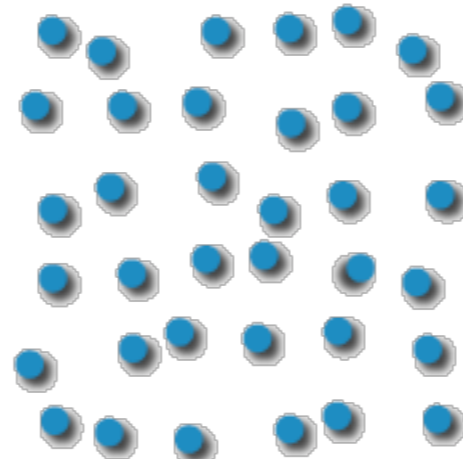
intersection



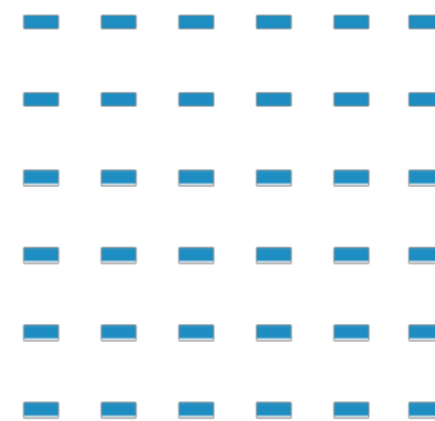
termination



lighting direction



flicker



## Pre-attentive processing facilities:

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

# Attentive counting

1281768756138976546984506985604982826762  
9809858458224509856458945098450980943585  
9091030209905959595772564675050678904567  
8845789809821677654876364908560912949686

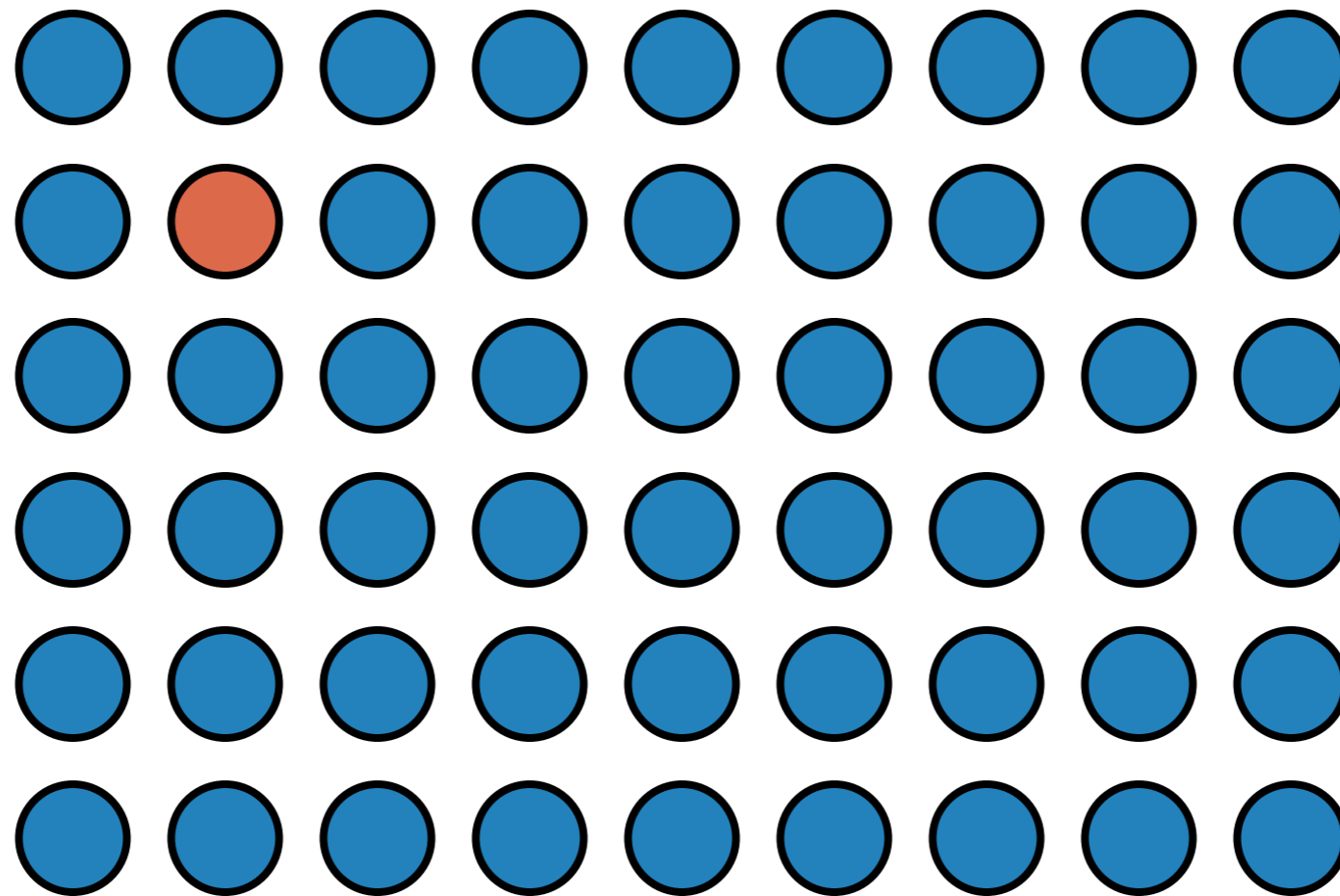
How many threes are there?

# Pre-attentive counting

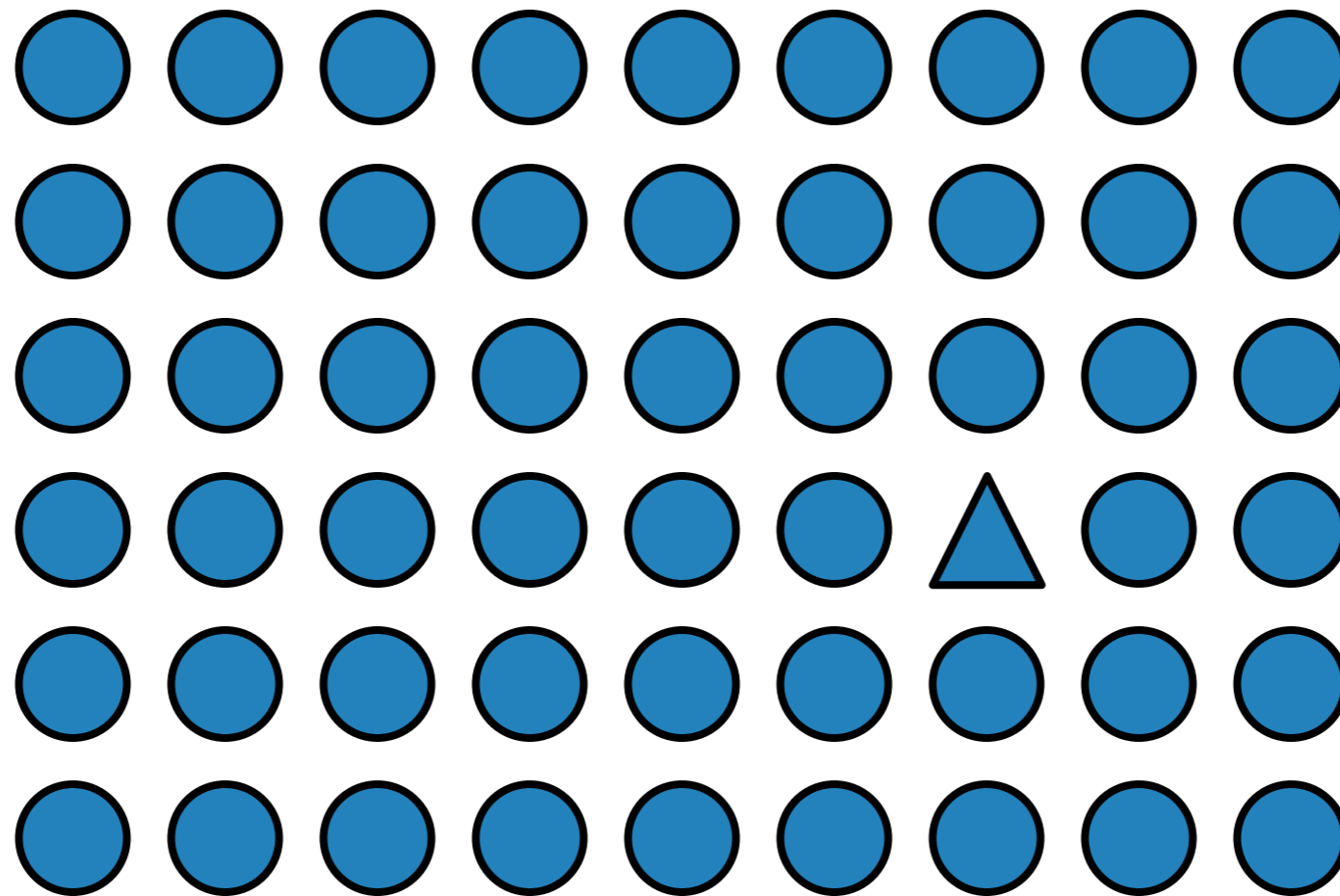
12817687561**3**8976546984506985604982826762  
980985845822450985645894509845098094**3**585  
90910**3**0209905959595772564675050678904567  
8845789809821677654876**3**64908560912949686

How many threes are there?

