

Lecture 2.8 – Basics of Data Visualization

Learning Objectives:

3.6.5 – Understand the importance of attention and accessibility to communicating ideas.

3.6.6 – Understand the importance of ethical presentation of data through visualization.

Converting Data to Understanding

Data

Mapping

Aesthetic attributes

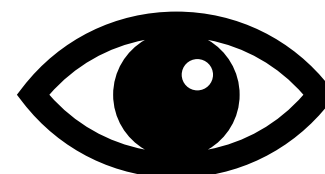
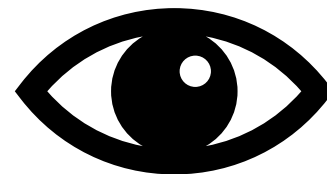
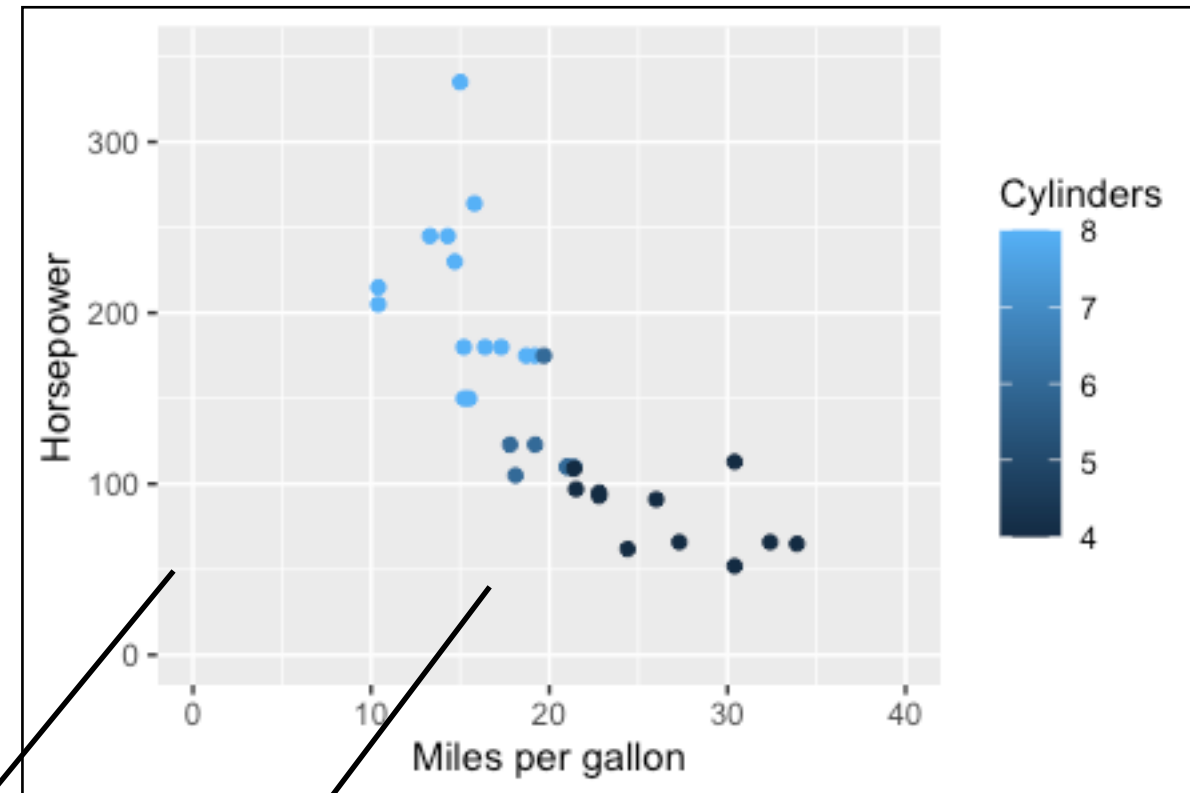
Geometric object

| | mpg | cyl | disp | hp |
|-------------------|------|-----|-------|-----|
| Mazda RX4 | 21.0 | 6 | 160.0 | 110 |
| Mazda RX4 Wag | 21.0 | 6 | 160.0 | 110 |
| Datsun 710 | 22.8 | 4 | 108.0 | 93 |
| Hornet 4 Drive | 21.4 | 6 | 258.0 | 110 |
| Hornet Sportabout | 18.7 | 8 | 360.0 | 175 |
| Valiant | 18.1 | 6 | 225.0 | 105 |
| Duster 360 | 14.3 | 8 | 360.0 | 245 |
| Merc 240D | 24.4 | 4 | 146.7 | 62 |
| Merc 230 | 22.8 | 4 | 140.8 | 95 |

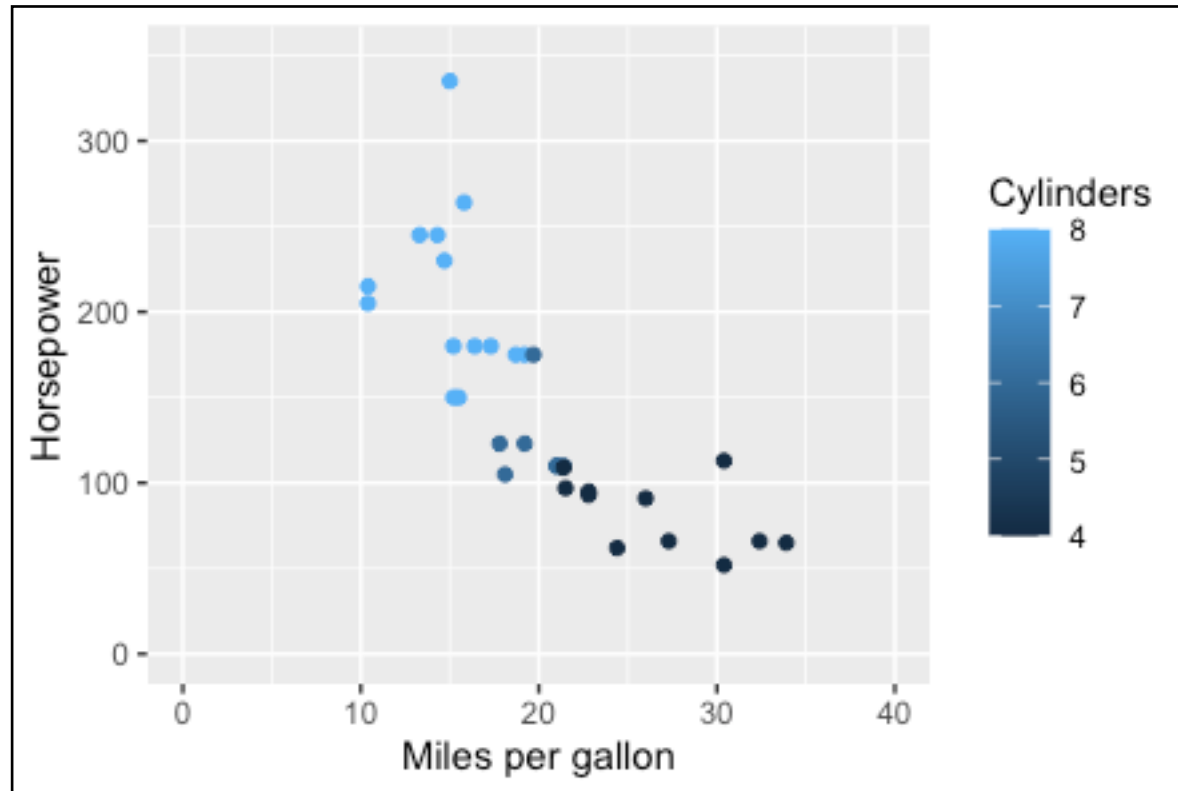
x

y

color/fill



Converting Data to Understanding



1. Using guides to orient the viewer to the chart accurately.
2. Representing data faithfully (and not misleading your viewer)
3. Maximizing clarity and understanding using what we know about visual perception and processing

Converting Data to Understanding

Data

Mapping

Aesthetic attributes

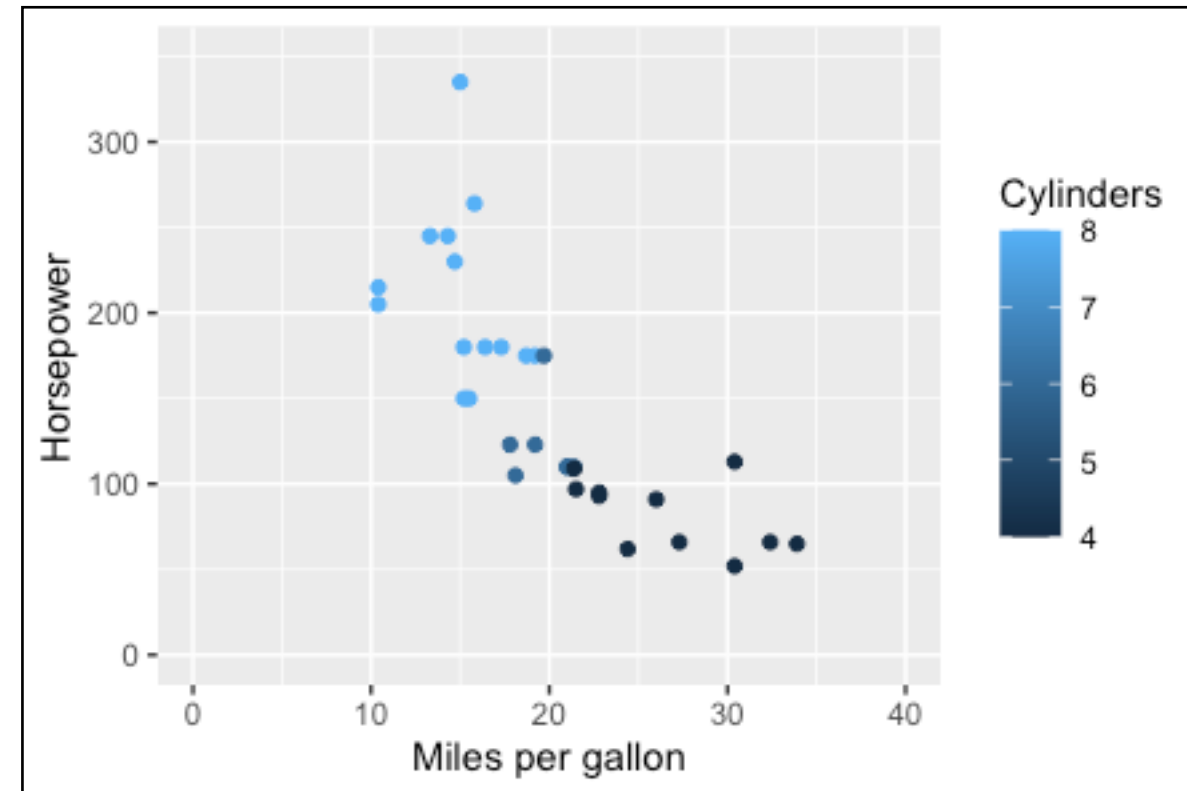
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x

