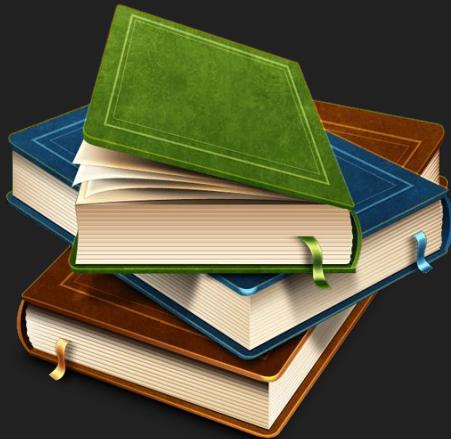
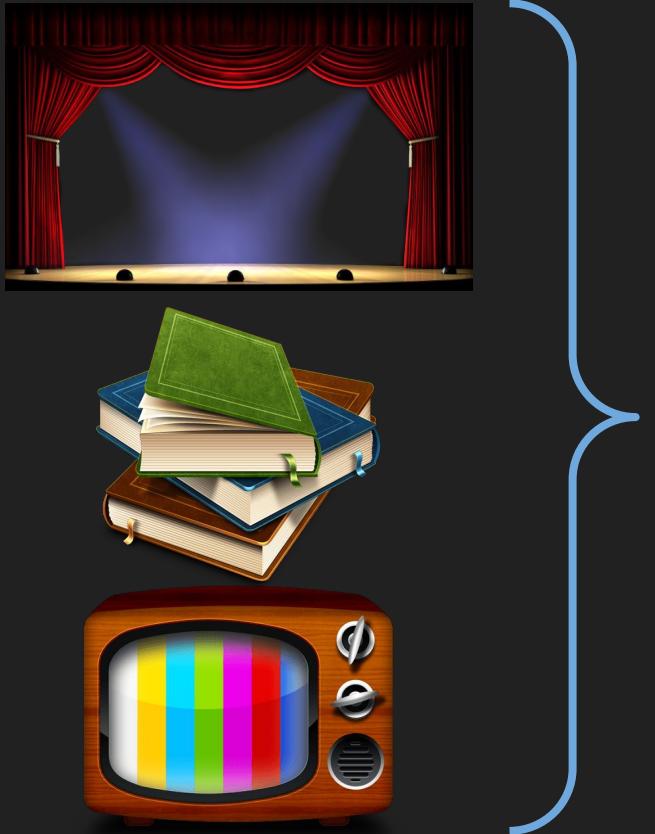