# Pre-attentive processing: color (hue)

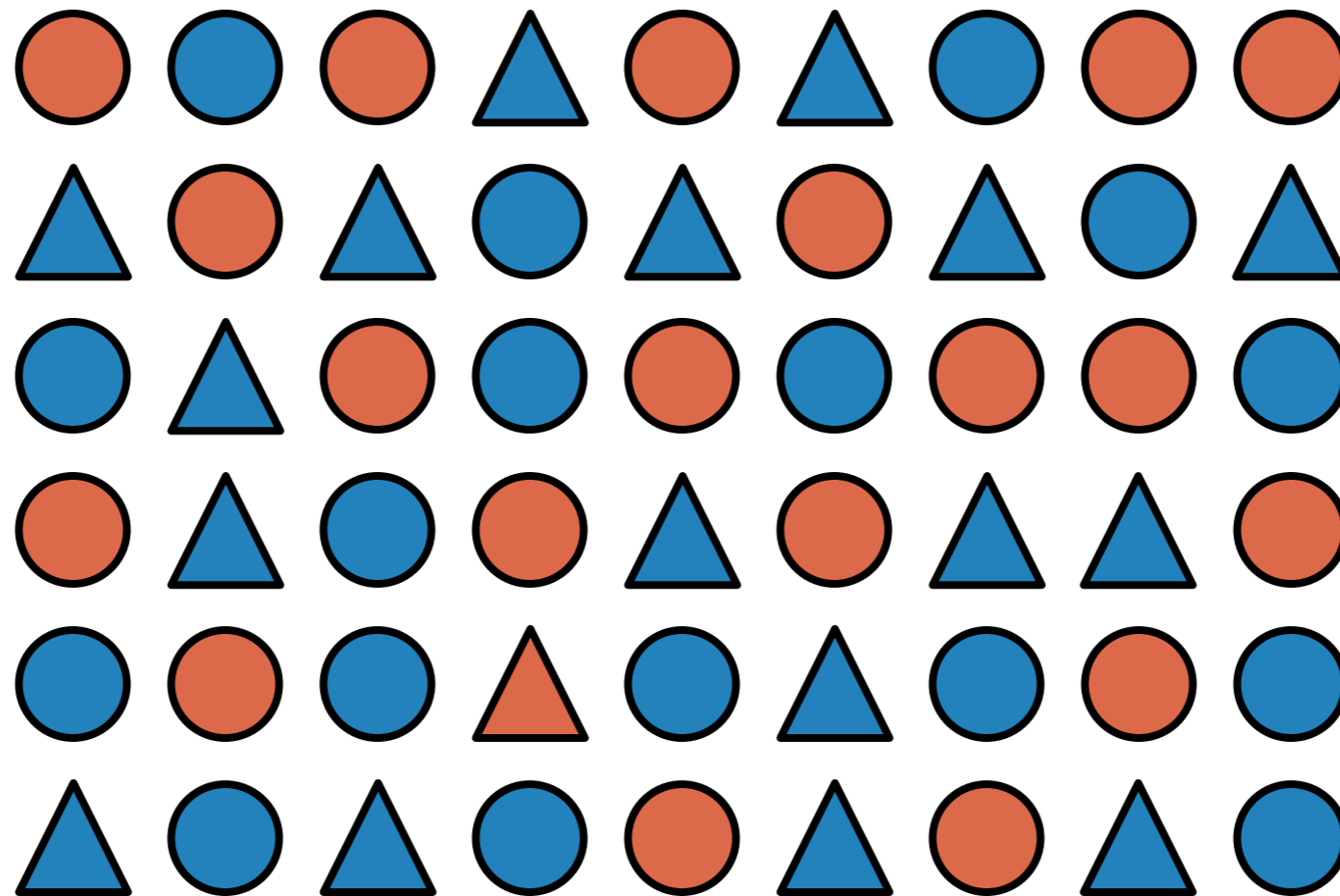


# Pre-attentive processing: shape (curvature)



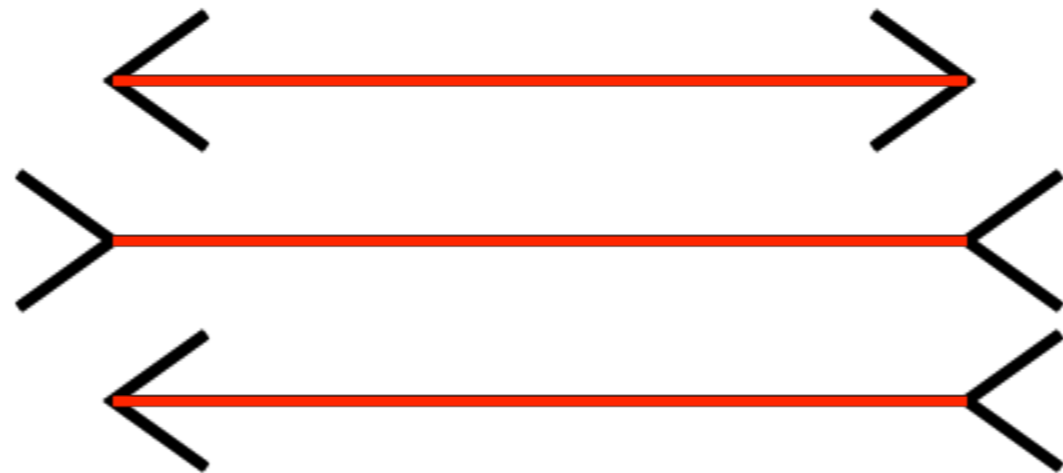


# Pre-attentive processing: shape + color?

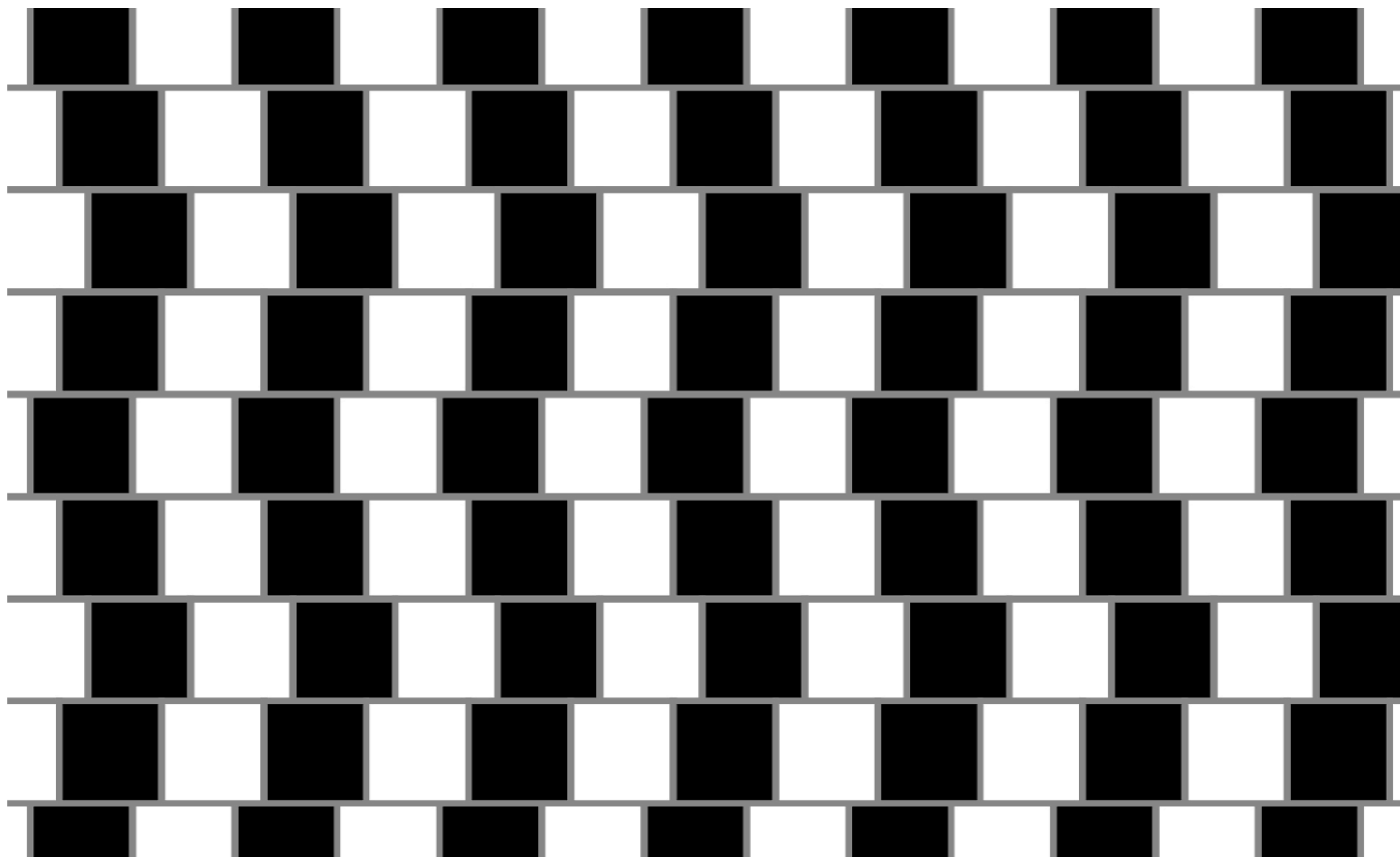


Discussion: what's  
going on here?

Sometimes gestalt and pre-attention compete



Sometimes gestalt and pre-attention compete



# Attentive processing

## Instructions

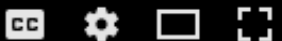
**Count how many times the  
players wearing white pass  
the basketball.**

# Attentive processing

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0:26 / 1:36

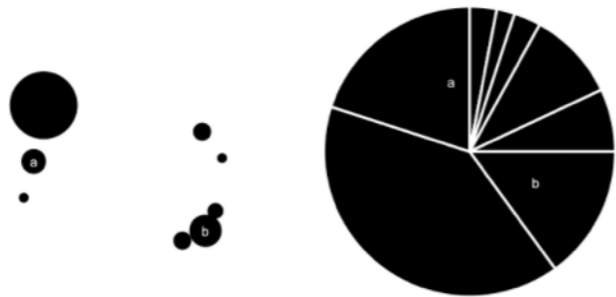
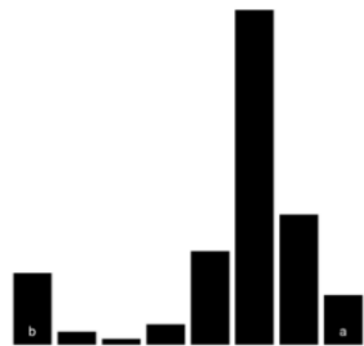


# Cleveland and McGill, 1984

The following are the 10 elementary tasks in Figure 1, ordered from most to least accurate:

1. Position along a common scale
2. Positions along nonaligned scales
3. Length, direction, angle
4. Area
5. Volume, curvature
6. Shading, color saturation