y

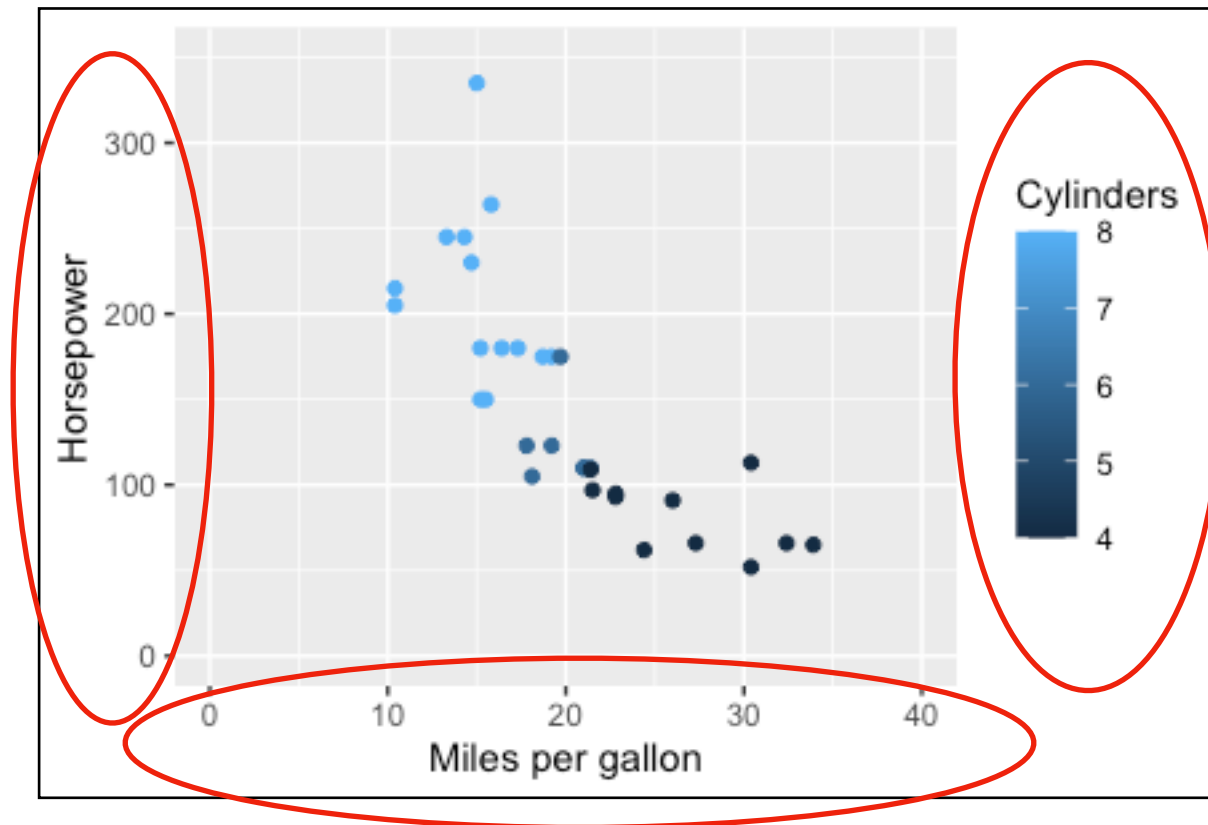
color/fill



- Get the basics right! Make sure your audience can map elements back to the data using guides!

Visualization Guides

- Guides include any element that helps the viewer map elements back to data.



- Axis labels
- Legends
- Scales
- Guide lines
- Figure captions

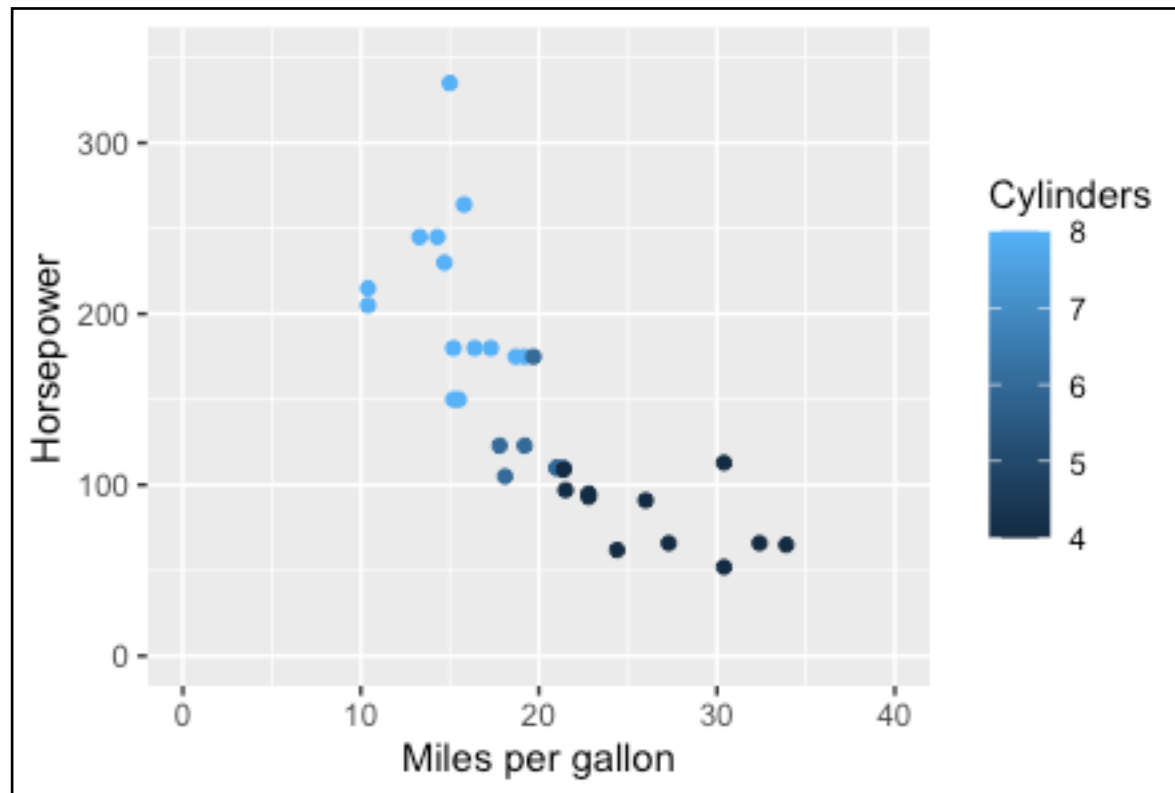
Make sure they are accessible!

- Guides should be easy to read, clear, and descriptive, containing units where appropriate.

Make sure your guides are descriptive enough that a naïve viewer will understand what the elements represent!

Converting Data to Understanding

The Good, The Bad, The Wrong, and The Ugly



1. Using guides to orient the viewer to the chart accurately.

2. Representing data faithfully (and not misleading your viewer)

3. Maximizing clarity and accessibility using what we know about visual perception and processing

The Good, The Bad, The Wrong, and The Ugly

- **Wrong:** graphs that have problems related to math or scaling, figures that mislead or are deceiving.
 - Figures could be misleading on purpose (deception) or by accident.
 - Unacceptable everywhere and all the time.
 - **First and foremost: you must NOT mislead your viewers!**
 - If your results are so weak you need to resort to deception or near deception, just admit it's not that strong of a conclusion.
- **Bad:** graphs that have problems related to perceptual issues, unclear or confusing, or overly complicated.
 - Unacceptable in this class, you can do better!
- **Ugly:** graphs that are clear and informative but have aesthetic problems (like, it's just ugly).
 - These are not great but acceptable. (I would rather have an honest and ugly graphic than a beautiful but deceiving graphic.)
 - Acceptable but can be improved

WRONG



James Hamblin

@jameshamblin

Fox added a "%" where it doesn't belong, decreasing fatality by 100x. Based on the CDC data it's not that .054% of people over 70 don't survive COVID. It's 5.4%.



Zeducation @RealZeducation · Sep 25

Just a reminder that everything in 2020 was over a virus that does this:



- Problems with math.

6:49 PM · Sep 26, 2020 · Twitter for iPhone

594 Retweets 25 Quote Tweets 1.9K Likes

BAD/ WRONG

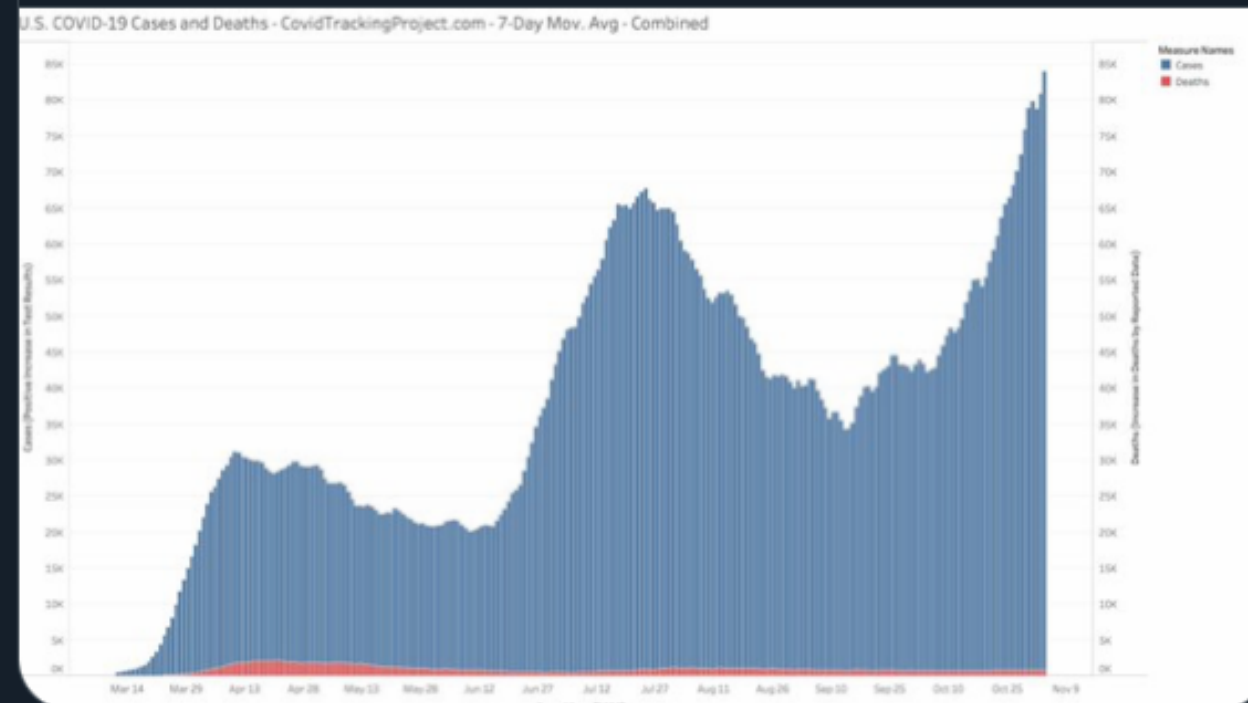


Nicole Radziwill @nicoleradzi... · 18m ...
this is a great example of why it's typically pretty bad to use double y-axes on the same grid, especially when the "tiny" thing has a comparatively huge impact