# Storytelling: Communication through the ages

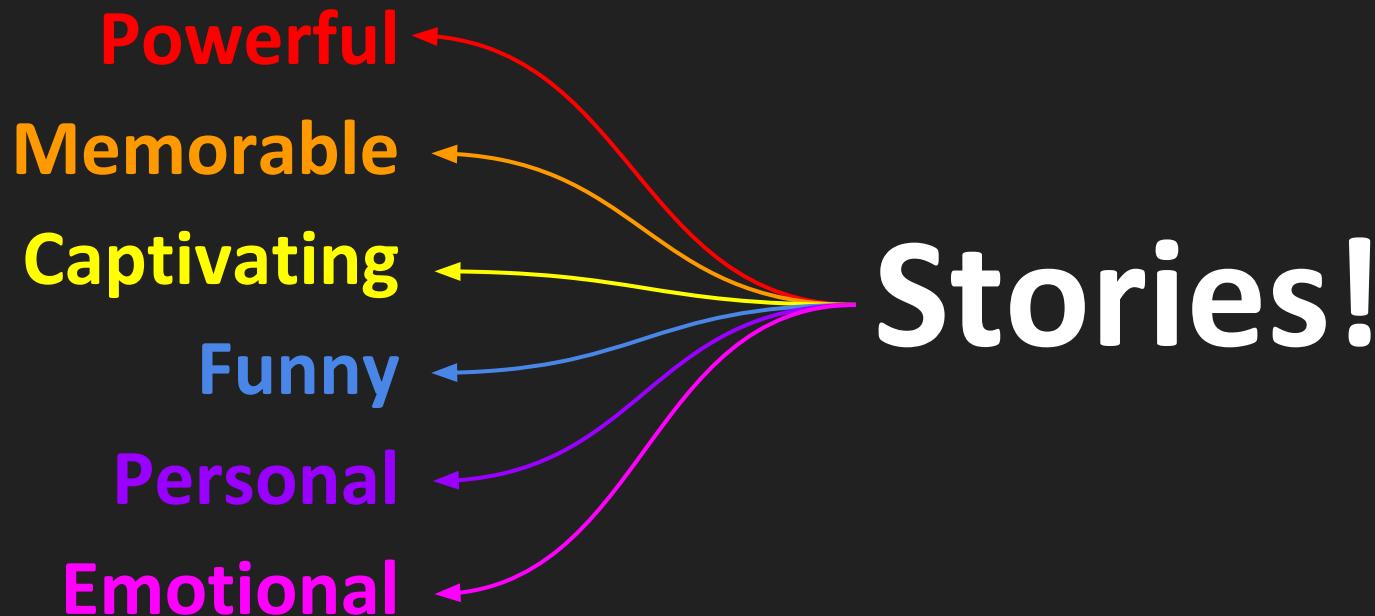


# Storytelling: Communication through the ages

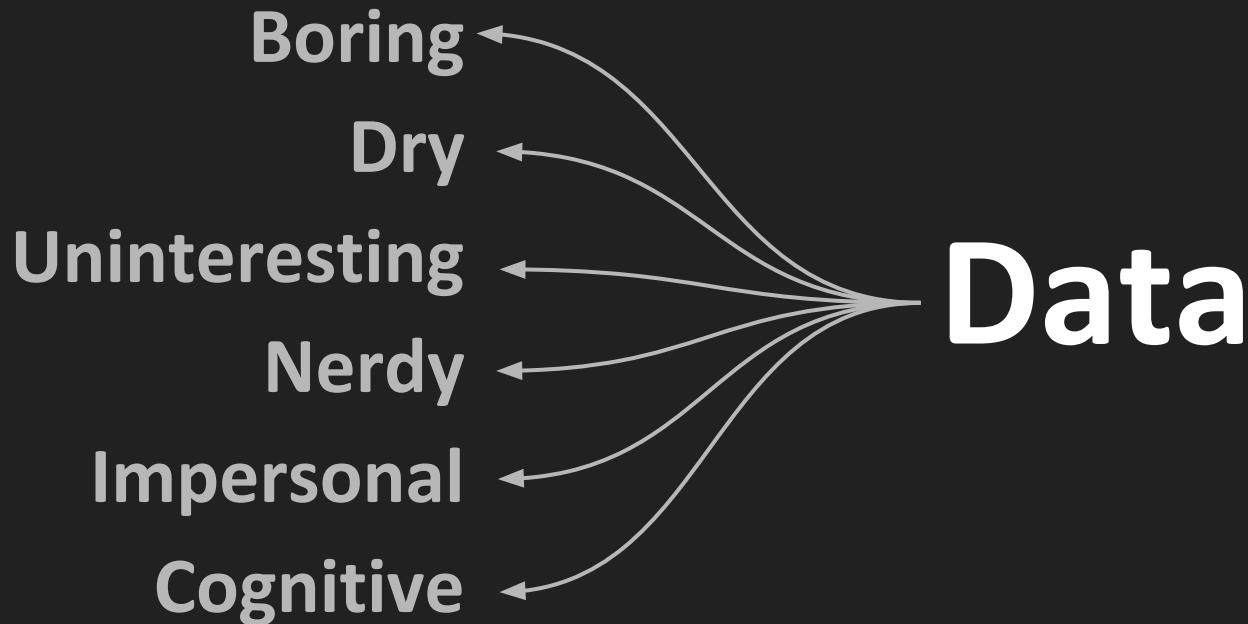


**Stories!**

# Storytelling: Communication through the ages



# Storytelling: Communication through the ages



# Storytelling: Communication through the ages

## Stories

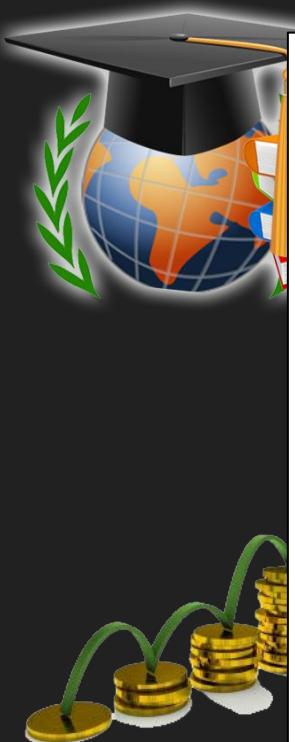
Powerful  
Memorable  
Captivating  
Funny  
Personal  
Emotional



## Data

Boring  
Dry  
Uninteresting  
Nerdy  
Impersonal  
Cognitive

# But data are necessary for progress



---

But data are necessary for progress

---

**People must *understand* data...**

**but data can be confusing and complicated...**

**YOU must help them!**

---

Tell a story about the data!

---

SdtaO+ray





# Demonstration: data in or out of a story

(1)

(2)

# Demonstration: data in or out of a story

Who is John's sister?

Who is James?

Where would John like to work?

Who is Tim's sister?

Who is Tom?

Where would Tim like to work?

# Demonstration: data in or out of a story

A police officer pulls over a car for driving too slowly on the highway. “**This is a highway, you must drive at least 50 mph.**”

“But the sign says 20!” said the driver.

“This is *highway route 20*, not *speed limit 20*.”

The officer then sees the passenger is unconscious. “**Is everything OK?**”

“She’s been like that since we turned off highway 180.”

An established finding in traffic safety is that vehicles should maintain speeds consistent with that of neighboring vehicles. For this reason, a minimum speed of fifty miles per hour is recommended by federal agencies to be adopted by local state and provincial governments. Nearly all local governments have conformed to this recommendation, as it promotes safety and also minimizes confusion as individuals pass from one jurisdiction into another, and when merging from one highway onto another highway.

# Question:

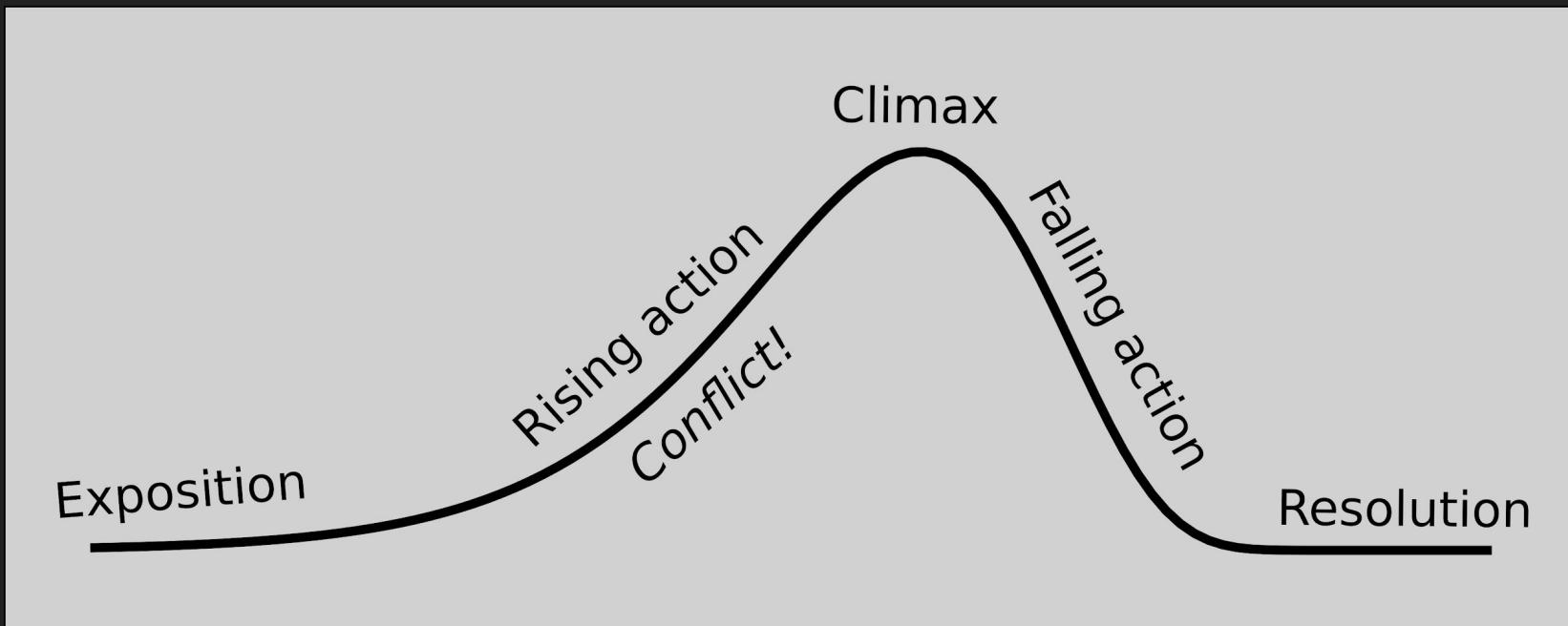
What is the minimum speed limit  
on a highway?