# Di Cook, 2016



Take the survey:  
<http://bit.ly/JSM-vis16>



# Heer and Bostock, 2010

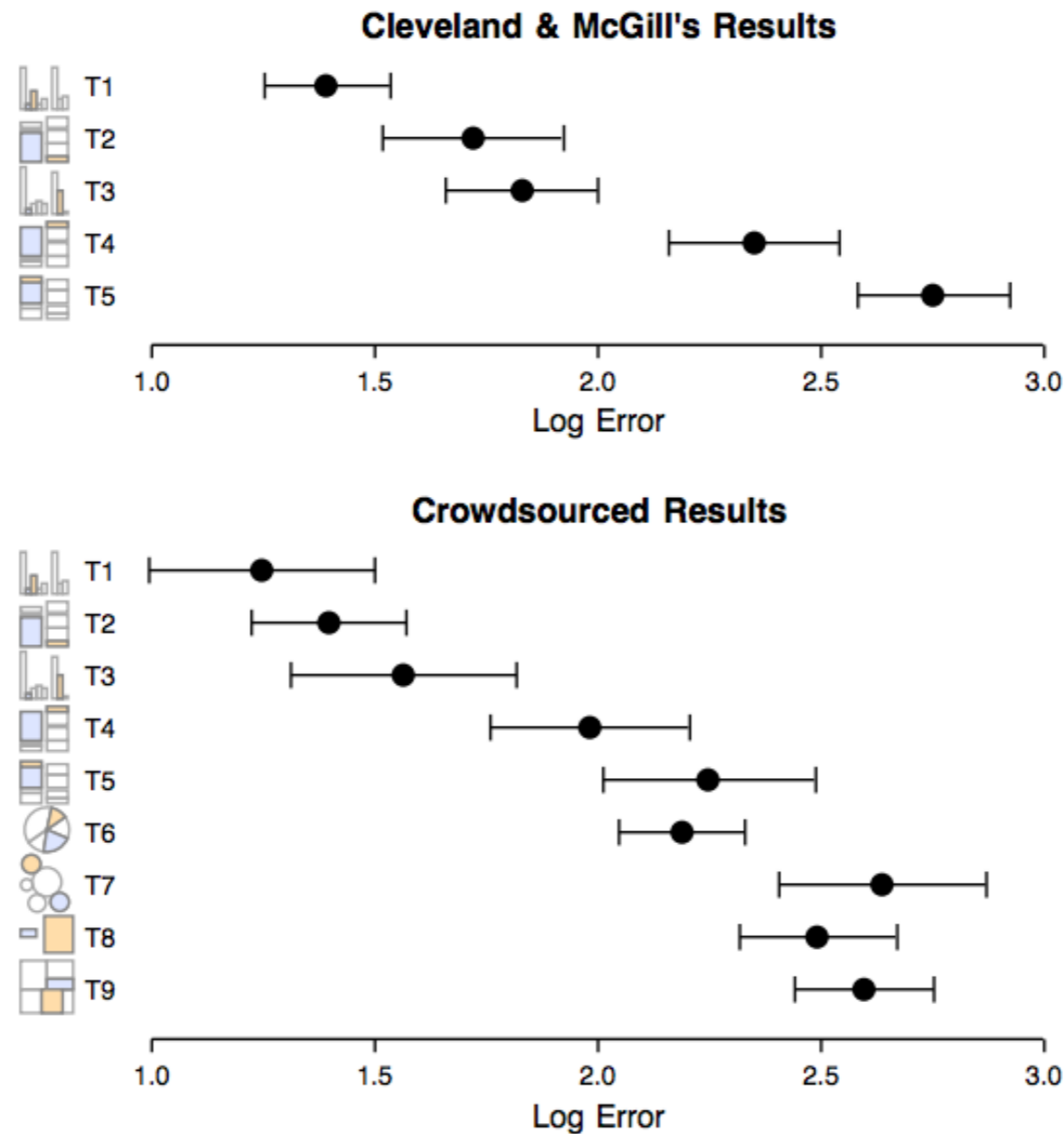


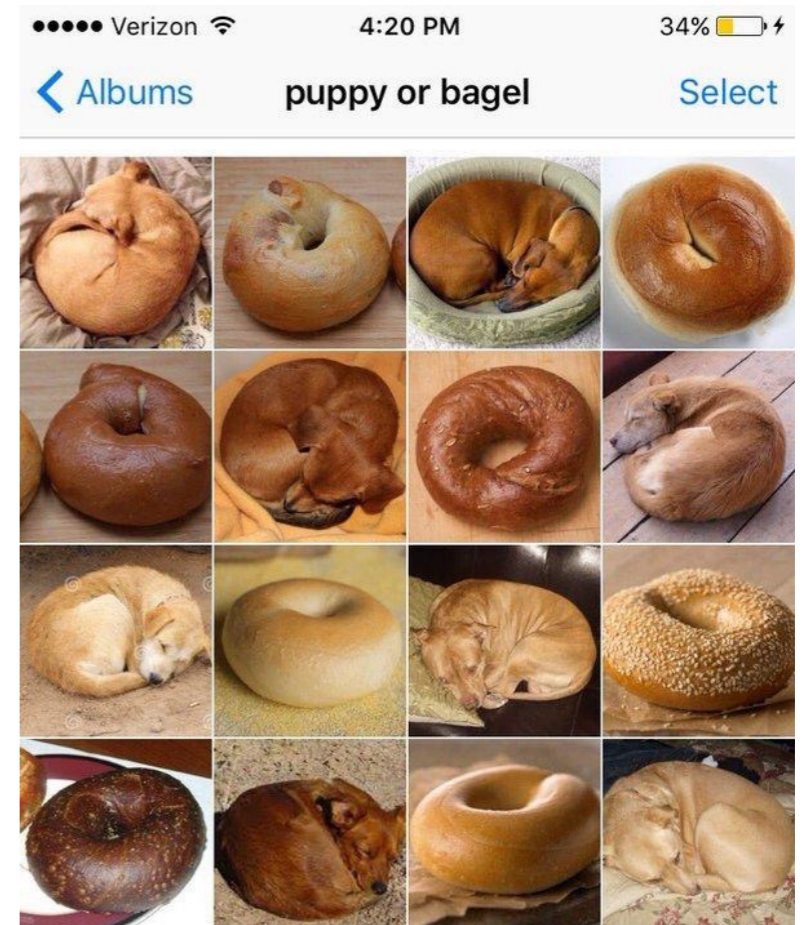
Figure 4: Proportional judgment results (Exp. 1A & B). Top: Cleveland & McGill's [7] lab study. Bottom: MTurk studies. Error bars indicate 95% confidence intervals.

# Aside— Amazon Mechanical Turk

- A platform for paying for and providing Human Intelligence Tasks (HITs)
- HITs are things that humans are good at, but computers are not
- Now, researchers use it to find study participants

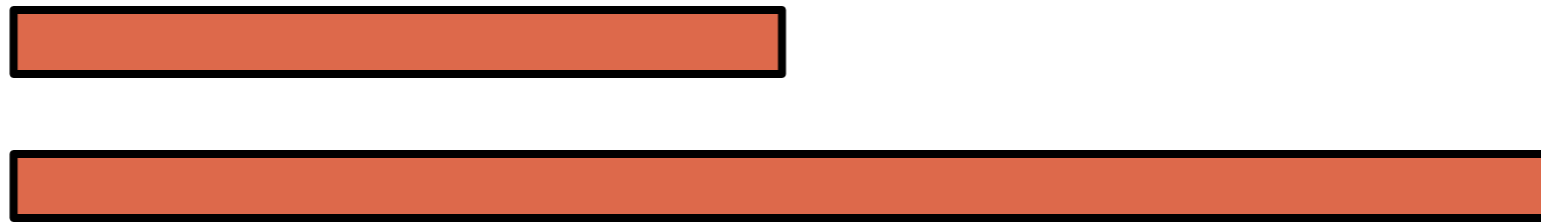


SO MUCH OF "AI" IS JUST FIGURING OUT WAYS TO OFFLOAD WORK ONTO RANDOM STRANGERS.



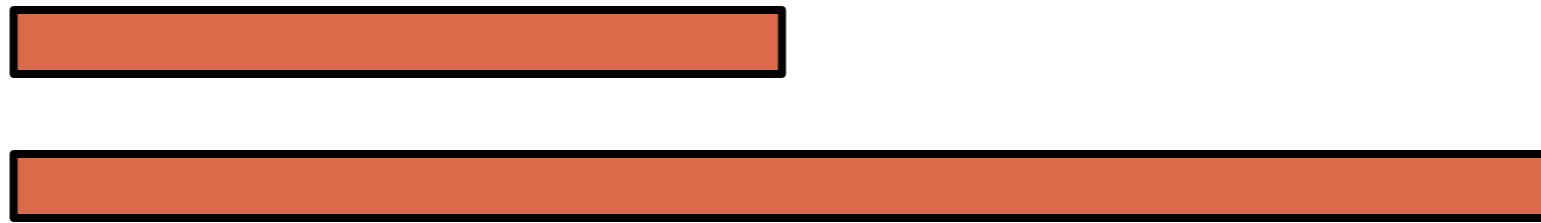
# Magnitude estimation

How much bigger is the lower bar?



# Magnitude estimation

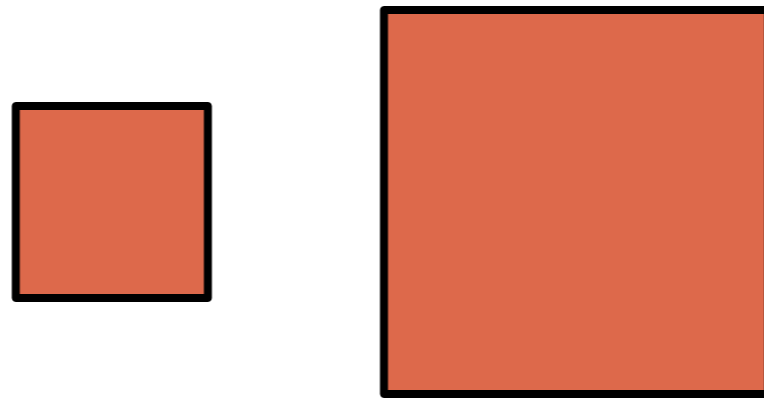
How much bigger is the lower bar?