Scott W. Atlas ✓ @SWAtl... · 33m

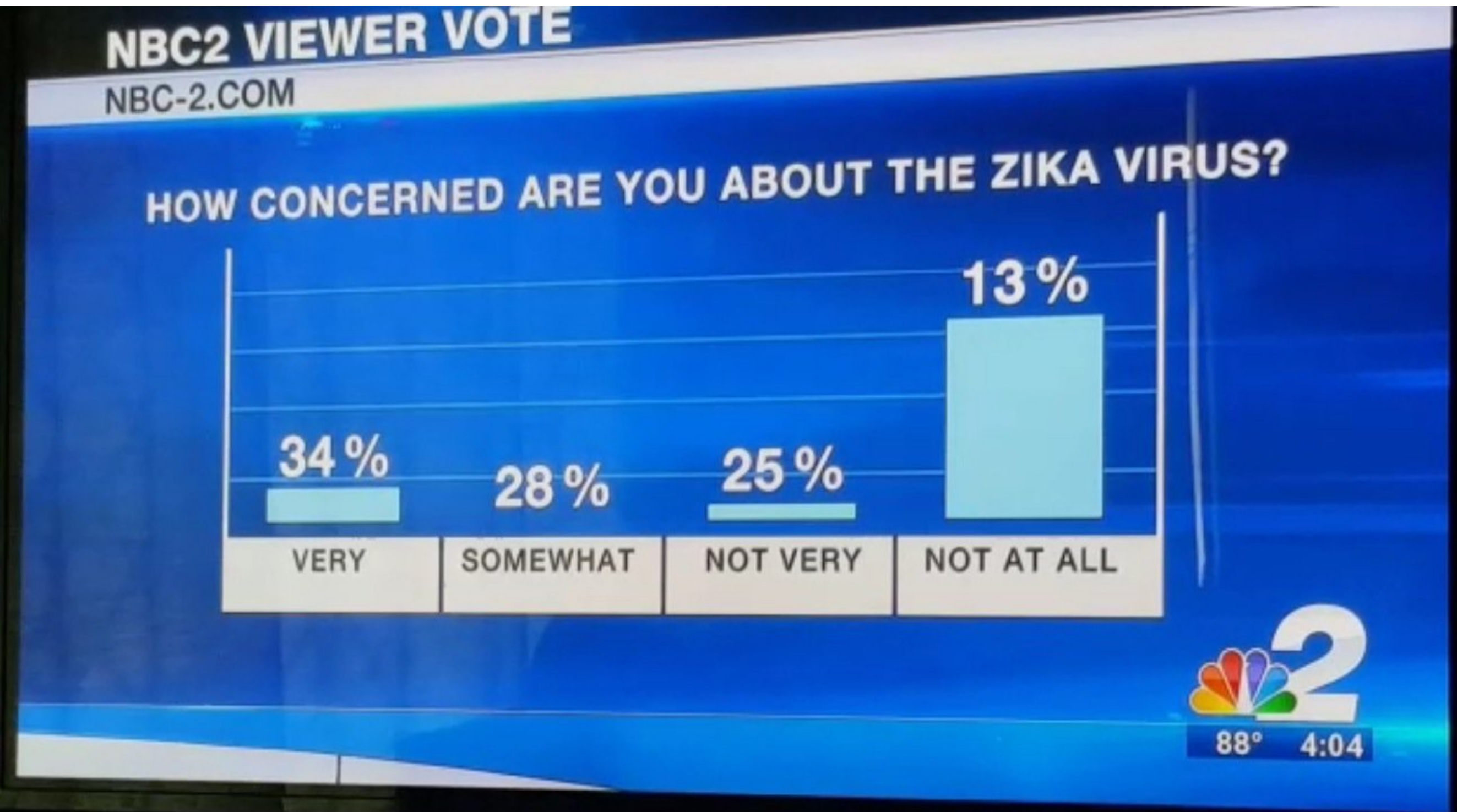
Anticipating hate because this is fact, not opinion, but ... Cases (blue) and deaths (bottom red) #FactsMatter #Perspective



- Misleading axis scaling.

WRONG

- Numbers don't match size of bars.

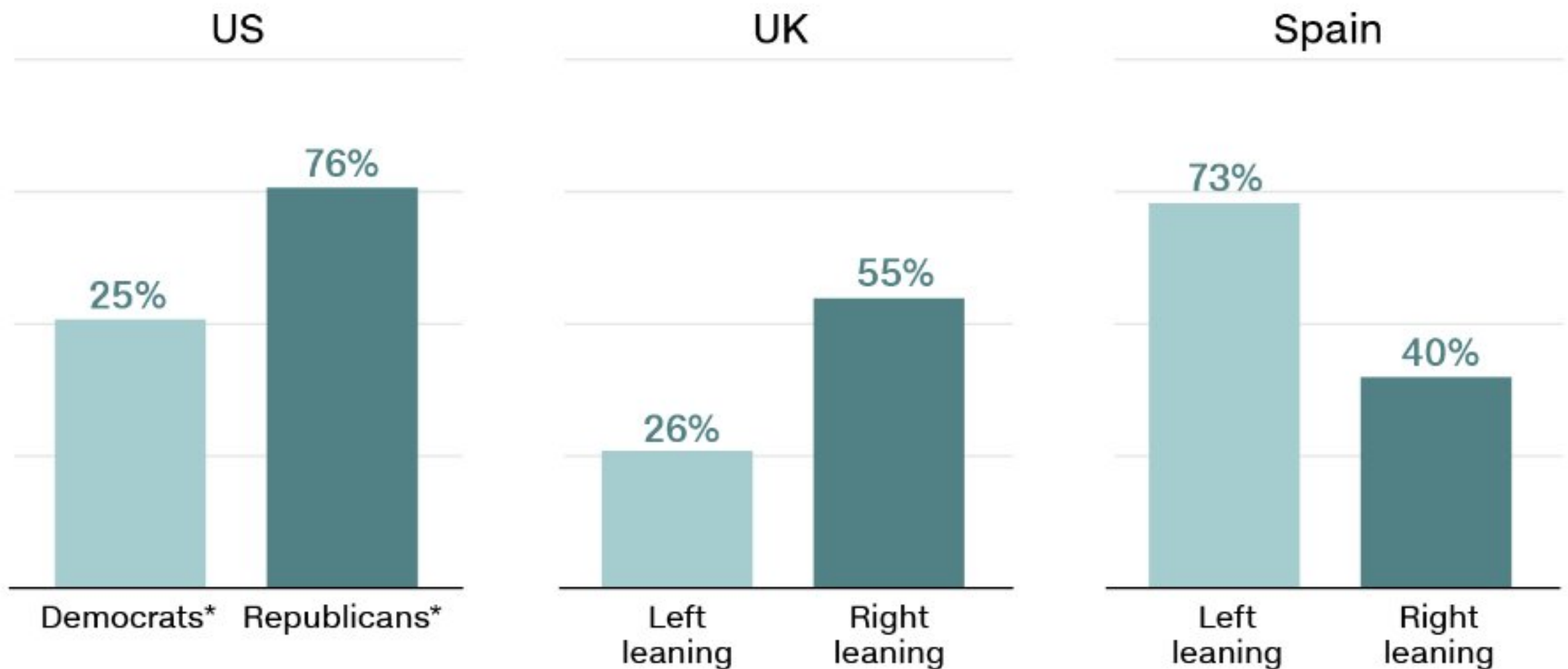


Seriously, wtf?

BAD

- Floating, unlabeled y axis, misleading.

People are more likely to say their government has done well if they are on the government's side of the political spectrum.



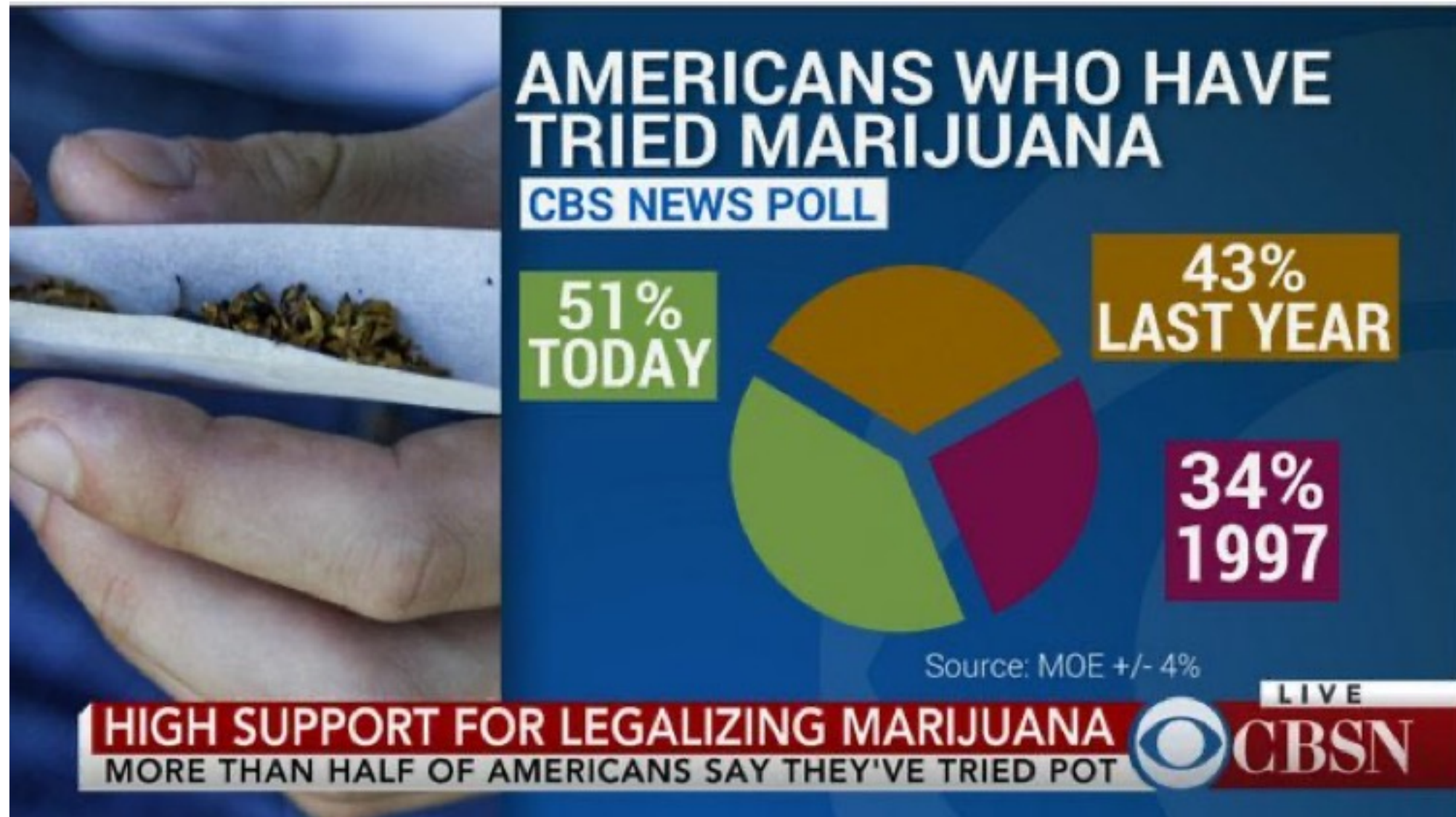
* Include Democrat- and Republican-leaning independents.