# Demonstration: data in or out of a story



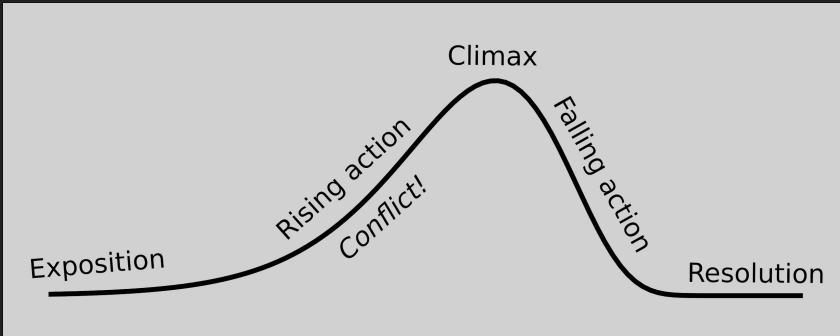


# The “5-stage” structure of storytelling



# The “5-stage” structure of storytelling

**Exposition:** Purpose and origin of the data.



**Rising action:** Build excitement about the findings.  
Generate or introduce *conflict*.

**Climax:** Key findings to be remembered and acted on.

**Falling action:** More details, context, interpretation.

**Resolution:** (1) key result, (2) importance, (3) action



# Example of 5-stage storytelling

Answers displayed here!

# Example of 5-stage storytelling

**My team:** Provide data-driven advice to companies for optimizing goals.

**Company X:** Produce and sell widgets online.

**Goal:** Sell more widgets, possibly by increasing advertisements.

Exposition

# Example of 5-stage storytelling

**My team:** Provide data-driven advice to companies for optimizing goals.

**Company X:** Produce and sell widgets online.

**Goal:** Sell more widgets, possibly by increasing advertisements.

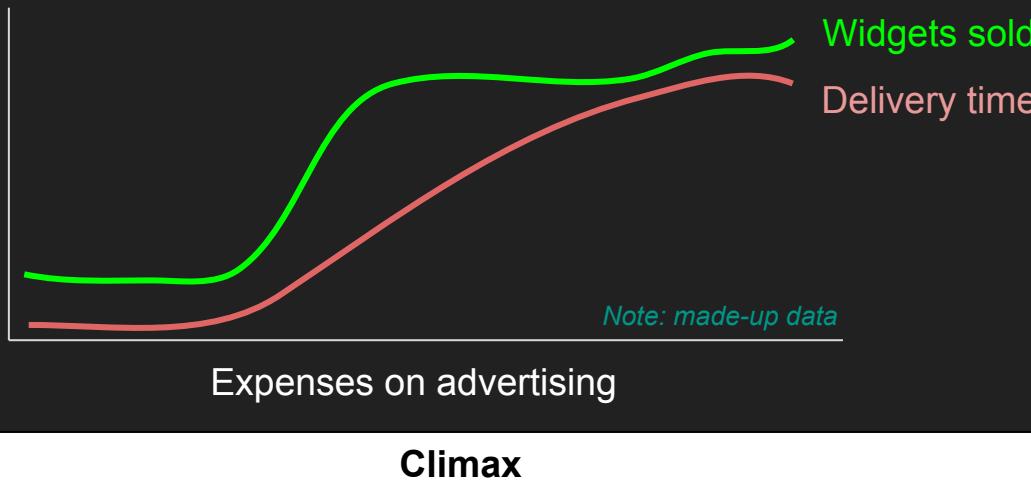
Rising action (and conflict)