Answer: 2x

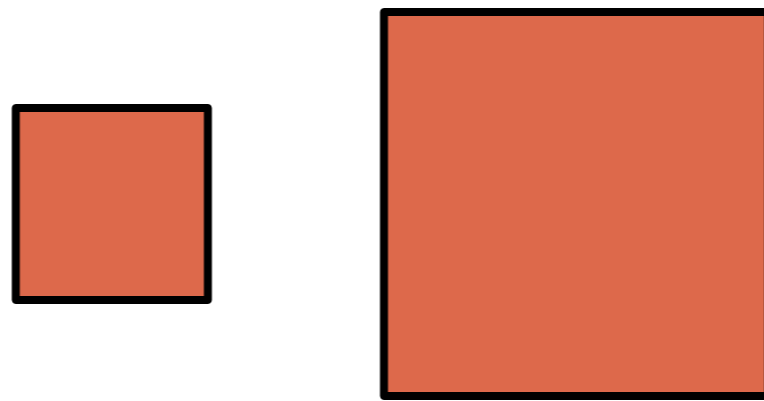
# Magnitude estimation

How much bigger is the right square?



# Magnitude estimation

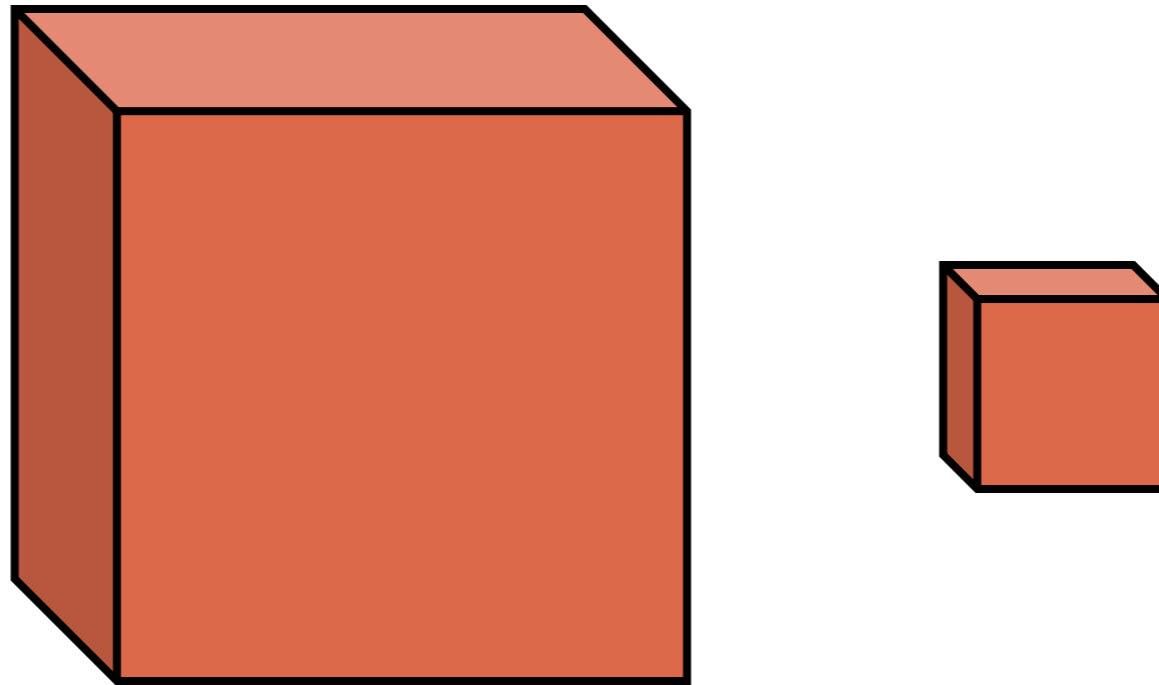
How much bigger is the right square?



Answer:  $4x$

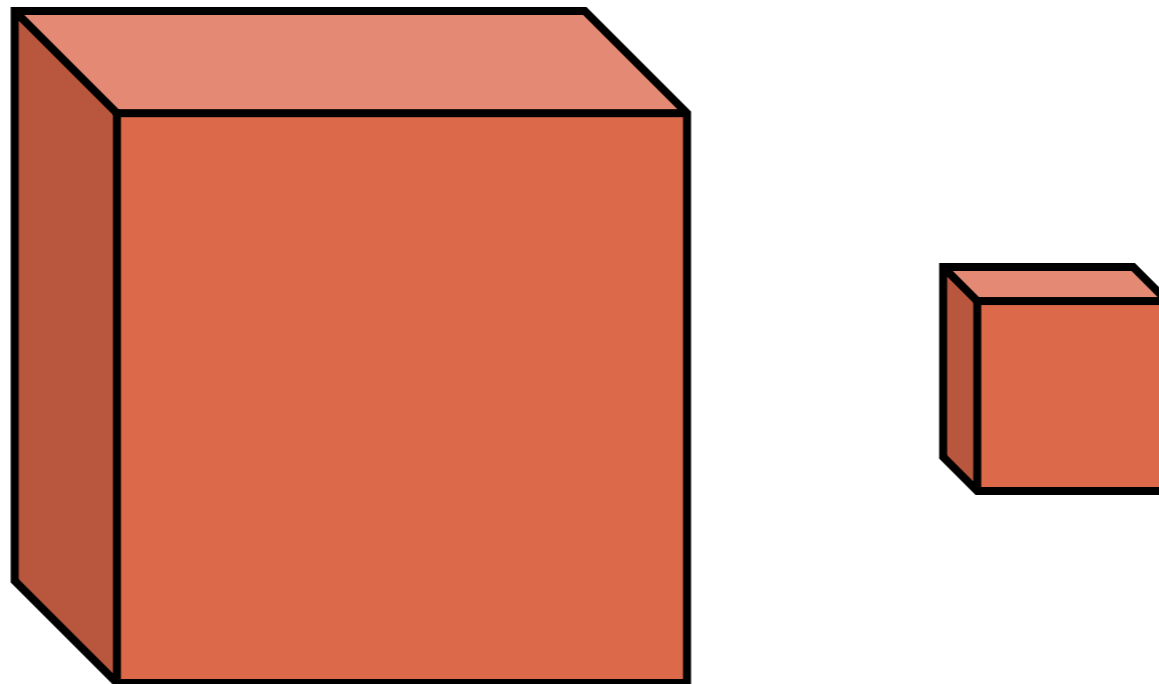
# Magnitude estimation

How much bigger is the left cube?



# Magnitude estimation

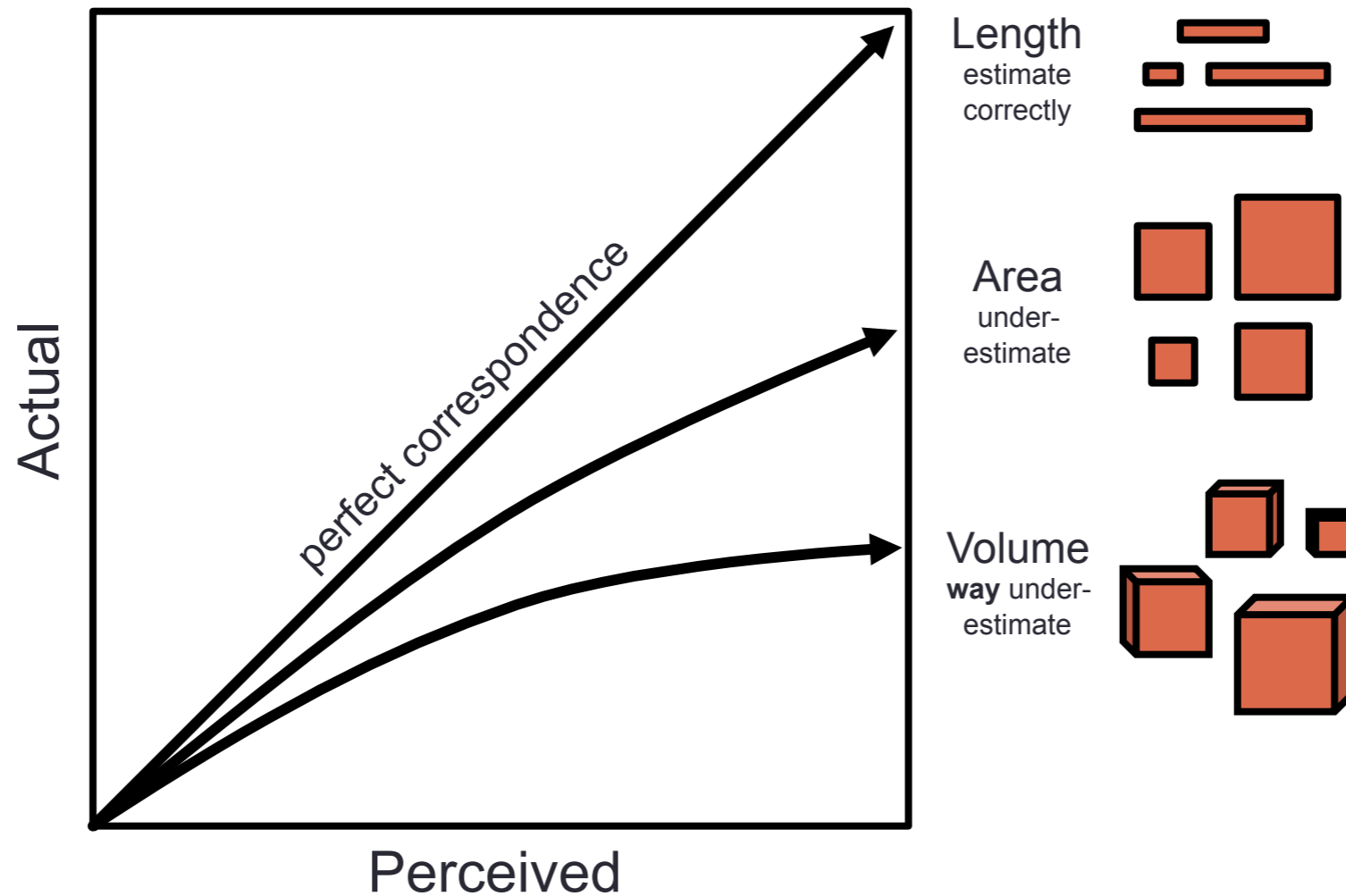
How much bigger is the left cube?