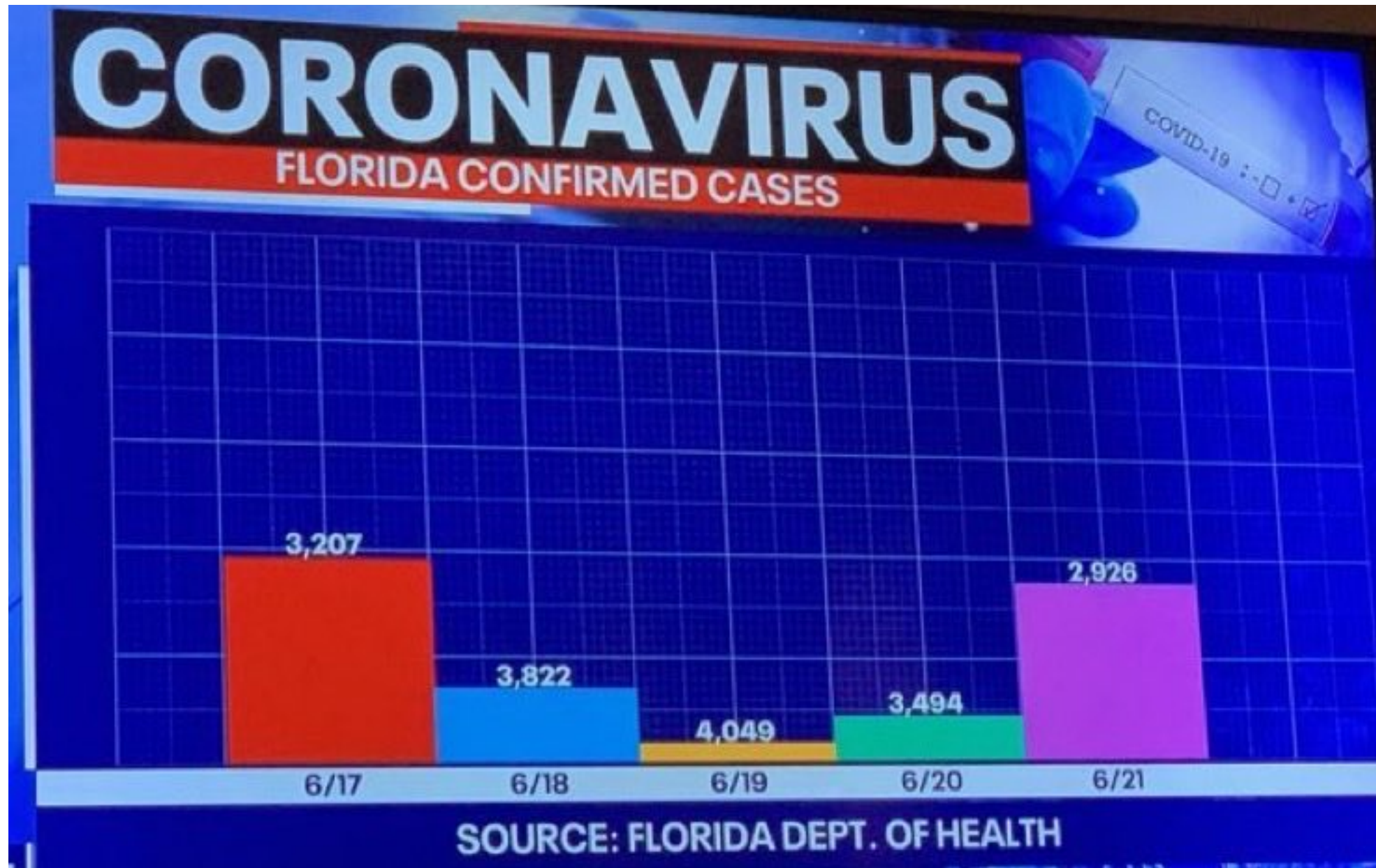
Source: Pew Research Center "Most Approve of National Response to COVID-19 in 14 Advanced Economies"
Survey carried out between June 10 and August 3, 2020. Audit size: 14,276 across the 14 countries surveyed.
Margins of error for all respondents in these countries: Spain ($\pm 4.1\%$), UK ($\pm 4.1\%$) and US ($\pm 3.7\%$).
Graphic: Henrik Pettersson, CNN

BAD

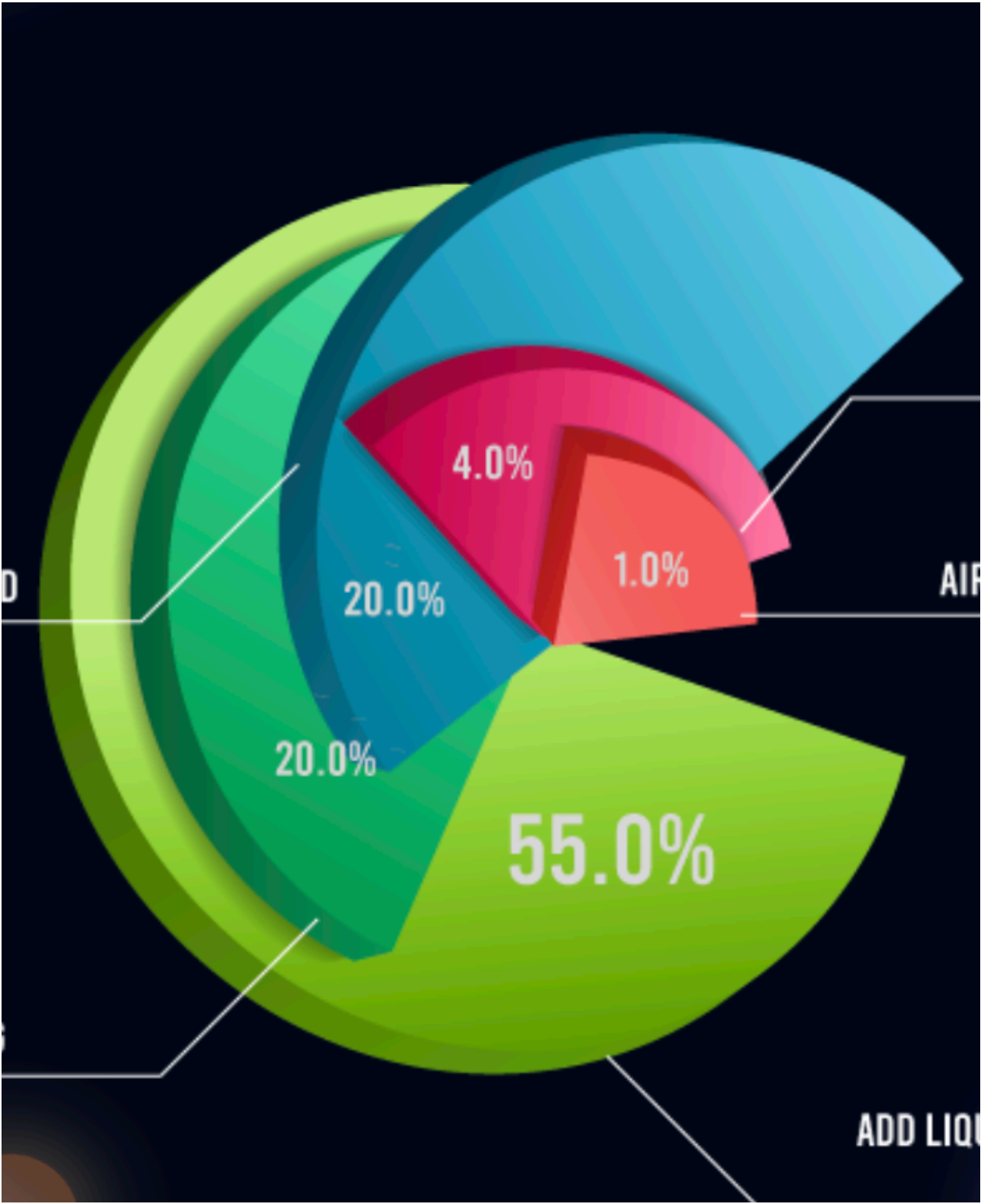
- Wrong chart type for data. (lolwut)



WRONG

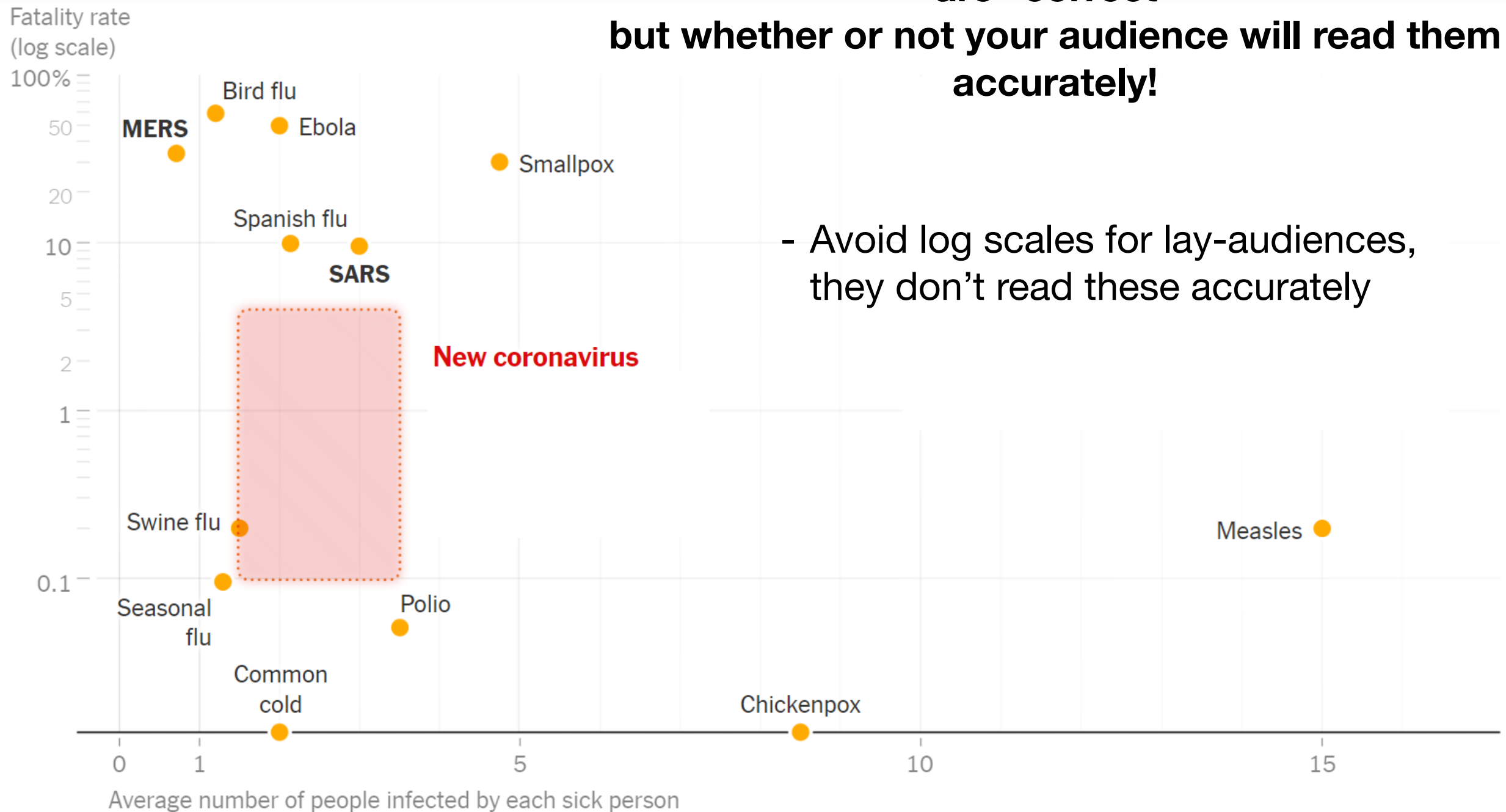


PLEASE STOP



BAD

You MUST take into account not only that things are “correct” but whether or not your audience will read them accurately!