# Example of 5-stage storytelling

**My team:** Provide data-driven advice to companies for optimizing goals.

**Company X:** Produce and sell widgets online.

**Goal:** Sell more widgets, possibly by increasing advertisements.

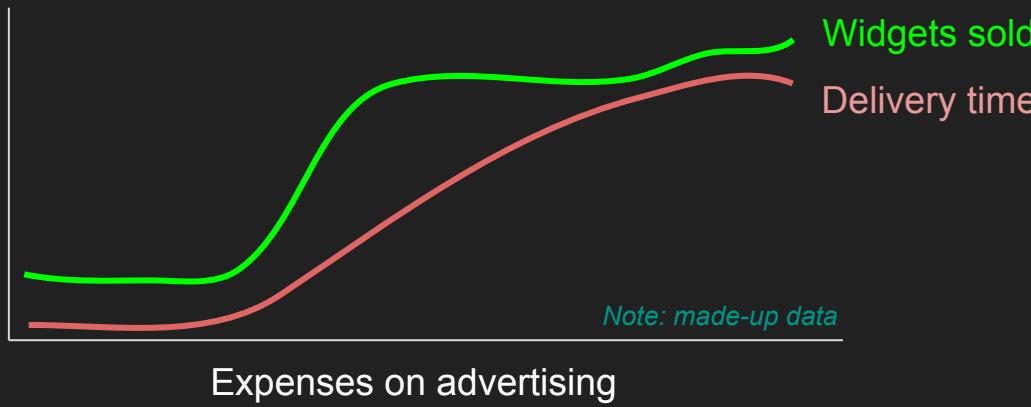


# Example of 5-stage storytelling

**My team:** Provide data-driven advice to companies for optimizing goals.

**Company X:** Produce and sell widgets online.

**Goal:** Sell more widgets, possibly by increasing advertisements.



Falling action

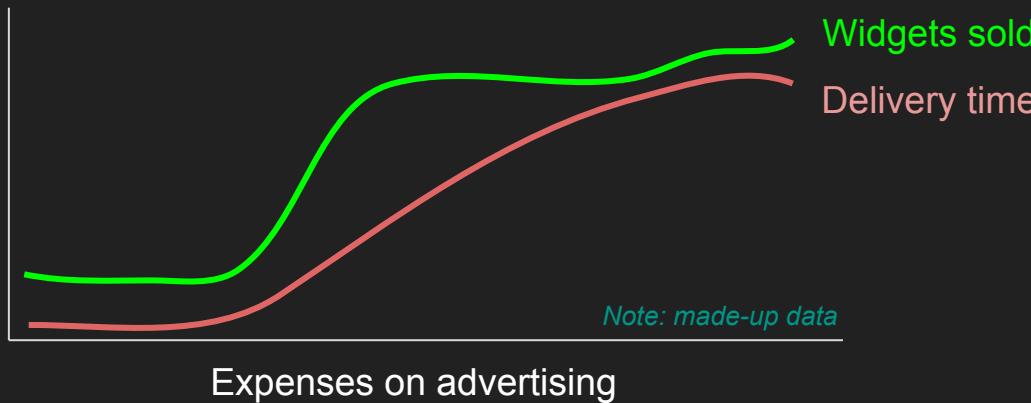
# Example of 5-stage storytelling

**My team:** Provide data-driven advice to companies for optimizing goals.

**Company X:** Produce and sell widgets online.

**Goal:** Sell more widgets, possibly by increasing advertisements.

**Recommendation:** More advertising should be balanced with more personnel.



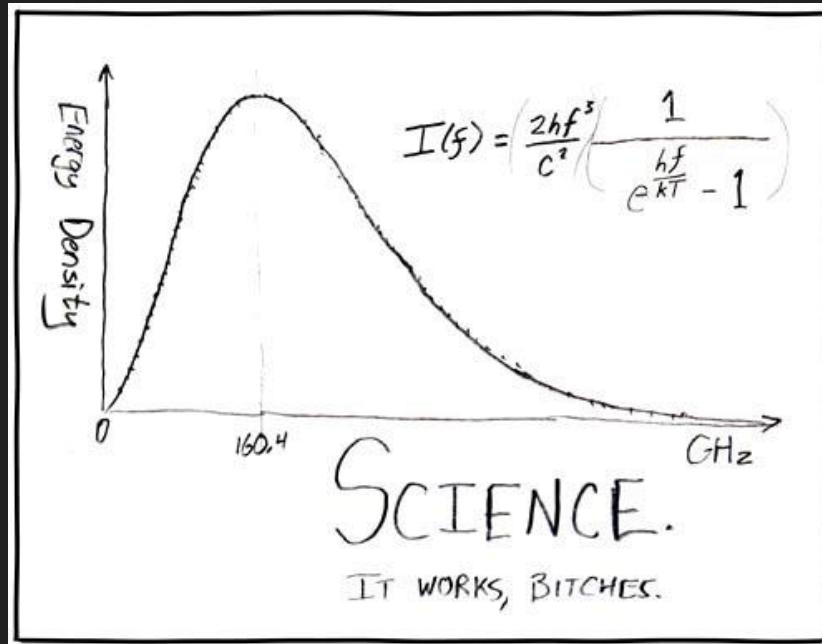
Resolution / conclusion



# Conflict and resolution



# Conflict and resolution



xkcd.com/54. Quote from Richard Dawkins

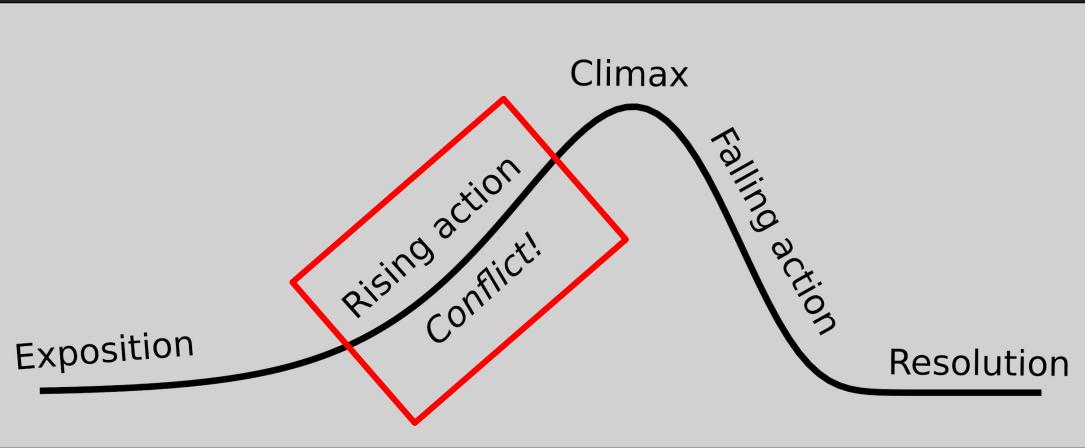
---

## Conflict and resolution

---

**Data can resolve conflict.**

# Conflict and resolution

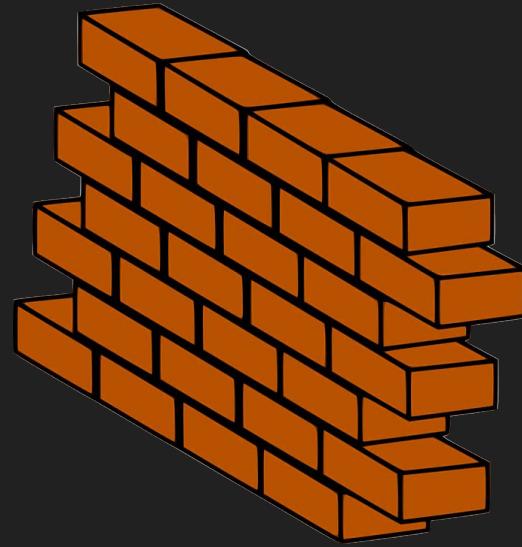
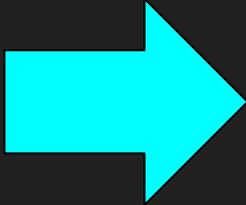
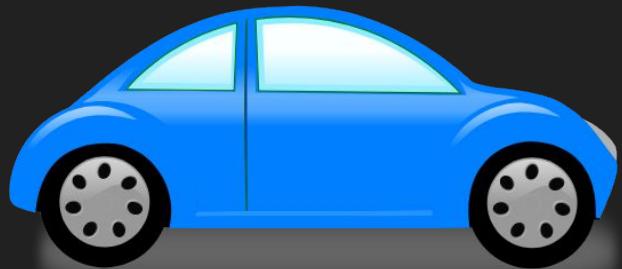