Answer: 27x times



# “Apparent” magnitude



# Weber's law

"Simple differential sensitivity is inversely proportional to the size of the components of the difference; relative differential sensitivity remains the same regardless of size."

$$dp = k \frac{dS}{S} \quad (1)$$

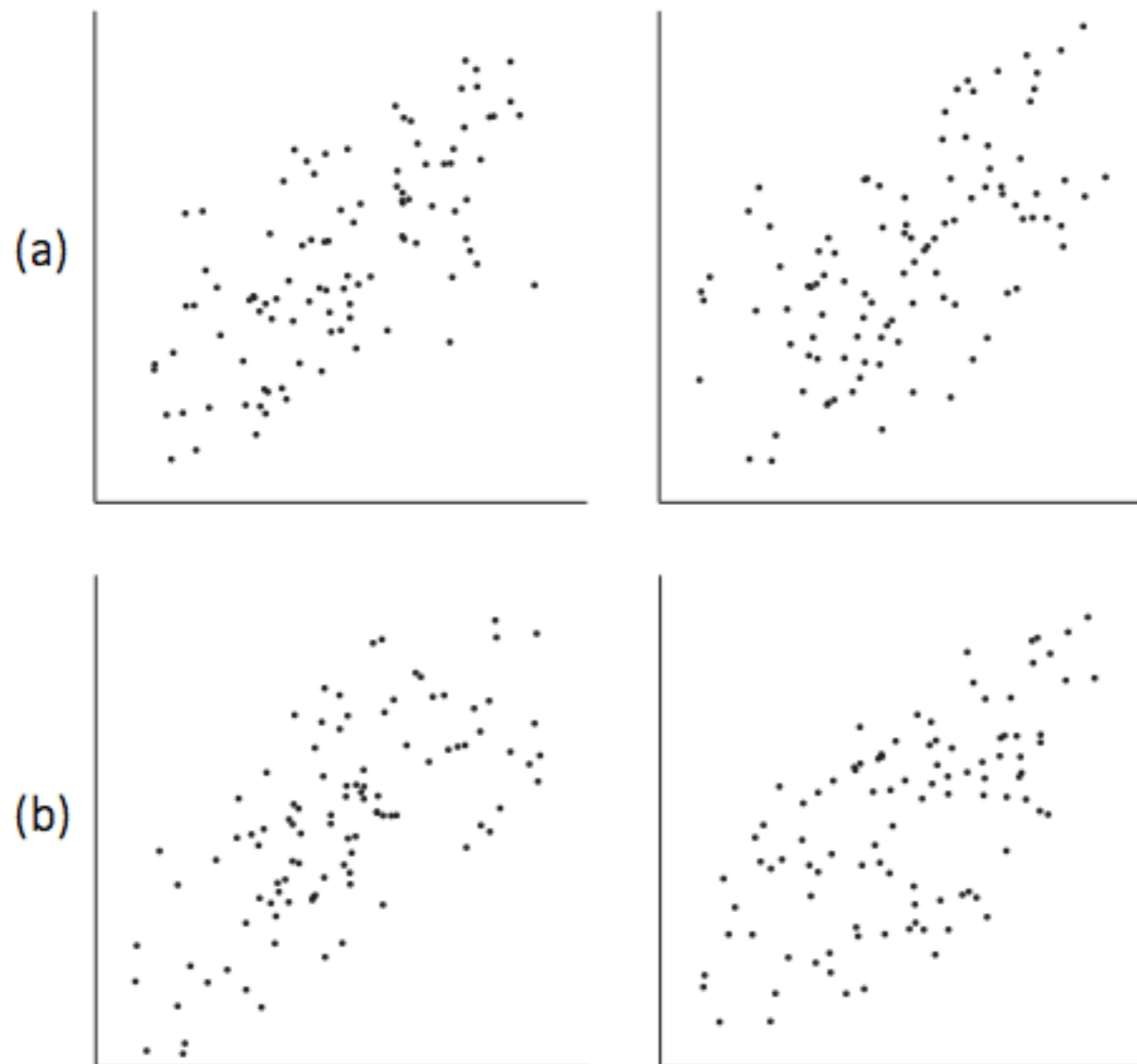
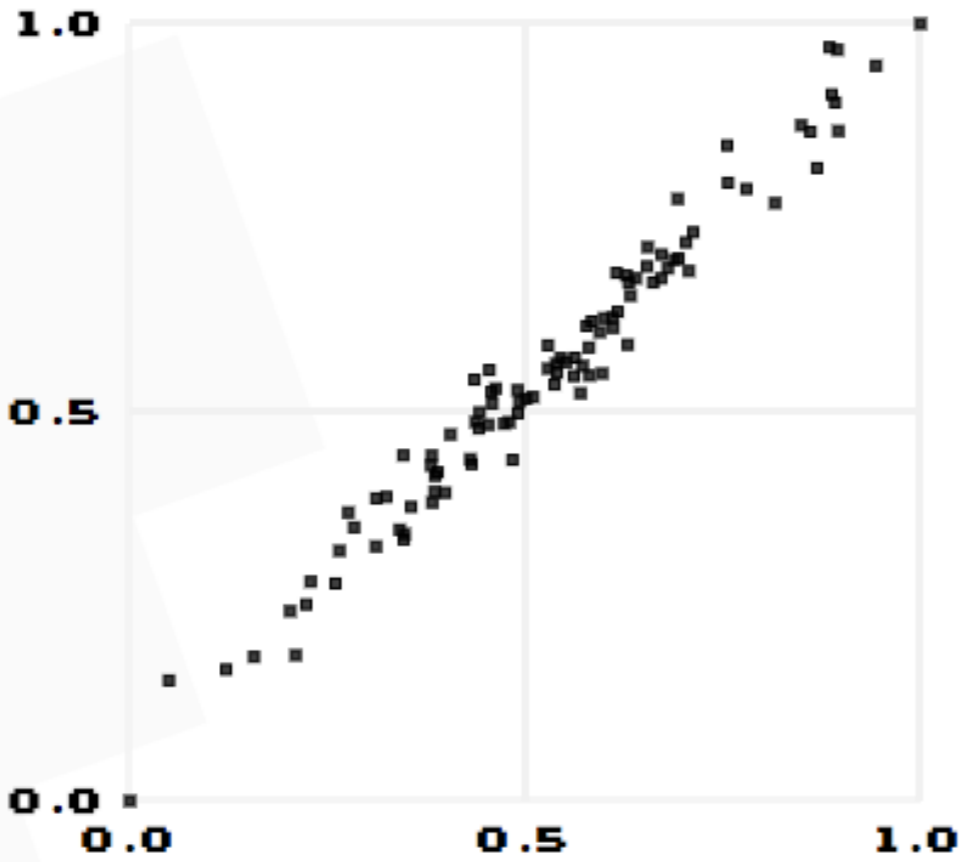


Fig. 1: a) A sample starting comparison from the experiment:  $r = 0.7$  on the left and  $r = 0.6$  on the right. Participants were asked to choose which of the two appeared to be more highly correlated. b) The staircase procedure hones in on the just-noticeable difference by gradually making comparisons more difficult:  $r = 0.7$  on the left and  $r = 0.65$  on the right.