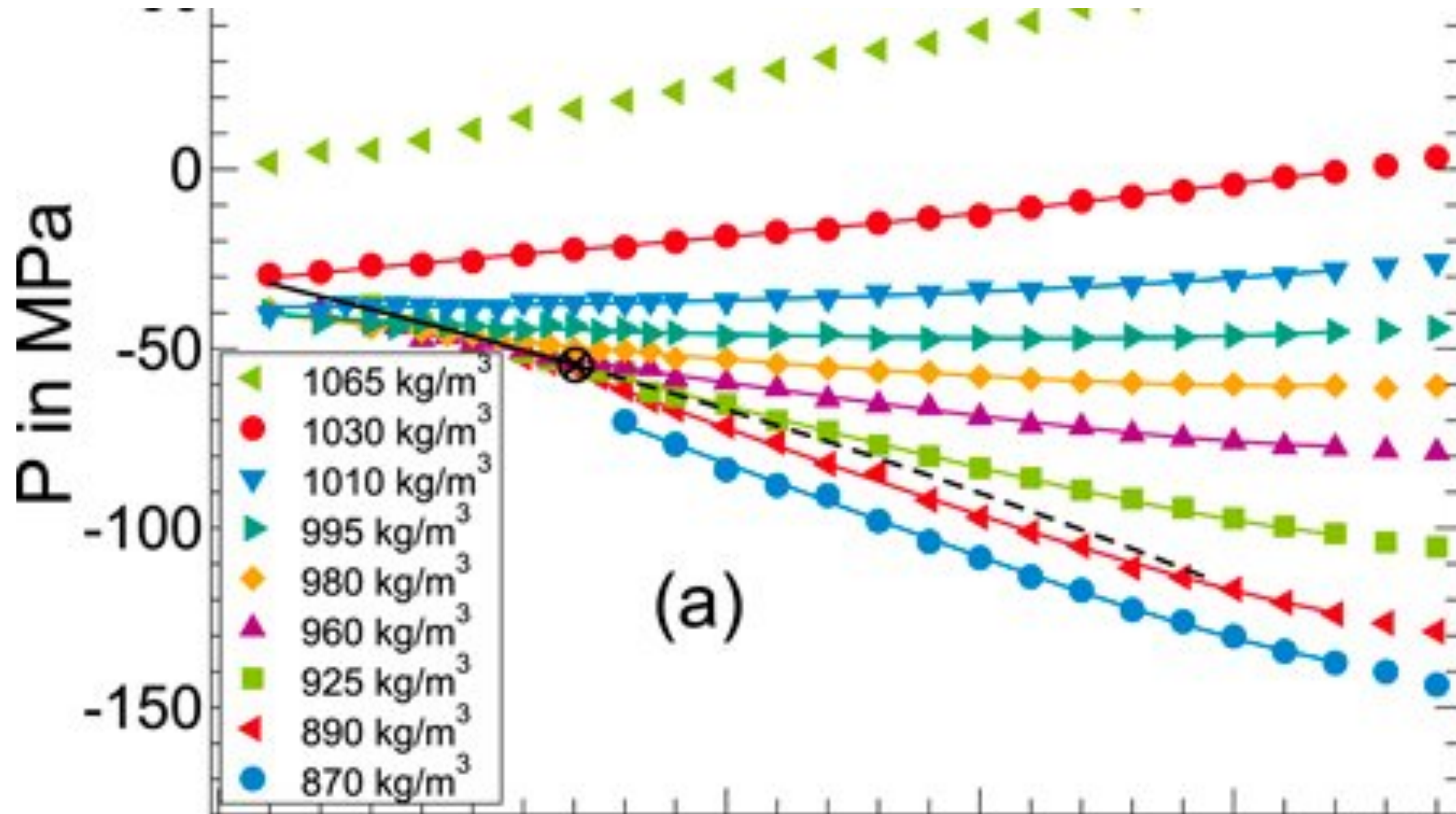
- Avoid log scales for lay-audiences, they don't read these accurately

Note: Average case-fatality rates and transmission numbers are shown. Estimates of case-fatality rates can vary. The preliminary estimates for the new coronavirus are shown in the pink region.

New York Times <https://www.nytimes.com/2020/02/18/learning/whats-going-on-in-this-graph-coronavirus-outbreak.html>

UGLY

- Some perceptual issues, could definitely be clearer.
- Places a large cognitive burden on viewer.



(X axis labels got cut off, my fault)

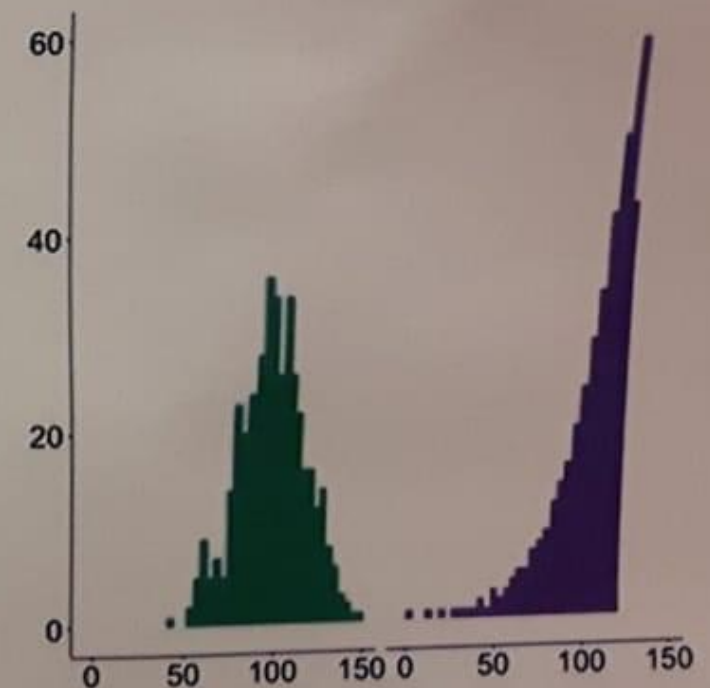
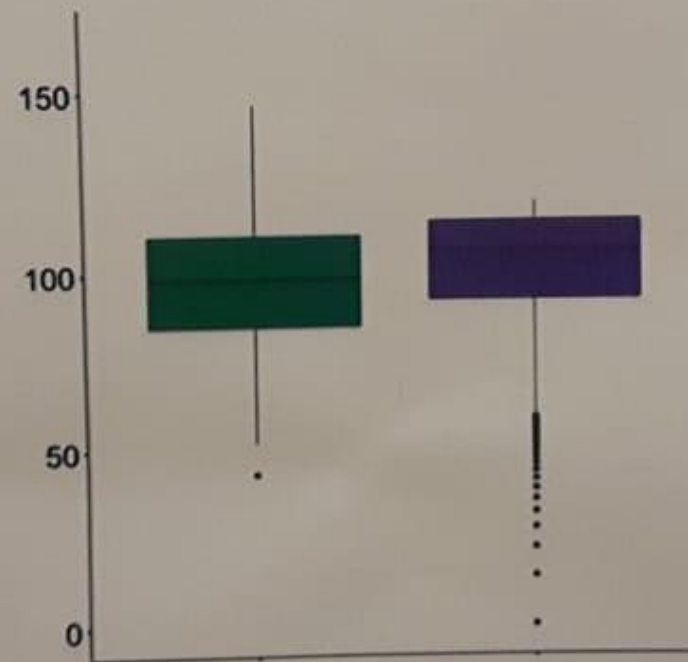
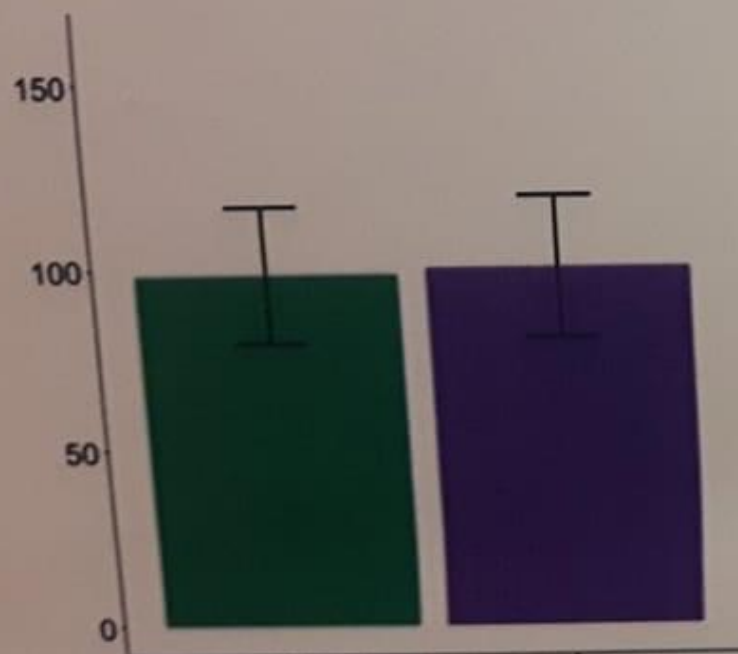
Bad to Good

Friends don't let friends make bar plots.

These look the same!

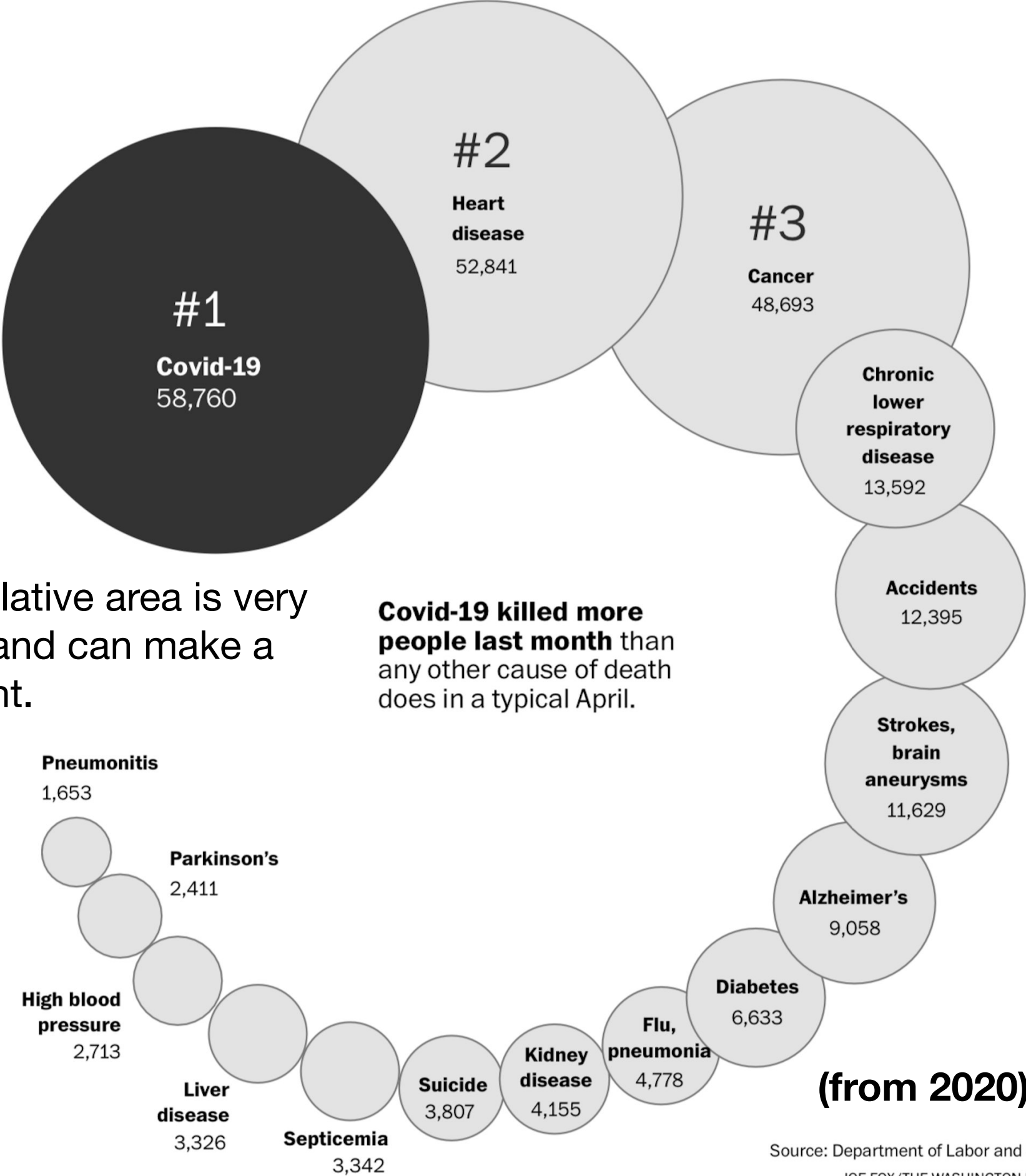
Wait a minute...