**Conflict comes from**

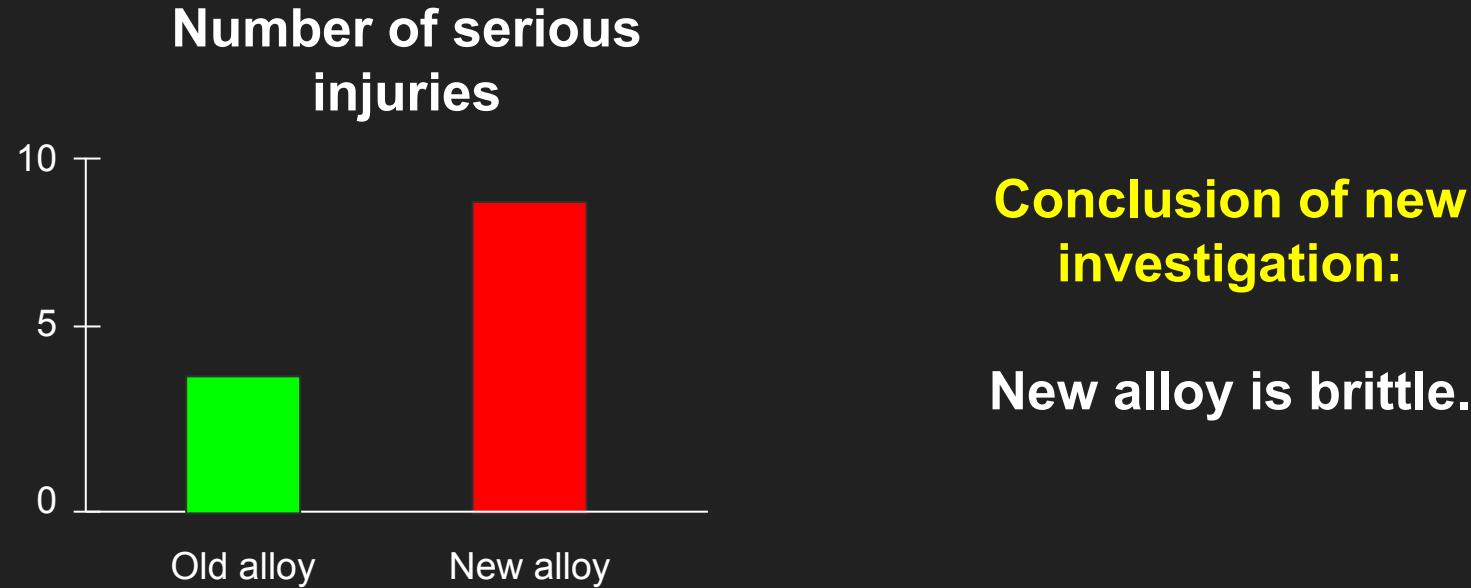
- 1) Opposing viewpoints.
- 2) Uncertainty.



# Examples of conflict and resolution



# Examples of conflict and resolution



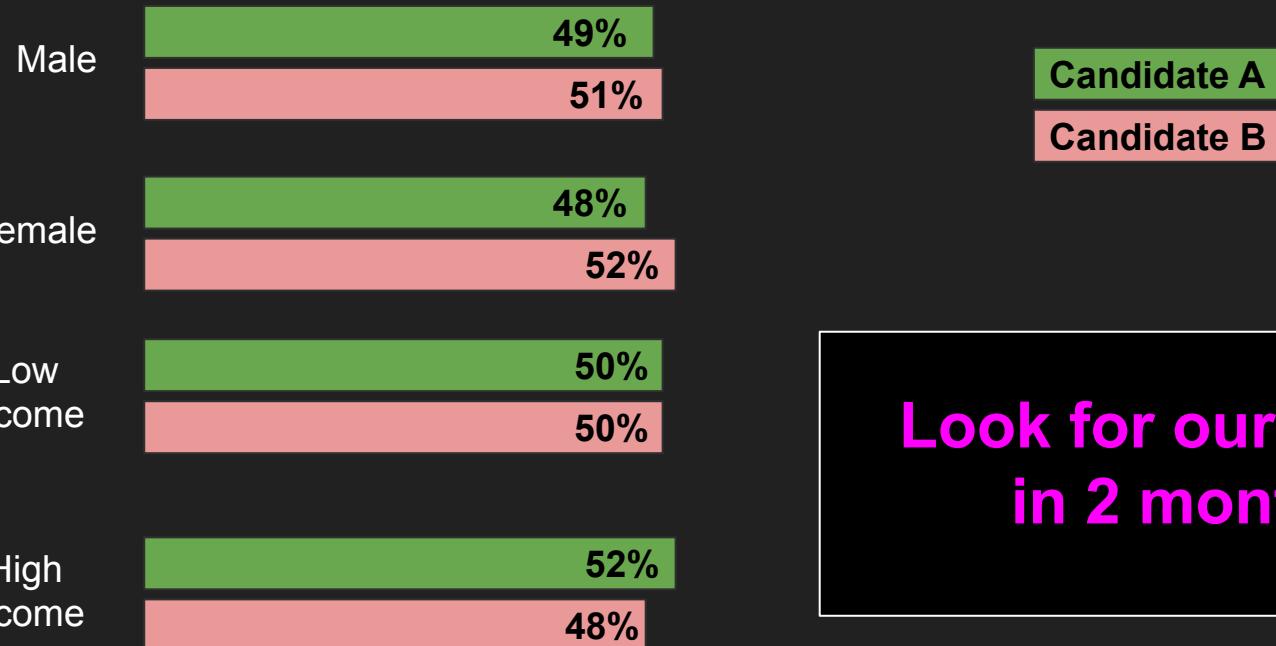
*Note: made-up data*

# Examples of conflict and resolution

Election results were unexpected,  
and *no one knew why.*

We conducted a large poll to find out.

# Examples of conflict and resolution



Look for our update  
in 2 months!

*Note: made-up data*

---

# Examples of conflict and resolution

---

Conflict is everywhere.

**Find and resolve it with data.**



---

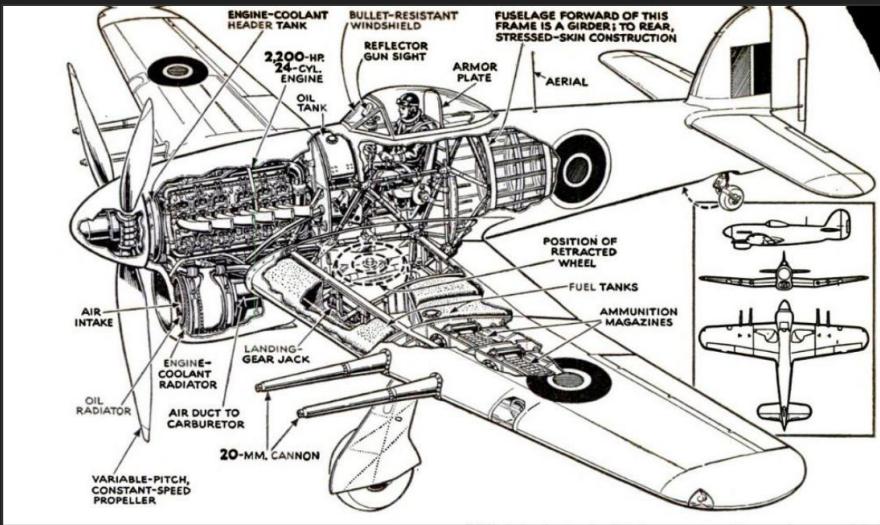
Is your audience in-field or out-of-field

---

Storytelling style is  
**context-dependent.**

Know your audience in advance.