**HIGH SCORE** MAIN MENU  
77

0.  GUESS

STREAKS 0  
MEAN ERROR -

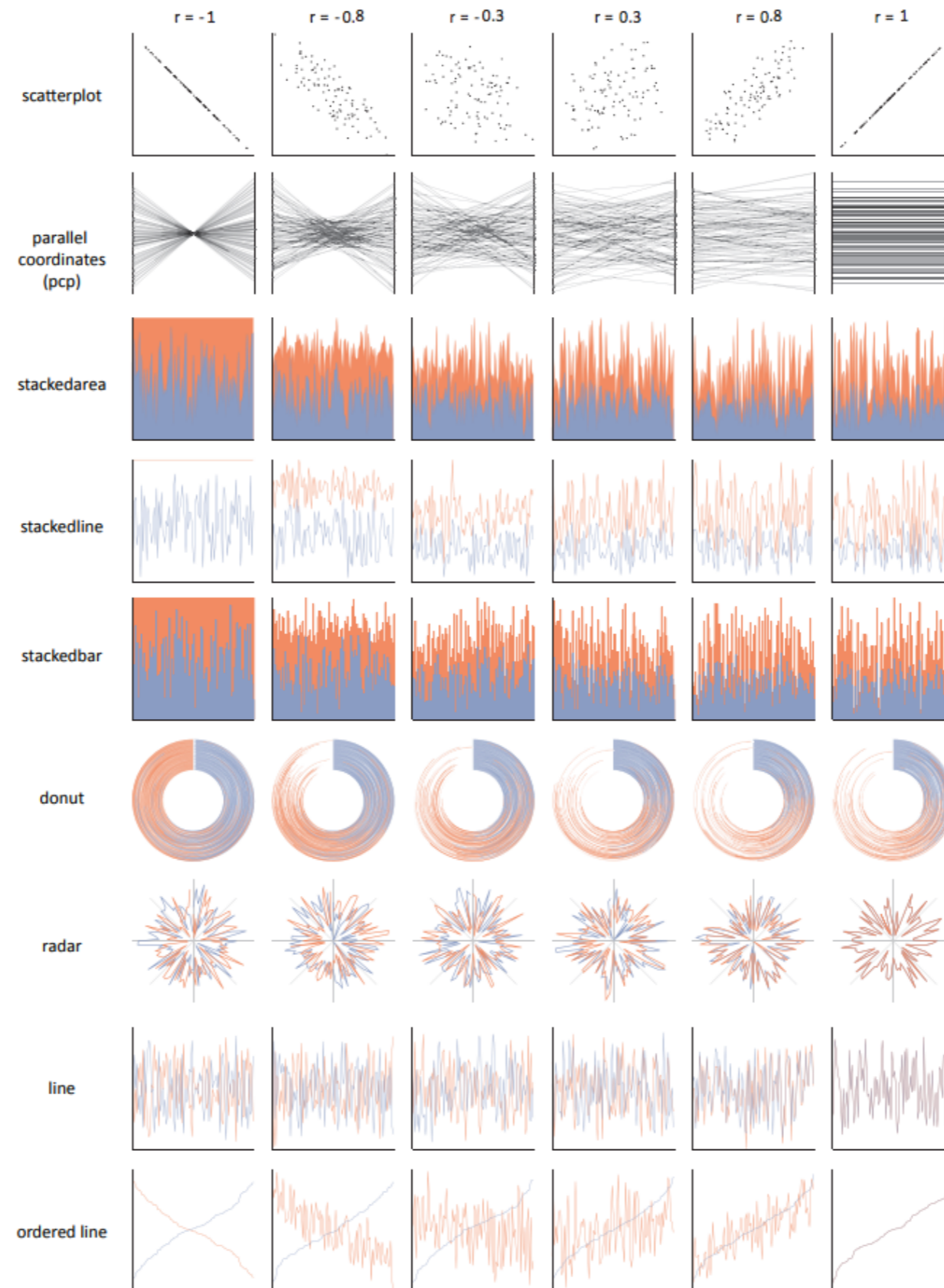
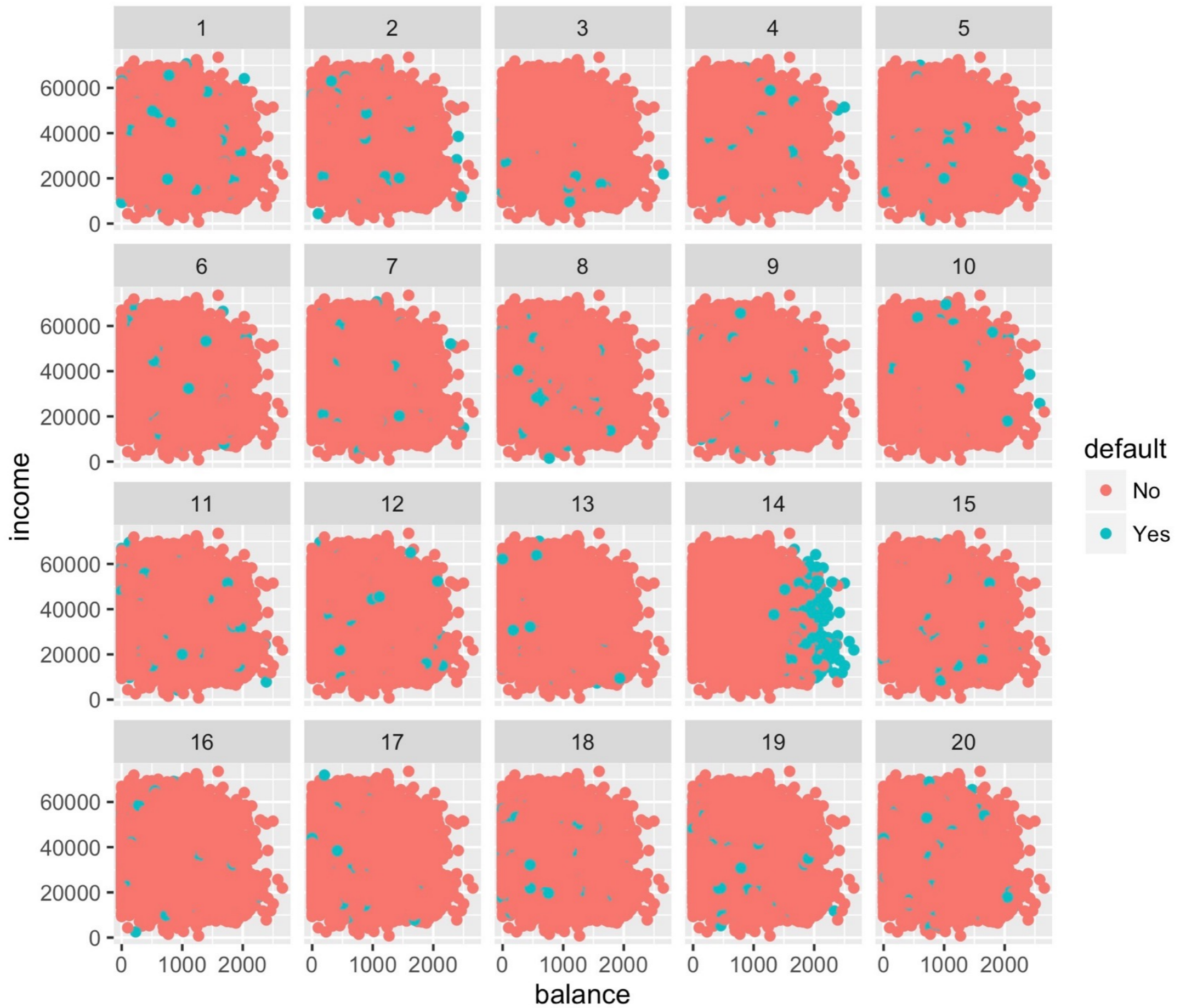


Fig. 3: The nine visualizations tested in our experiment, at several correlation values. Because many of these visualizations appear differently when depicting negatively versus positively correlated data, we test both in our experiment. The visualizations were larger (300×300 pixels) when presented to participants. The color scheme used is colorblind-safe, chosen from ColorBrewer.

# Graphical inference: the lineup





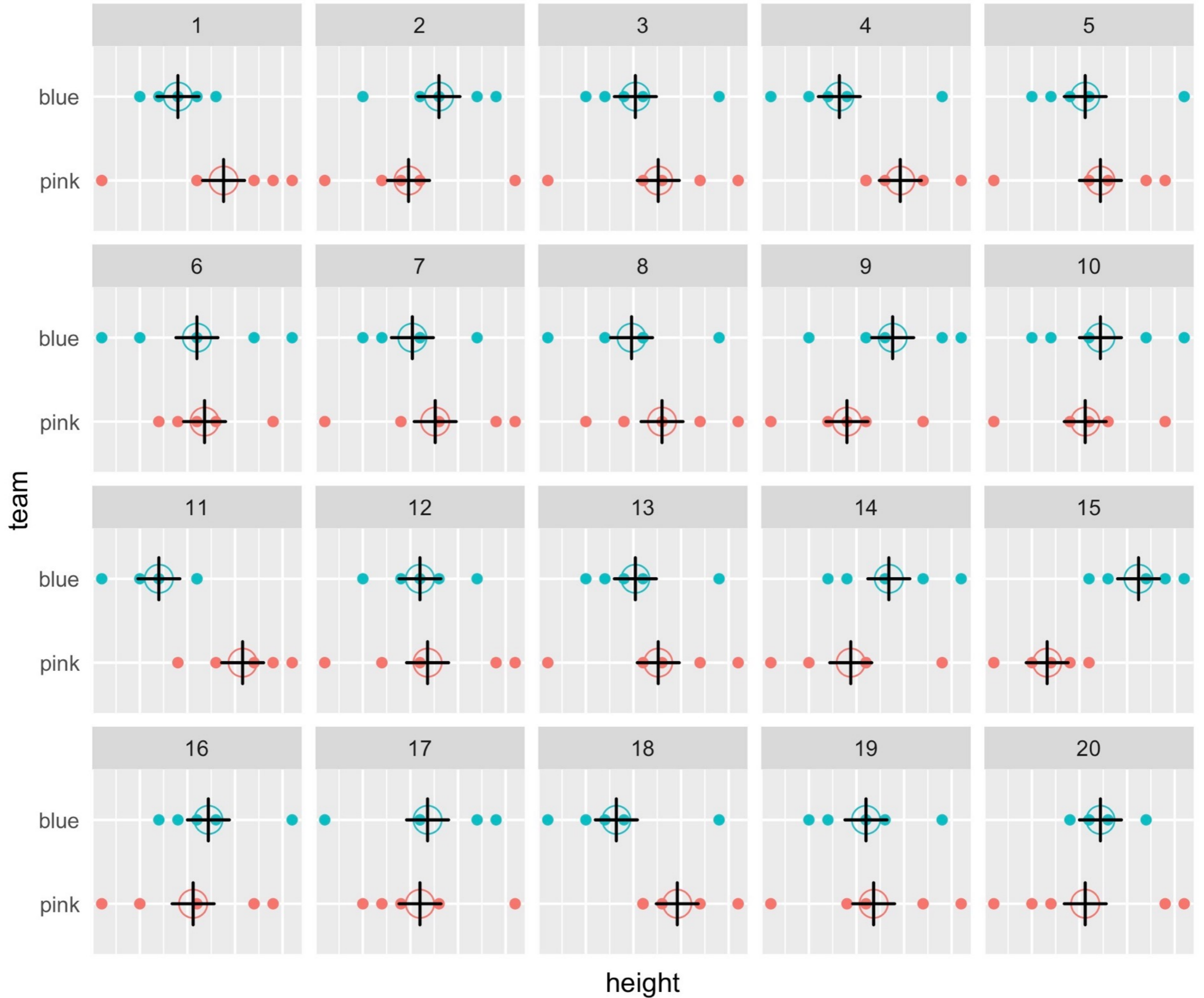
```
library(ggplot2)
ggplot(Default)+
  geom_point(aes(x=balance, y=income, col=default))
```

```
library(nulllabor)
ggplot(lineup(null_permute('default'), Default))+
  geom_point(aes(x=balance, y=income, col=default)) +
  facet_wrap(~.sample)
```

```
decrypt("0lCE bQTQ Aw GWPATAWw d")
```

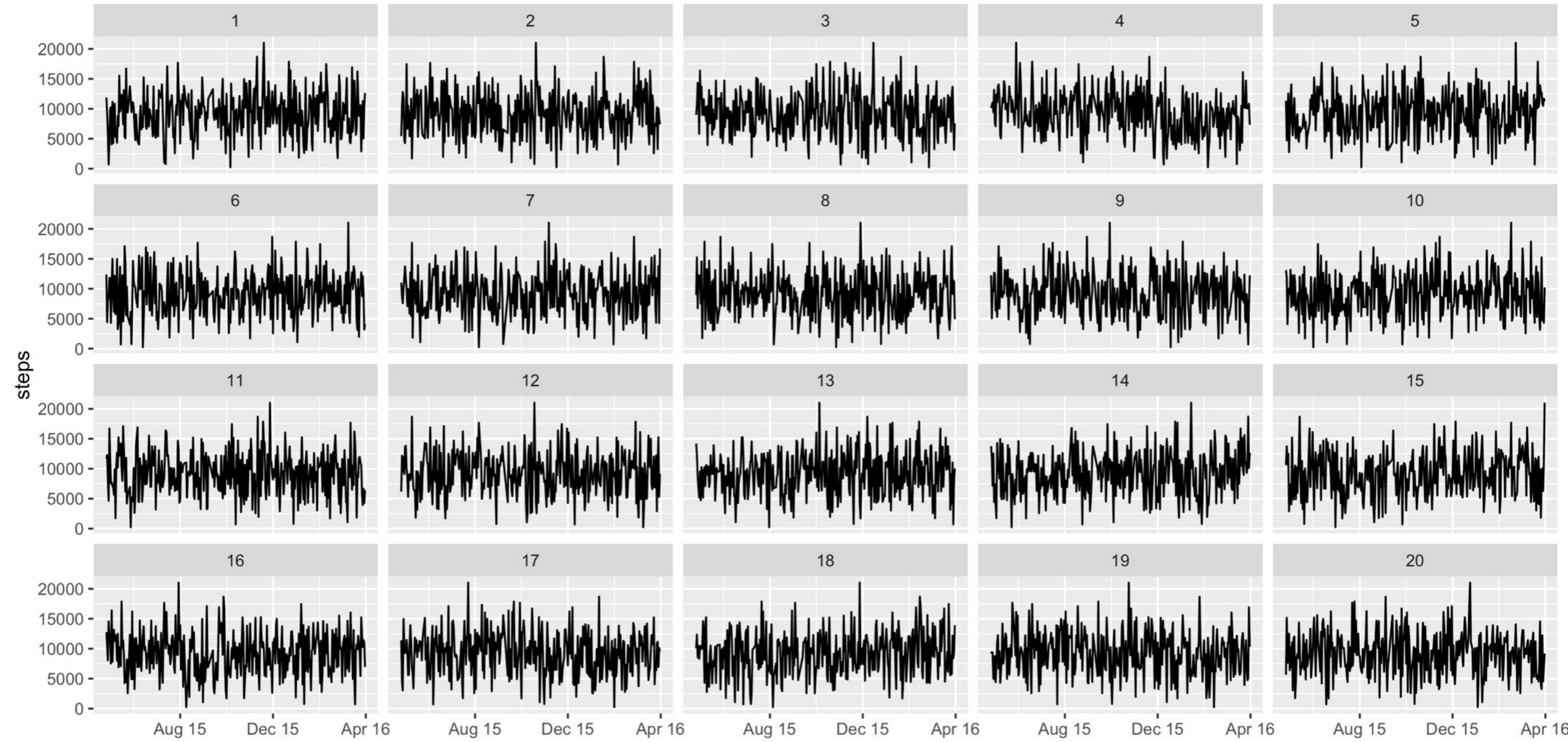
```
[1] "True data in position 14"
```





```
decrypt("0lCE bQTQ Aw GWPATAWw J")
```