Oooh!



- Your job is to represent your data accurately, with as much representation to the raw data as possible. Sometimes this means choosing geometric objects carefully!

GOOD



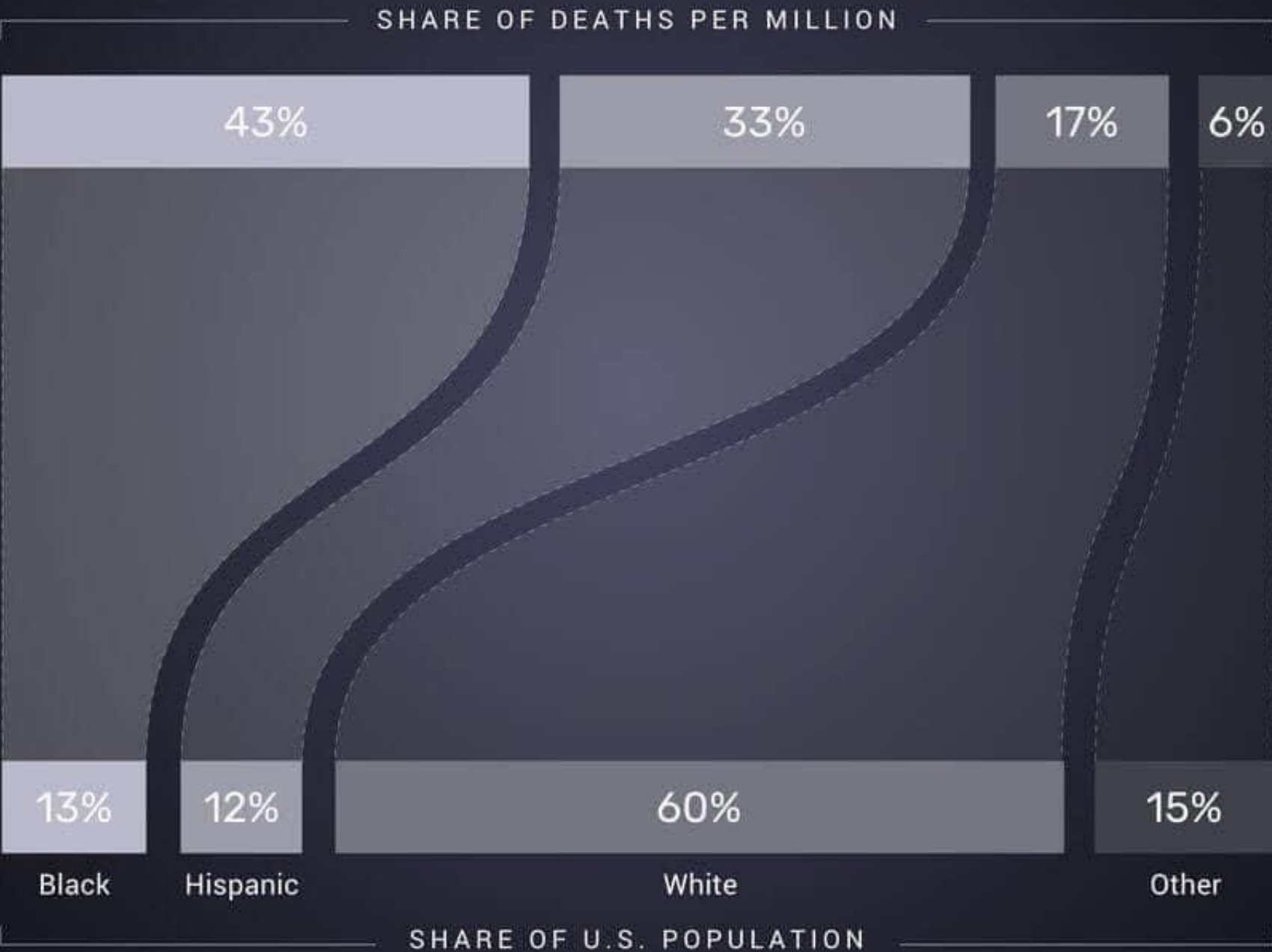
- Remember that relative area is very easily processed and can make a powerful statement.

Covid-19 killed more people last month than any other cause of death does in a typical April.

(from 2020)

U.S. POLICE SHOOTINGS

Fatal police shootings in the U.S. since January 01, 2015
Black Americans are disproportionately affected

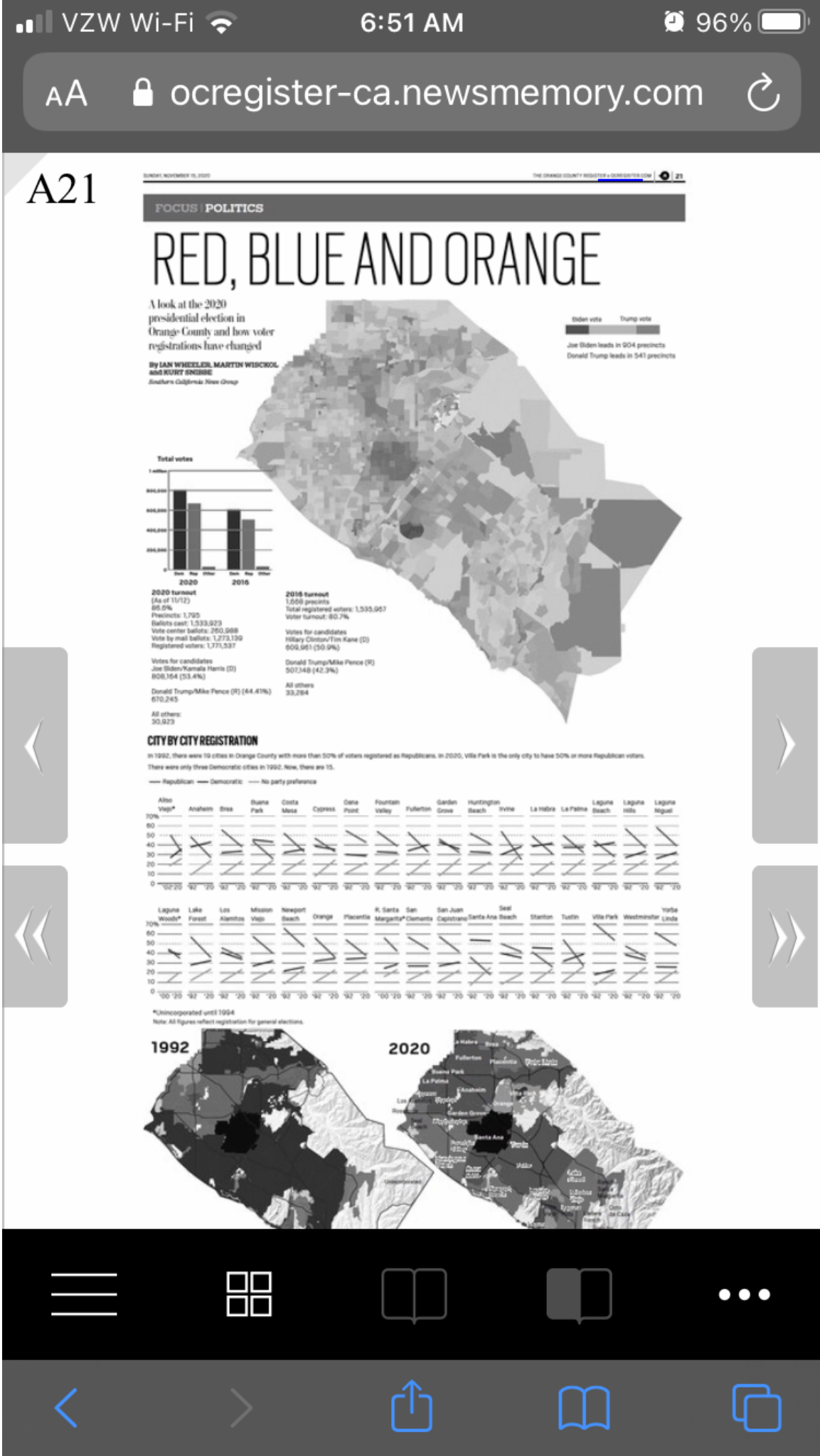


This is how you do Data Viz, folks.



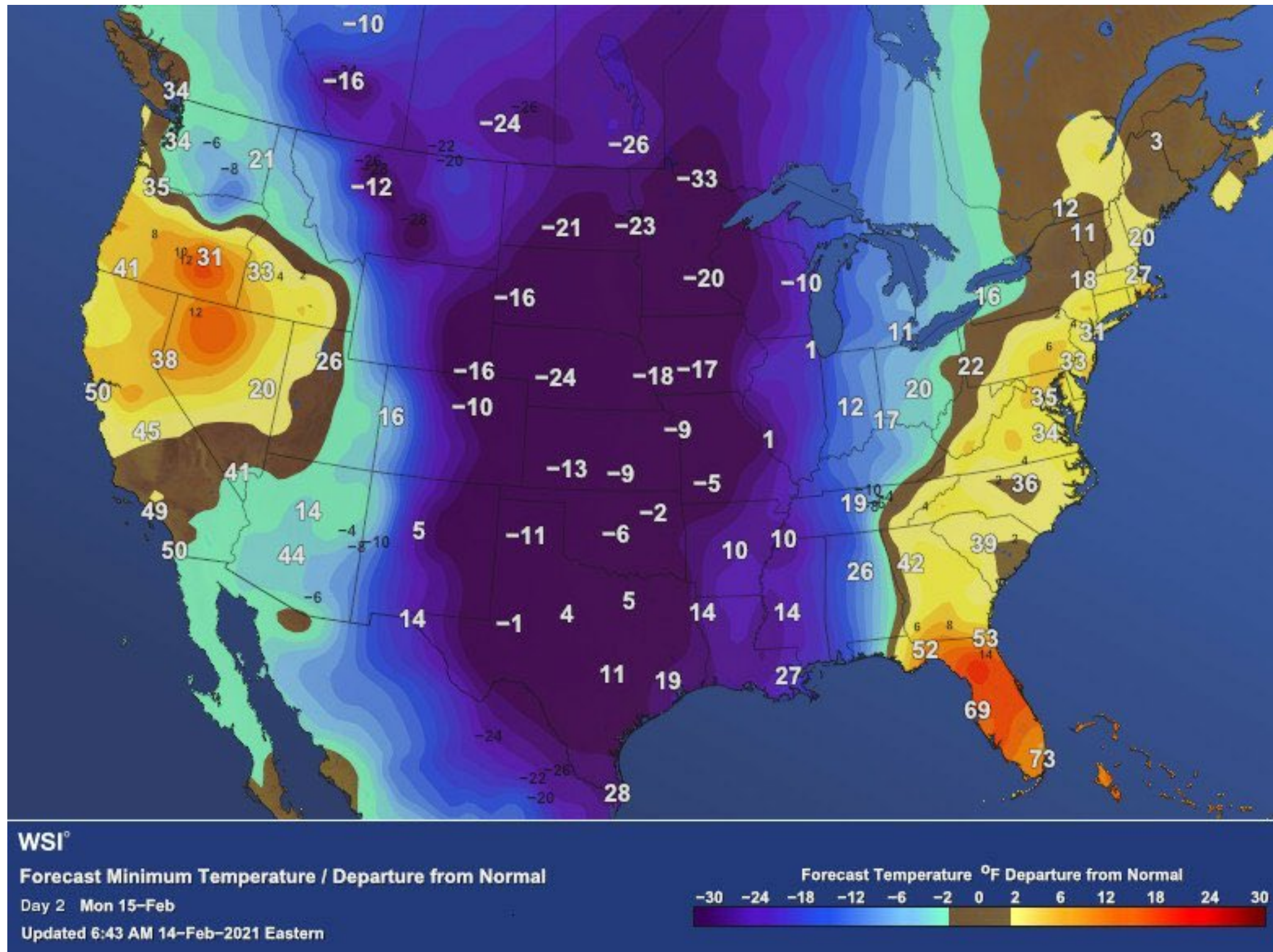
You decide

Orange county voting
results in 2020
presidential election
(exactly as they
appeared on my
phone)



Check Your Understanding

Discuss one good thing and one thing that is confusing about this graphic.