# Is your audience in-field or out-of-field



Audience: engineers



Audience: investors

---

Is your audience in-field or out-of-field

---

**Plan for a general audience,  
but prepare to discuss details.**

**Bad:** “You wouldn’t understand the details.”

**Good:** “I’m happy to talk details later.”



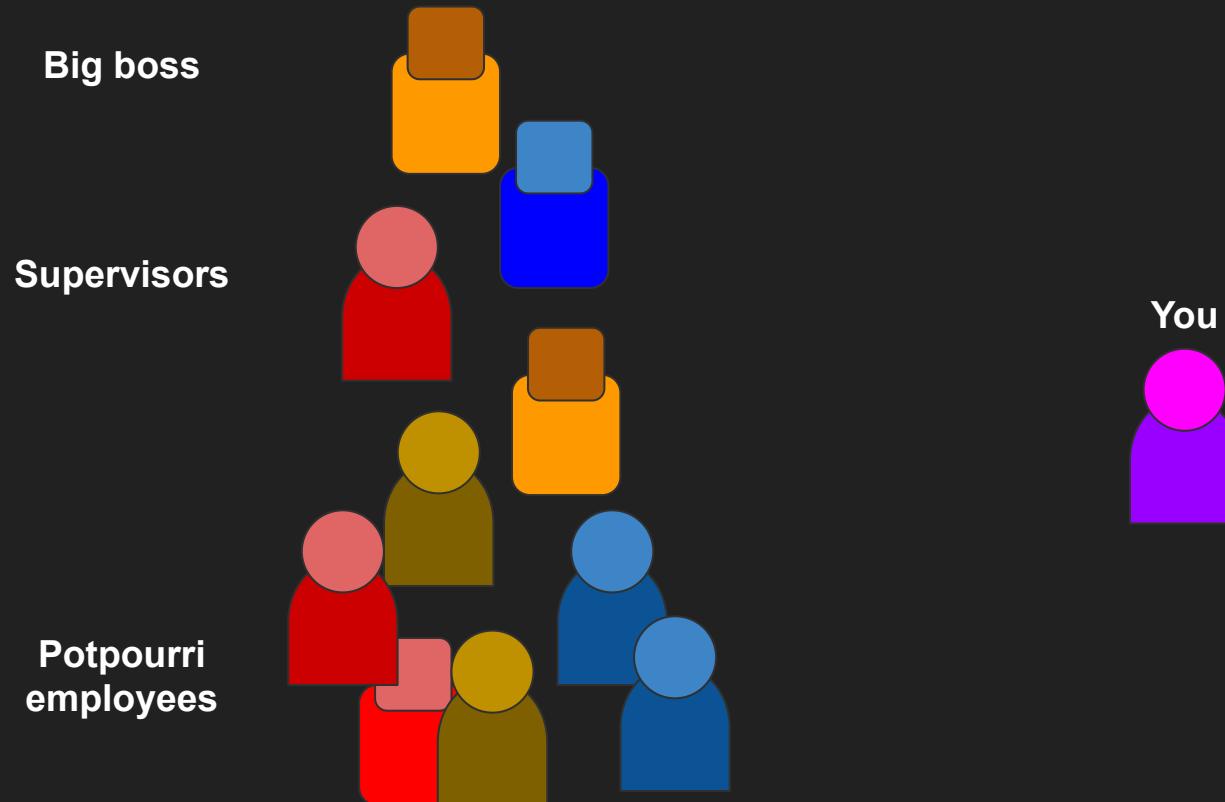
---

# Is your audience horizontal or vertical?

---



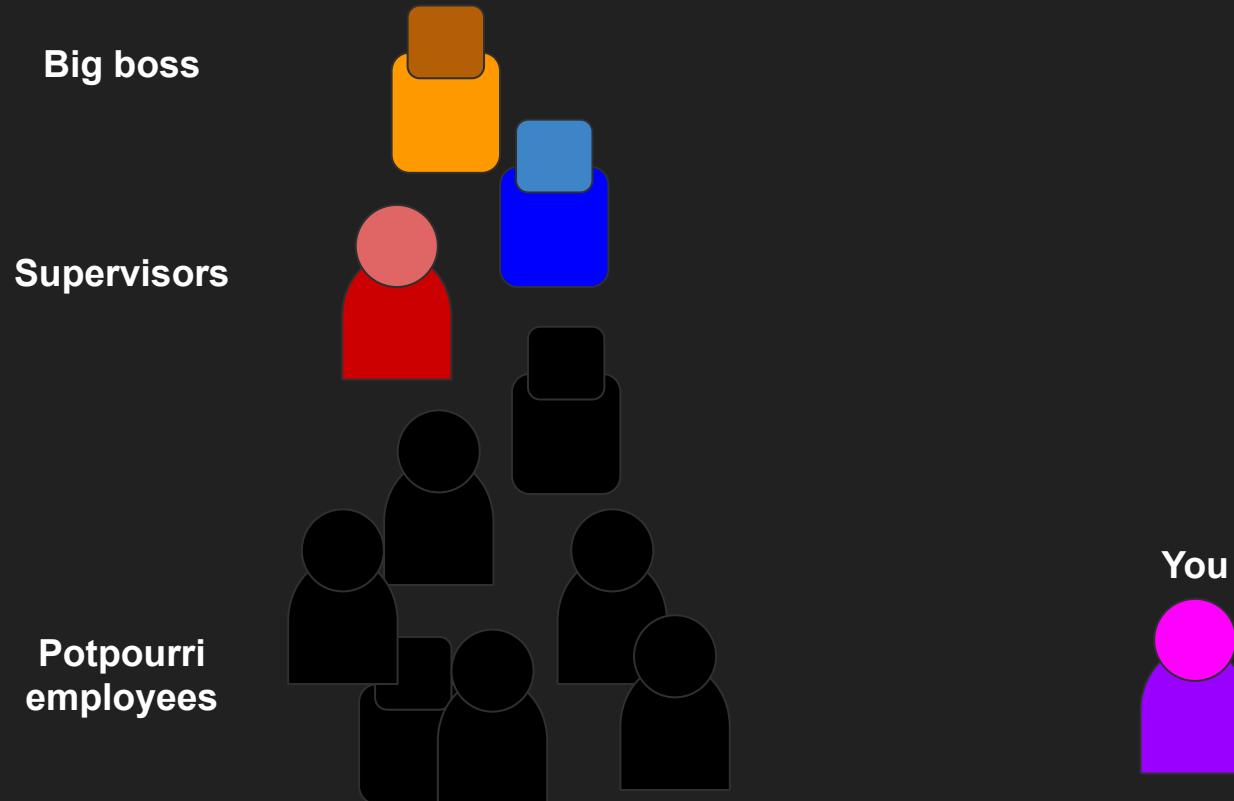
# Is your audience horizontal or vertical?