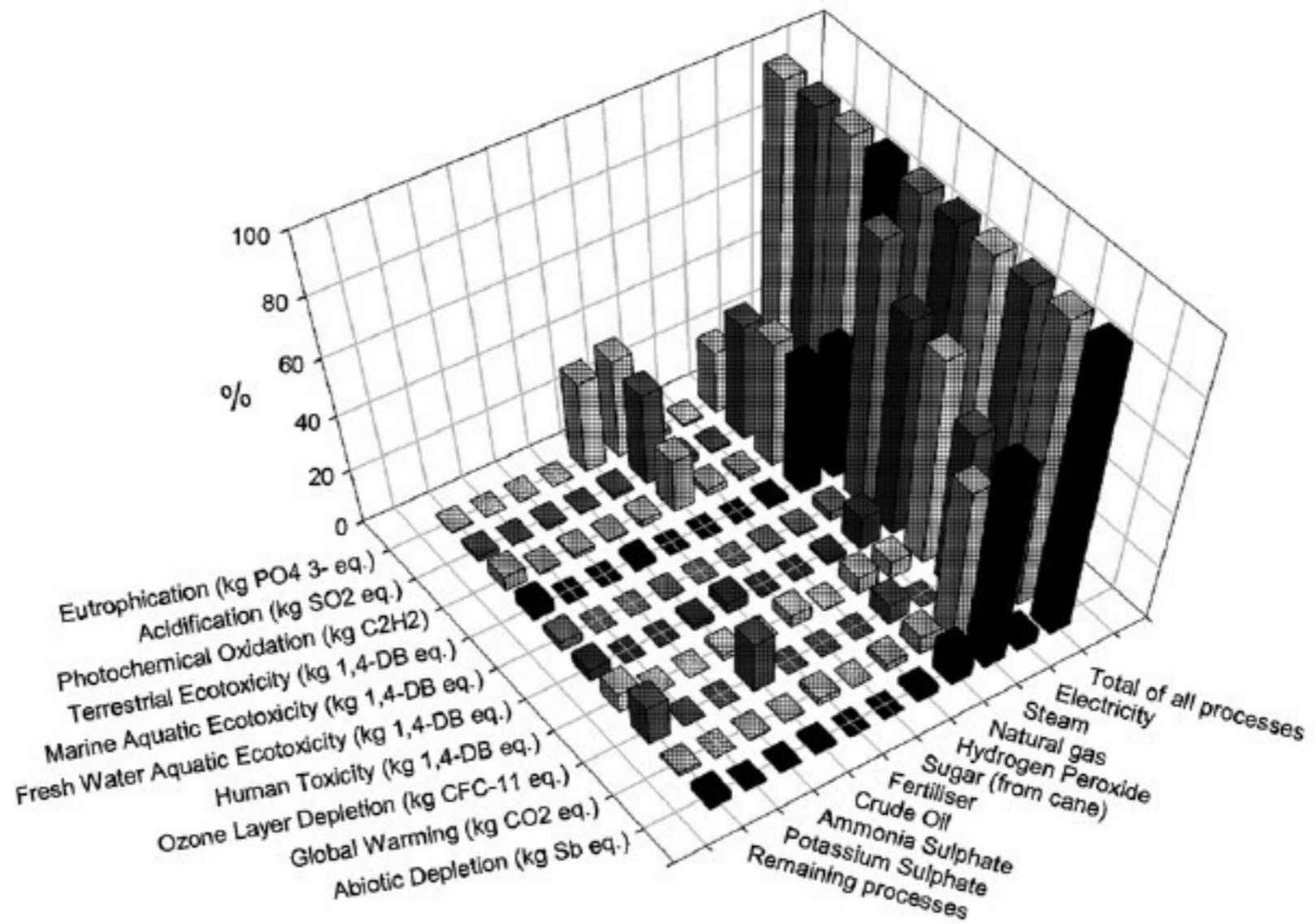
```
[1] "True data in position 5"
```



```
decrypt("01CE bQTQ Aw GWPATAWw y")
```

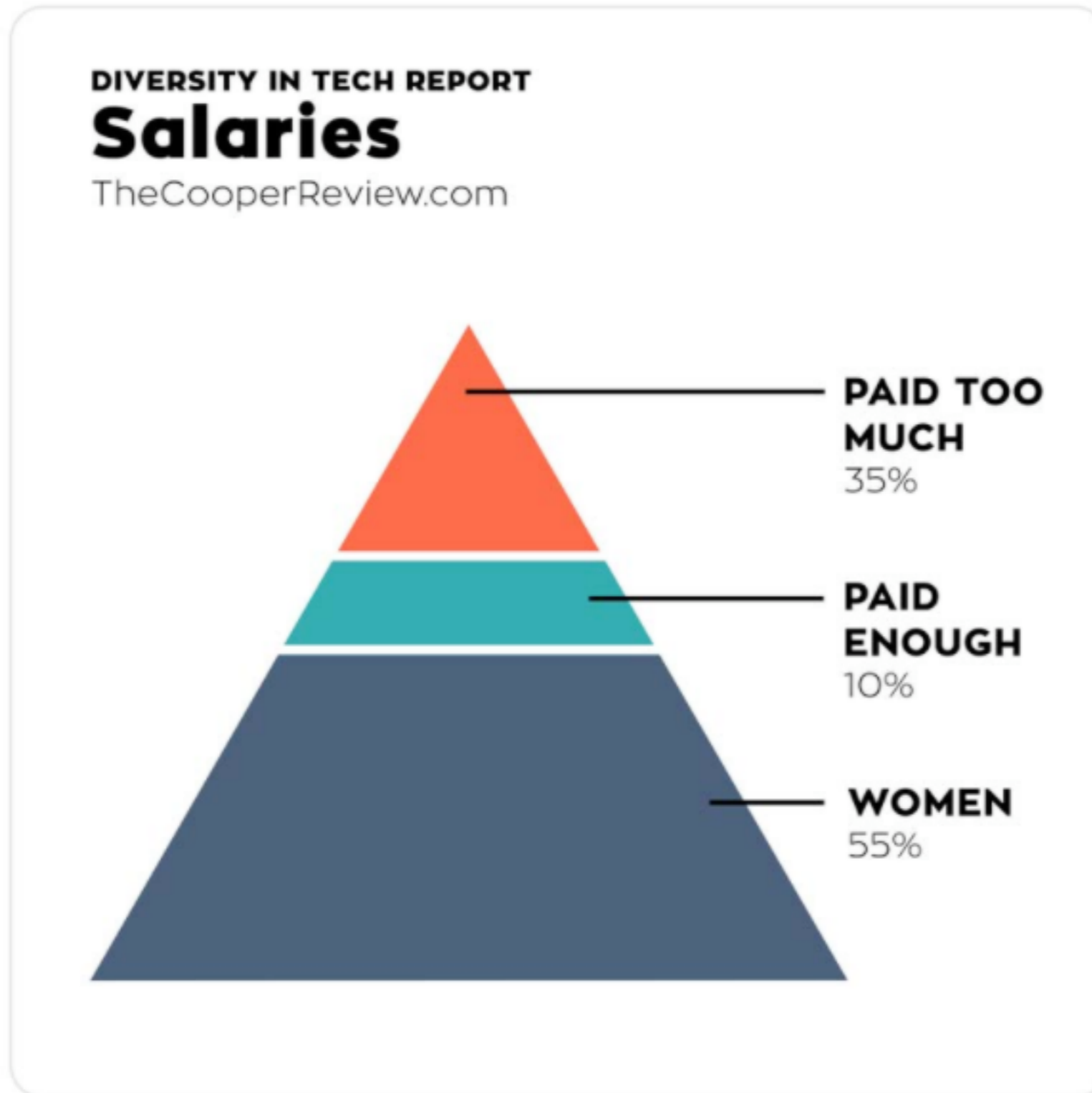
```
[1] "True data in position 4"
```

Activity: apply what we know about graphical perception to the visualizations on <http://viz.wtf/>