How do you move your work from “ugly” to “good?”

- Maybe you have a graph that is ugly or hard to read (but honest), how can you move it into that ***really good, powerful*** category?
 - It has much more to do with storytelling than it does coding!
 - The point of data visualization is to communicate ideas about data to your audience.
 - Figures should be much more than random plots of the data you have.
 - ***Think carefully*** about ***what the point is*** and what idea you want to communicate. **Let these guide your design!**

OCAR Storytelling

- Form figures around OCAR storytelling, basic structure:
 - **Opening**: who are the players? What metrics are on the x and y axes? What values are being shown?
 - **Challenge**: what is the question these data are trying to answer by showing the reader relationships?
 - **Action**: How do the data need to interact in order to show you the answer to the challenge?
 - **Resolution**: What does the relationship mean? Spell it out for the audience either in the caption or by speaking.

What are the OCAR elements to this graphic?

Opening:

Share of deaths,
share of population,
race

Challenge:

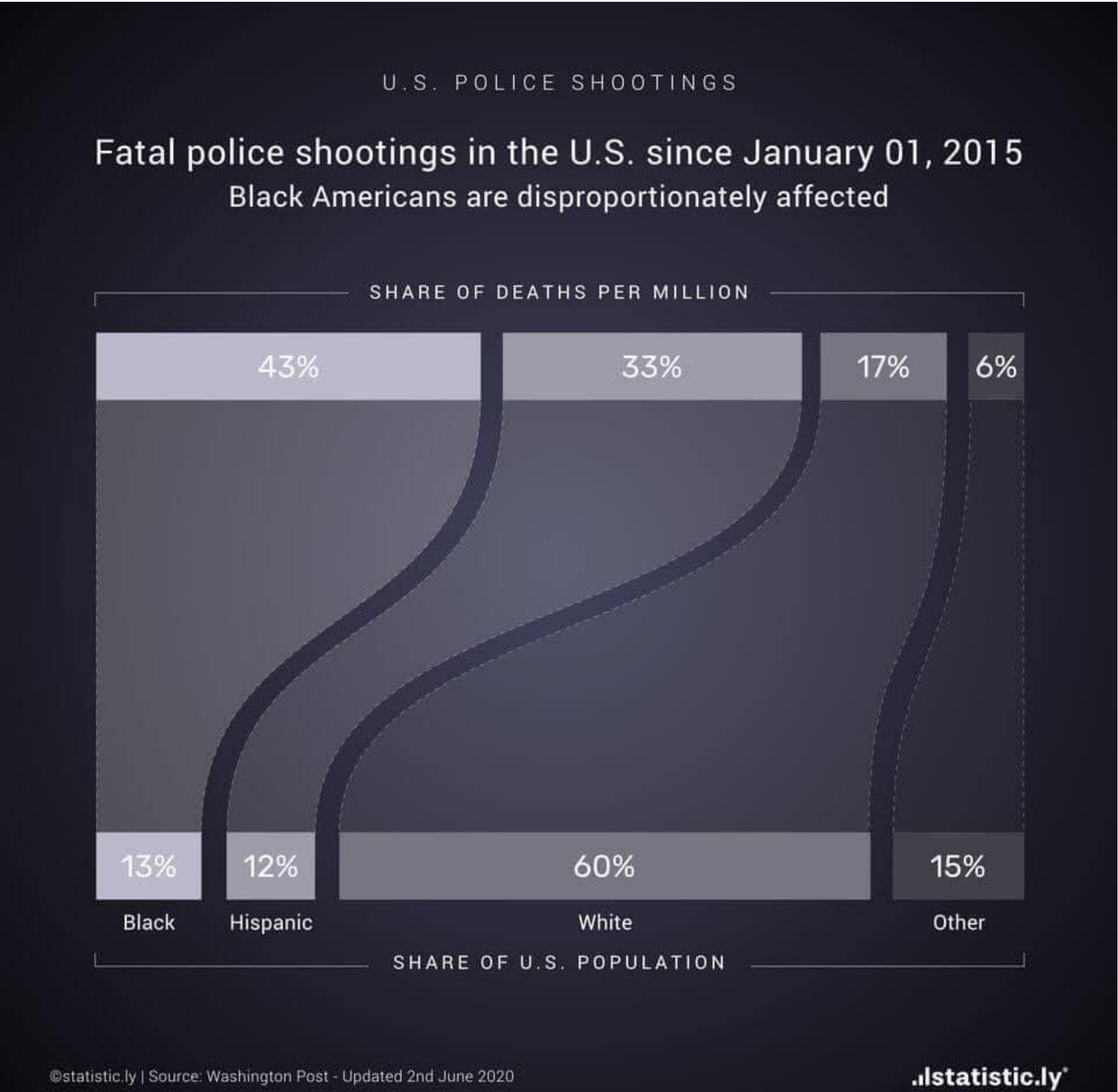
How many black people
are killed by police
compared to whites?

Action:

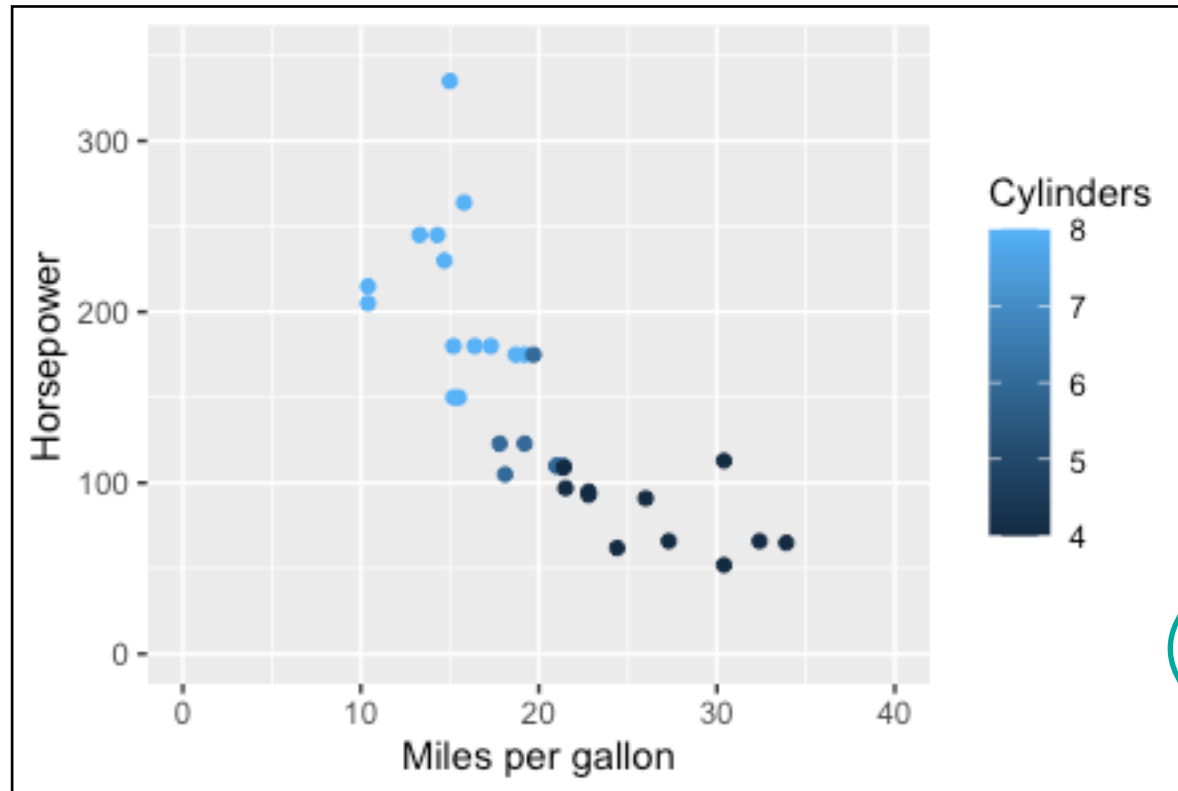
Flow of proportionality
between two scales.

Resolution:

Black people are killed
disproportionately more
than whites.



Converting Data to Understanding

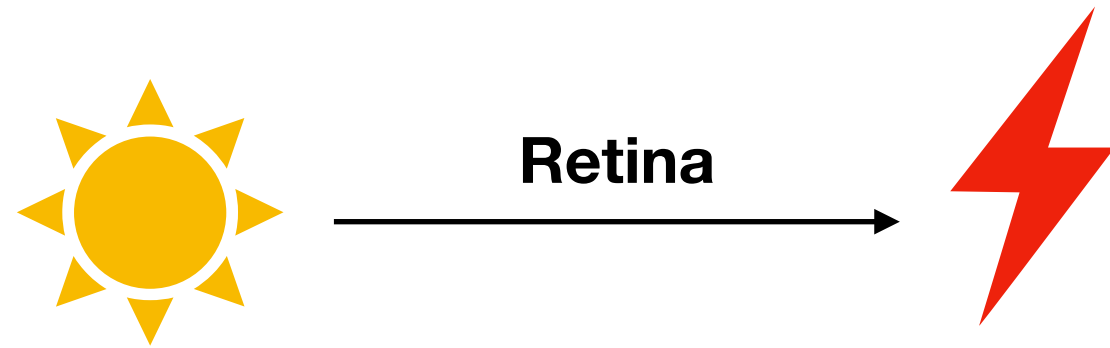


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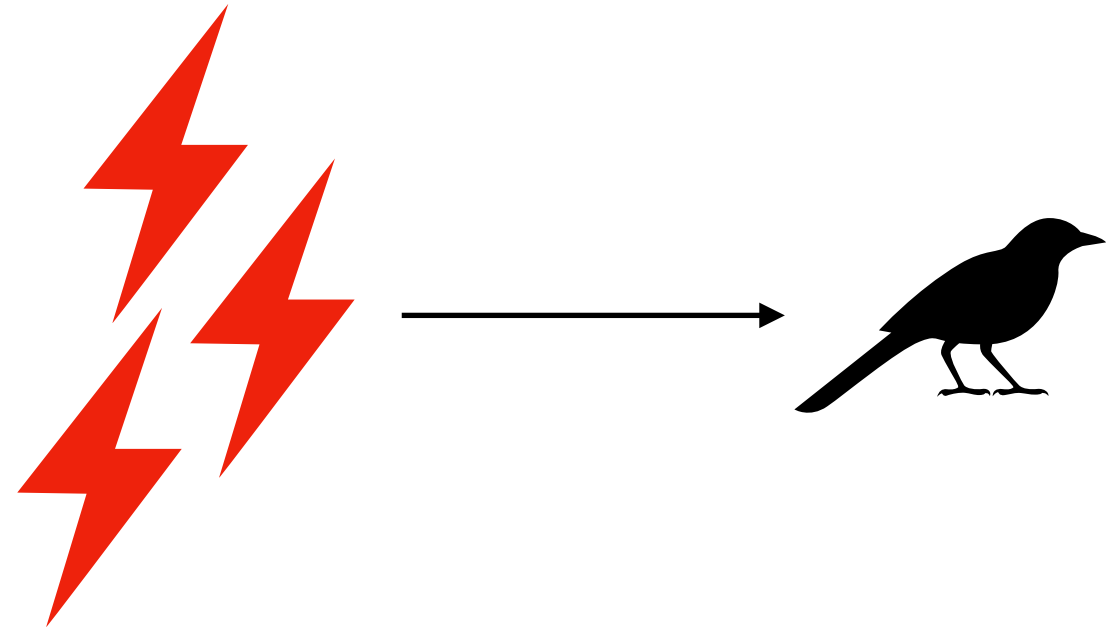
- attention
- working memory
- processing