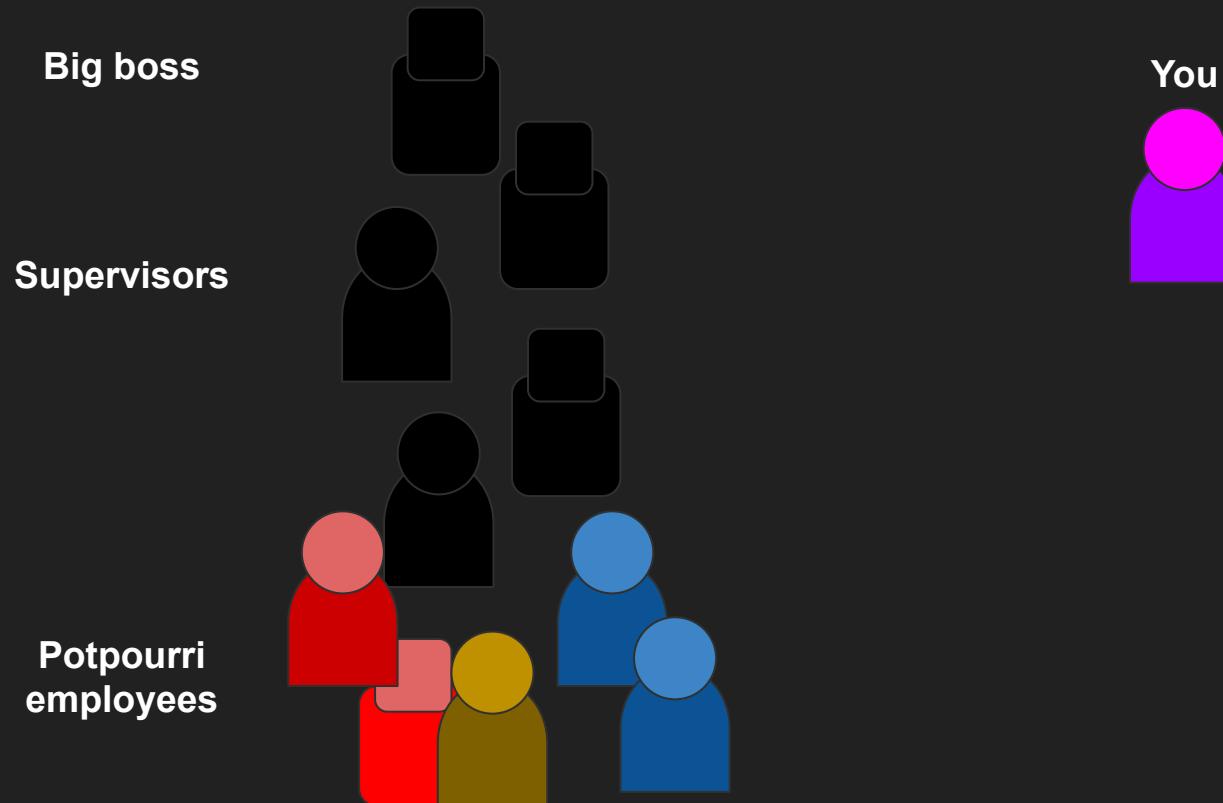
# Is your audience horizontal or vertical?



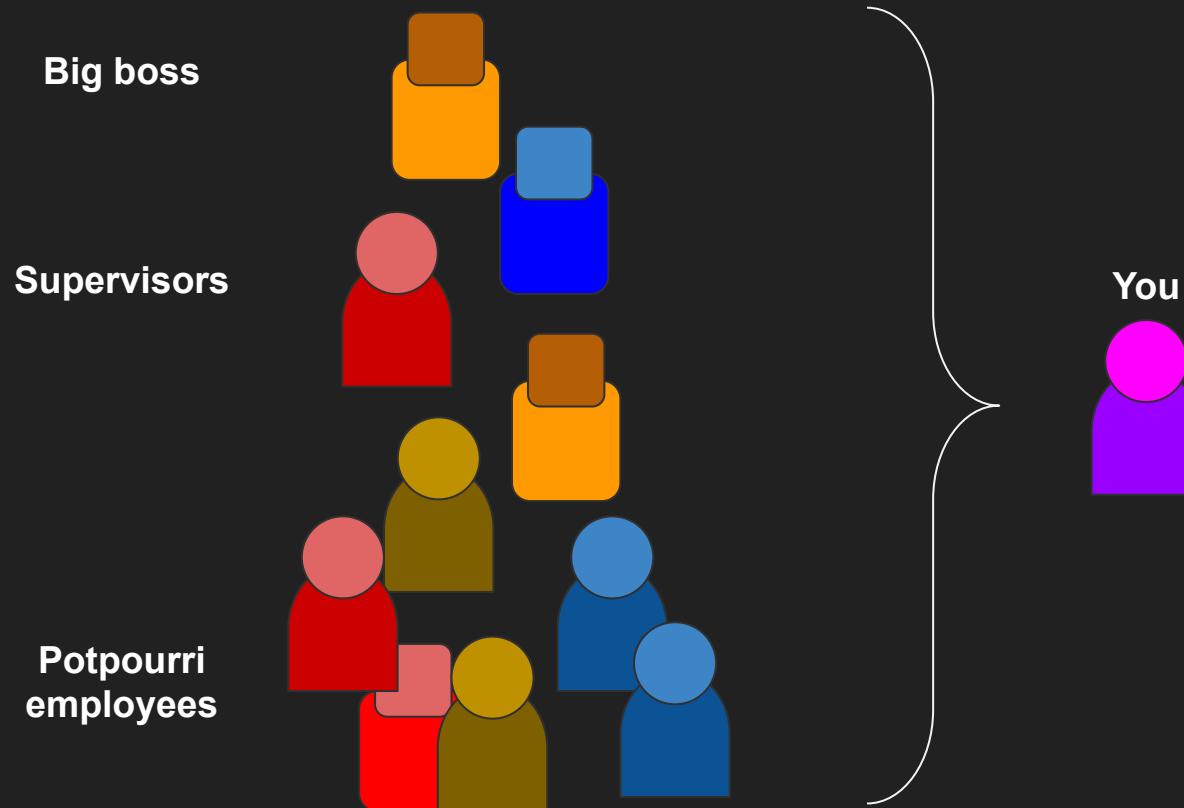
# Is your audience horizontal or vertical?