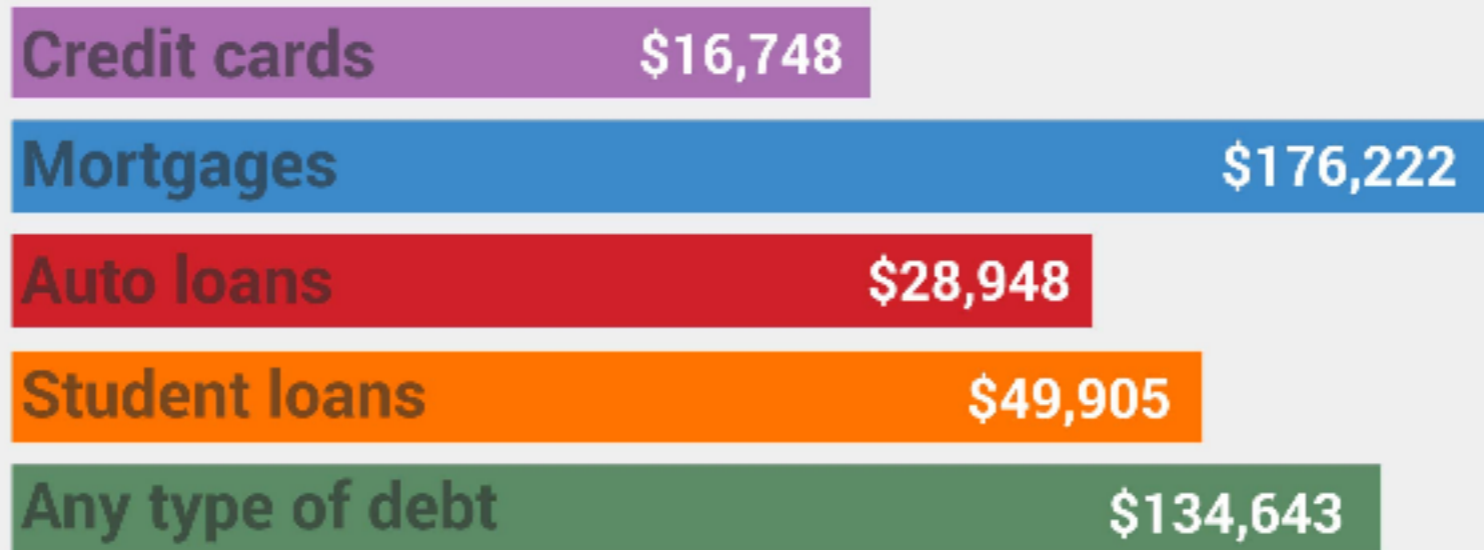
# 7. Salaries

Salaries are also diverse.



# Types of debt

The total owed by the average U.S. household, by debt type.



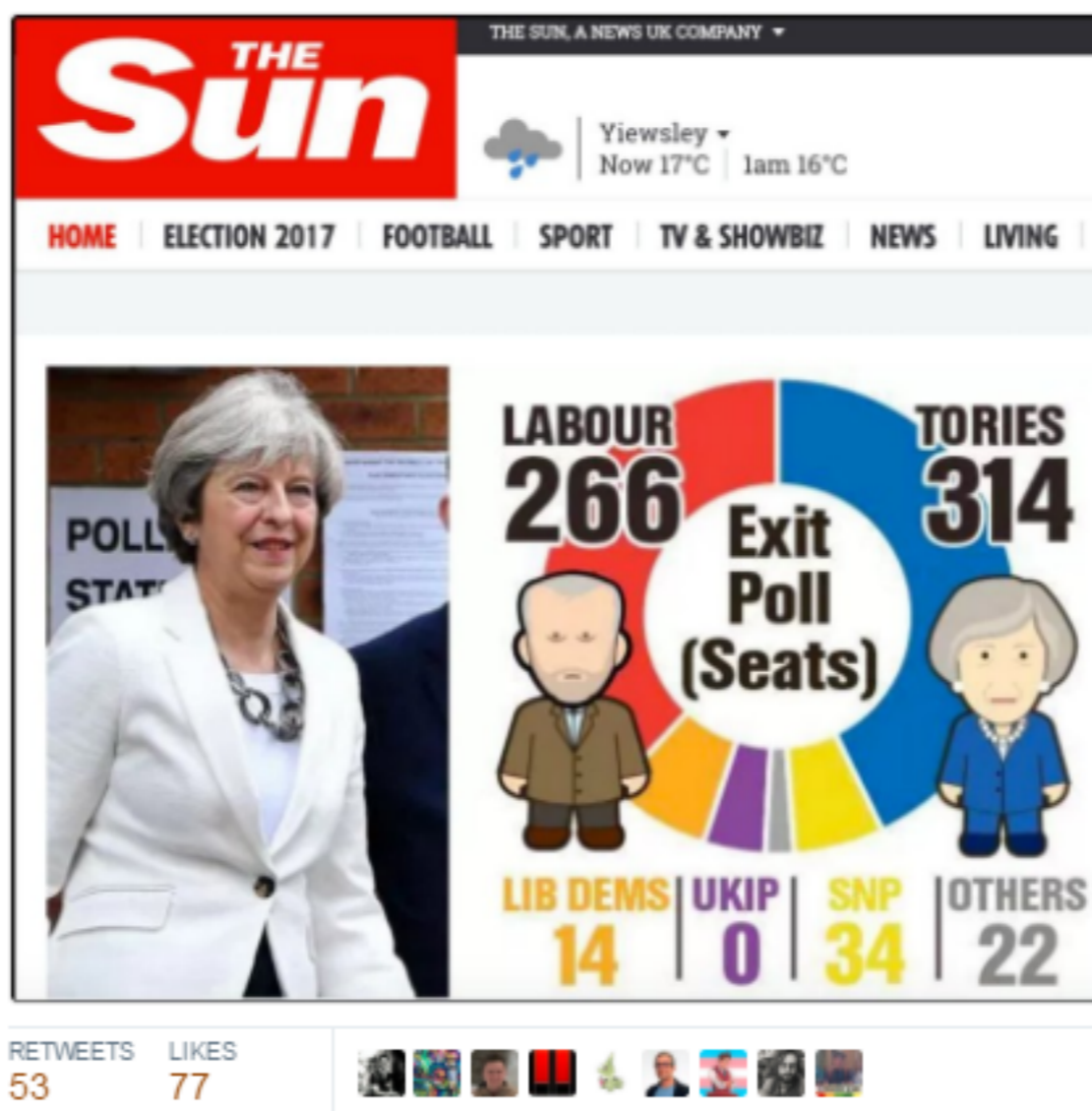




Arieh Kovler  
@ariehkovler

Follow

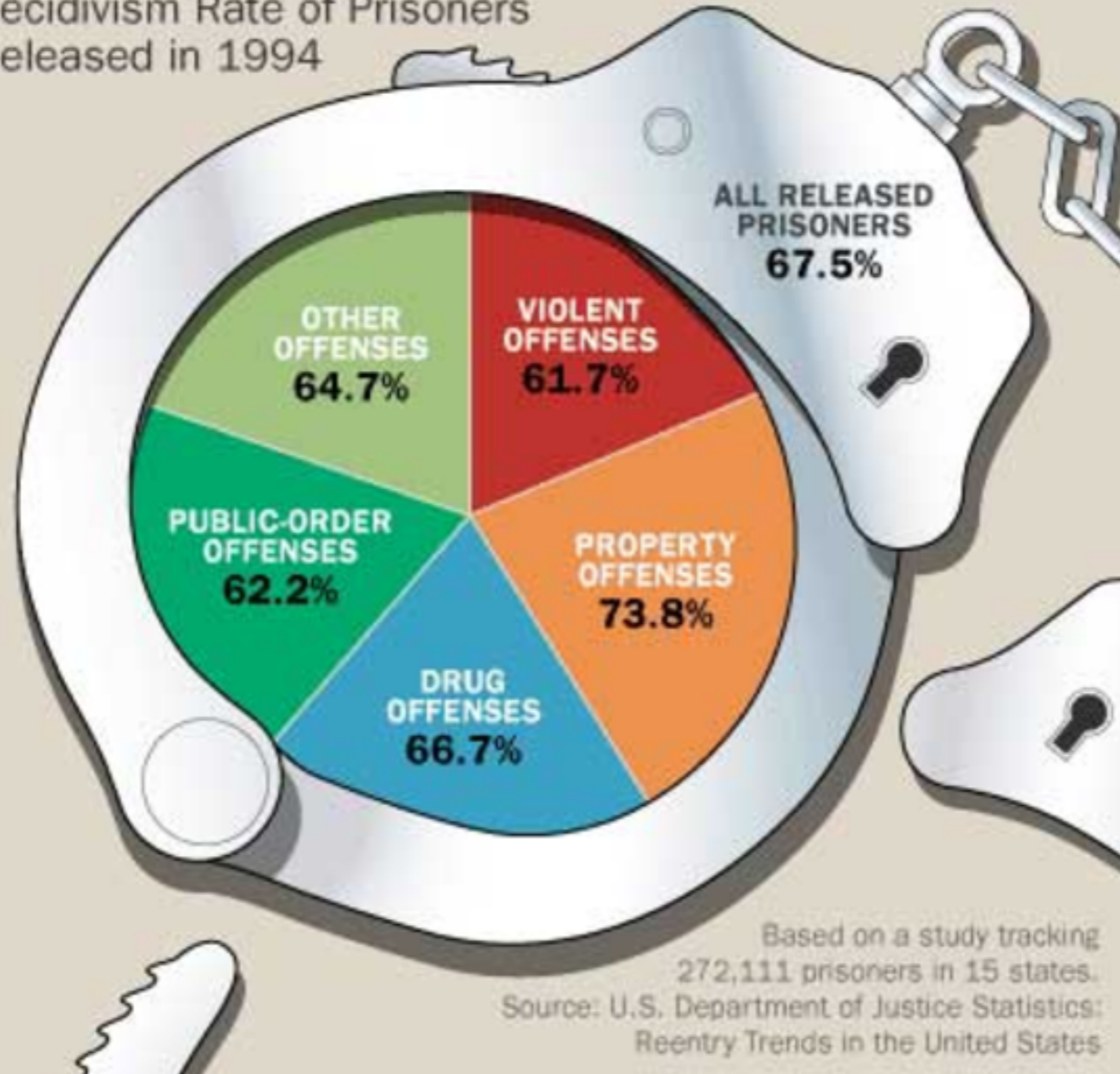
"Is 34 bigger or smaller than 14?"  
"Smaller. Definitely smaller"  
"What about zero?"  
"Zero's a bit less than 34 but it's much more than 22"



# How Prison Works

©2007 HowStuffWorks

Recidivism Rate of Prisoners Released in 1994



# Illinois Spending vs. Job Growth

**State spending increased 66%**



Mt. Everest:  
29,029 feet



**Jobs increased 0.001%**

Molehill: 5.1 inches



\*Change measured from 2000 - 2017

@GovRauner