Visual Cognitive System

1. Encoding



2. Pattern Processing

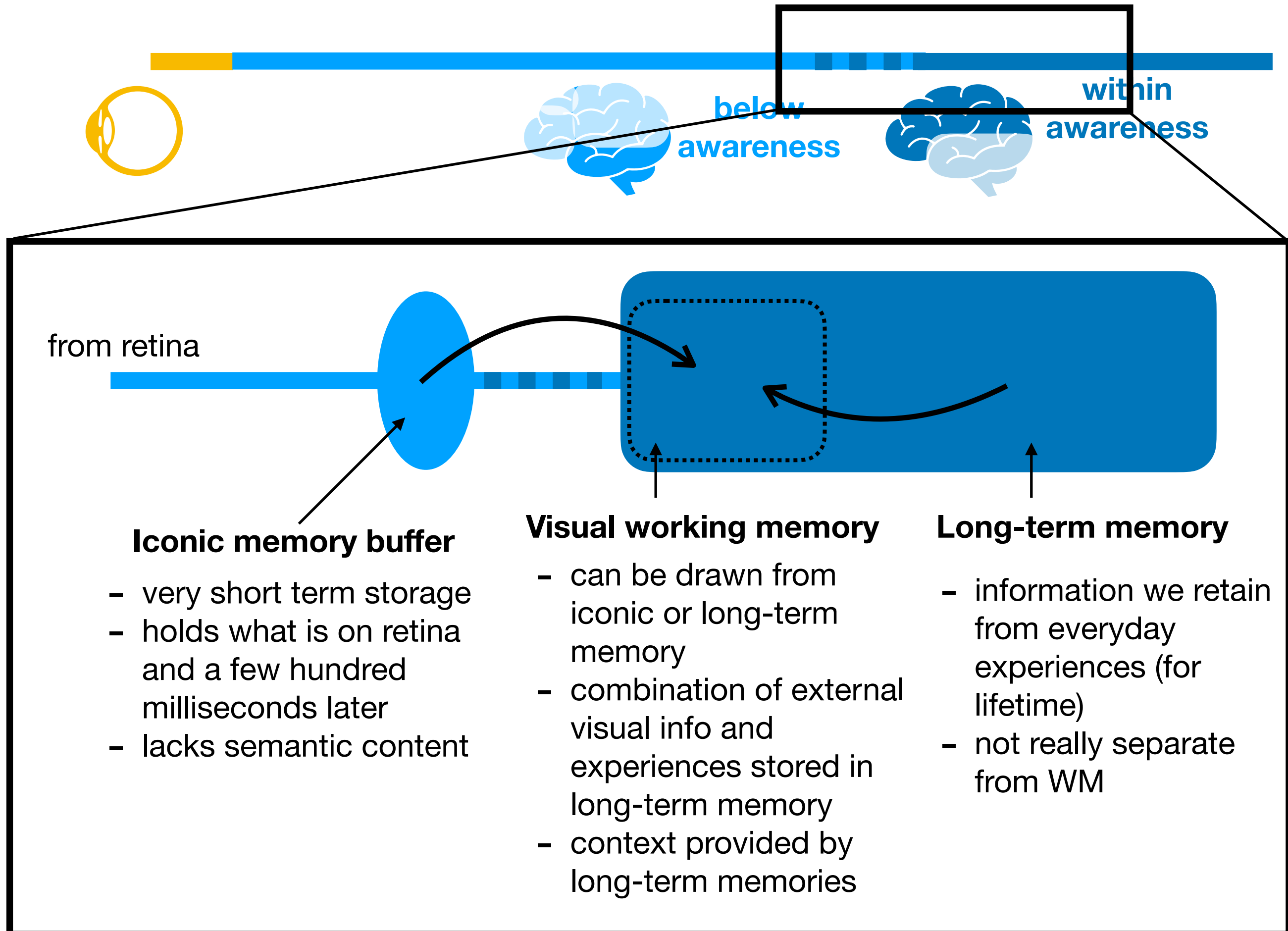


3. Visual Processing

visual working memory
long-term memory

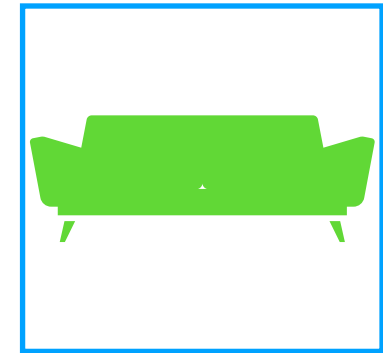
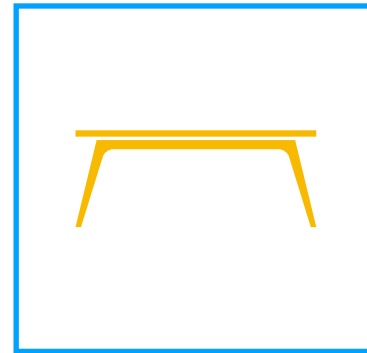
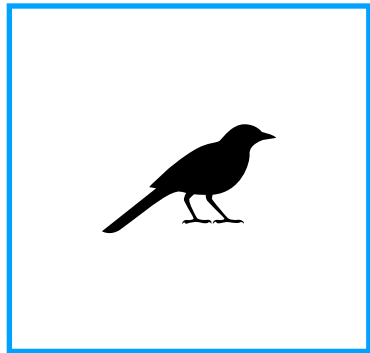


Working memory



Memory and Attention

- Visual Working Memory: very few available slots



What color was the lamp?

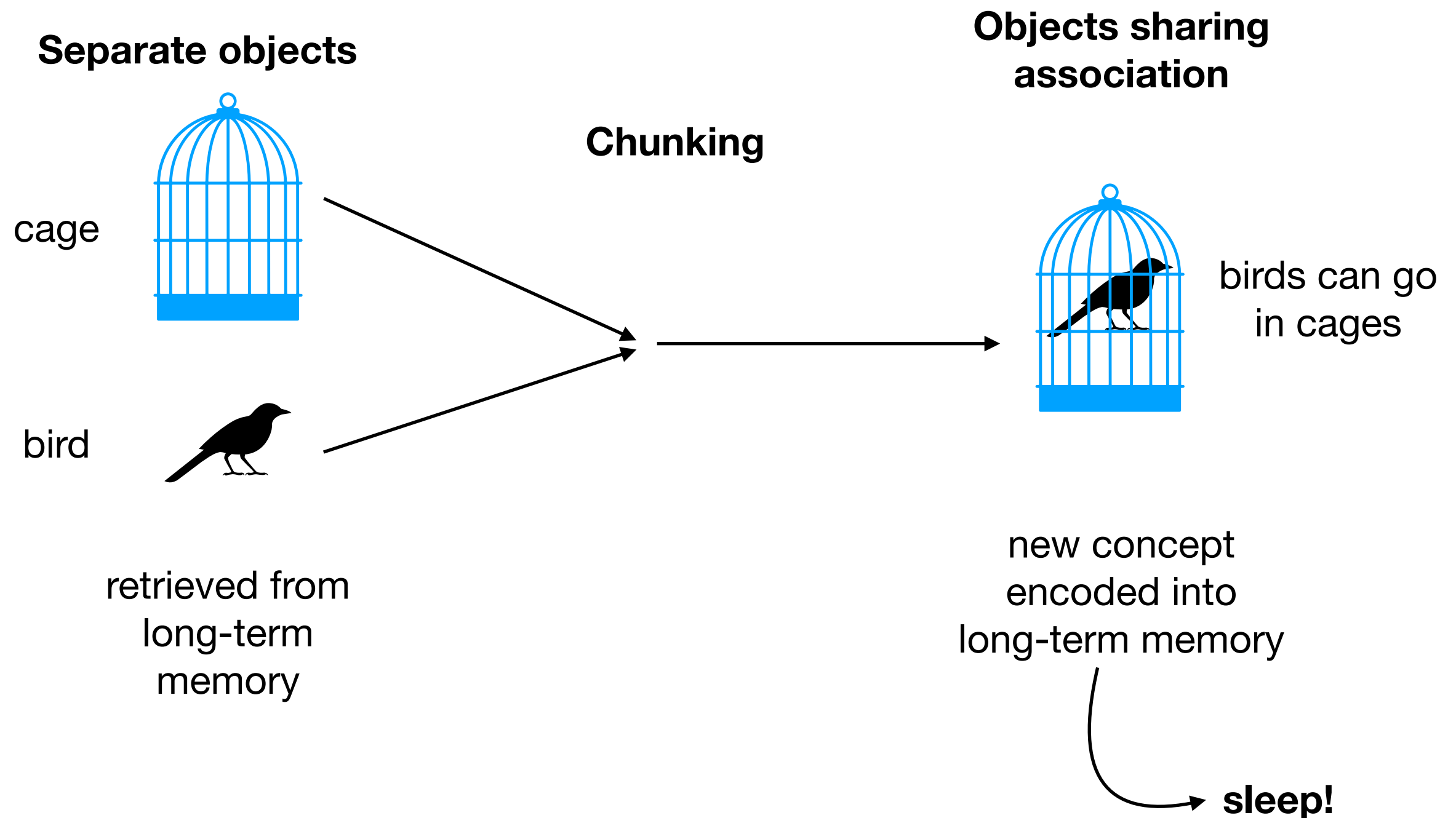
pink

- Objects held in iconic memory a very short time (<400 ms).
- Eye movements help reset slots when needed.
- **Attention helps guide how those slots are filled.**

<https://www.youtube.com/watch?v=VkrrVozZR2c>

Memory and Attention

- Memory slots are not limited to objects, also concepts and other “chunks.”
- A **chunk** is just about anything — it is an object, concept, group of objects, plan, etc.



What does this mean for data visualization?

1) Attention is Queen.

- Following OCAR will help you determine how many working memory slots your figure is using, and how to reduce if necessary.



What are the things most important? How do you draw your viewer's attention?

2) Reduce demand on visual working memory by improving processing.

- Limit the number of concepts/relationships you present in each graphic.
- Use elements that make visual processing easier.
- Make guides clear and easy to understand.

How can you revise your graphic to make understanding easier?

Check Your Understanding

Are flawless diamonds on average smaller than those with inclusions?

1) **Attention is Queen.** What is the most important point to draw your viewer's attention to? How can you create a relationship that shows this point?

2) **Reduce demand on working memory.** Is there anything not relevant in your graph that you could exclude? Are your graph elements easy to understand and visually process?

Action Items

1. Prepare Project 1 for submission.