# Is your audience horizontal or vertical?

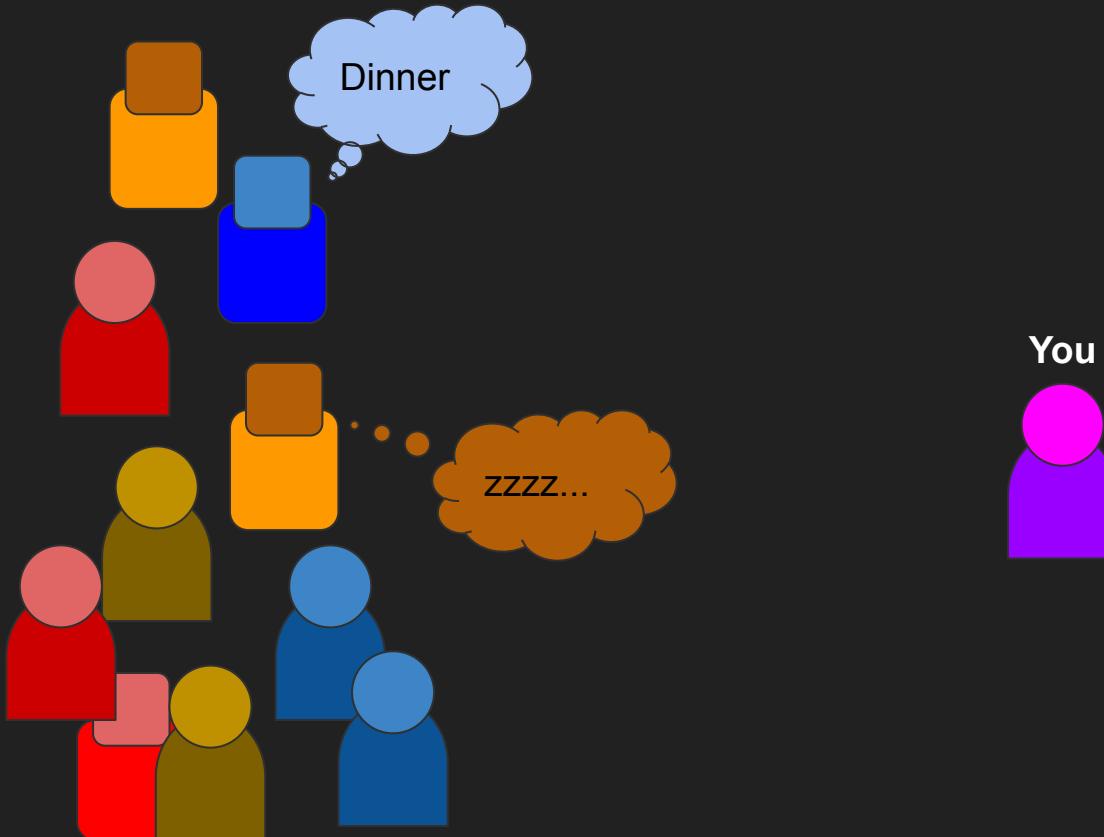


# Is your audience horizontal or vertical?

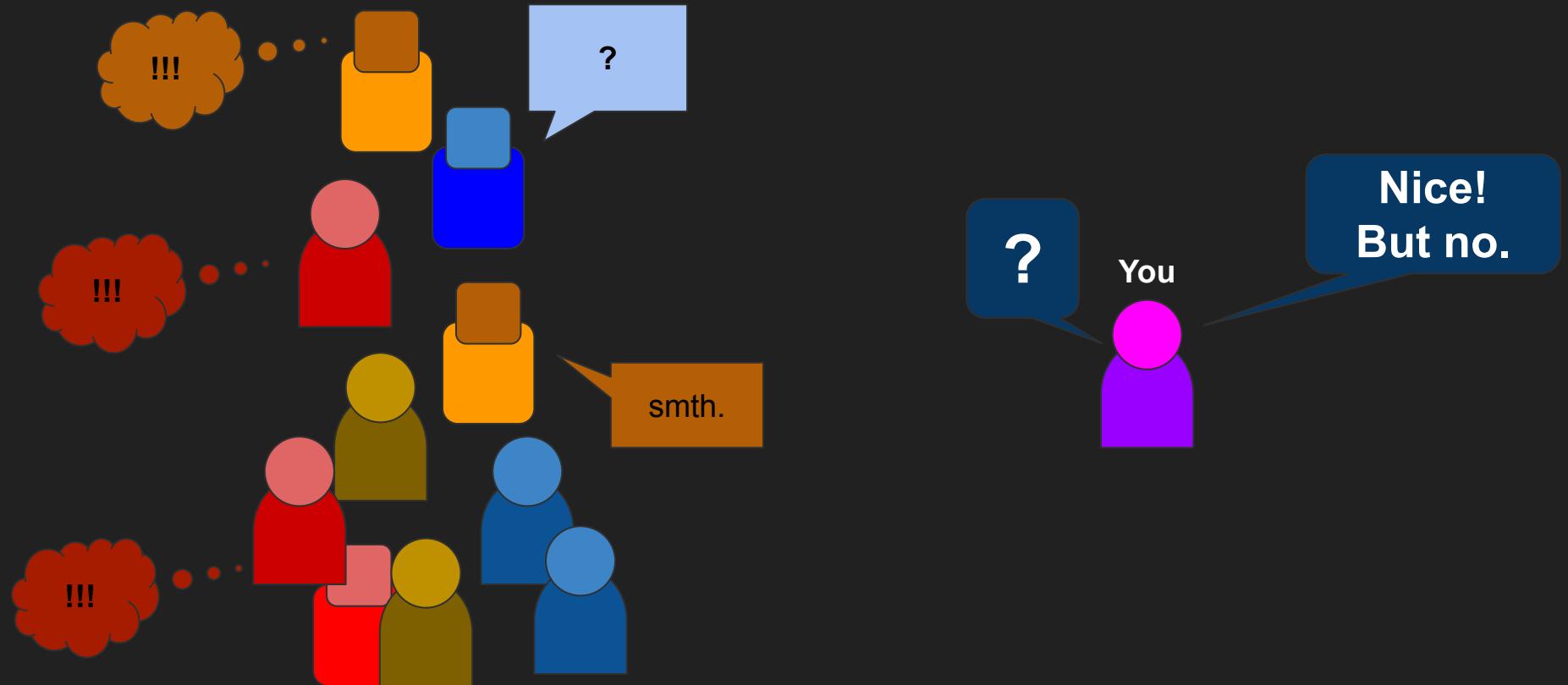




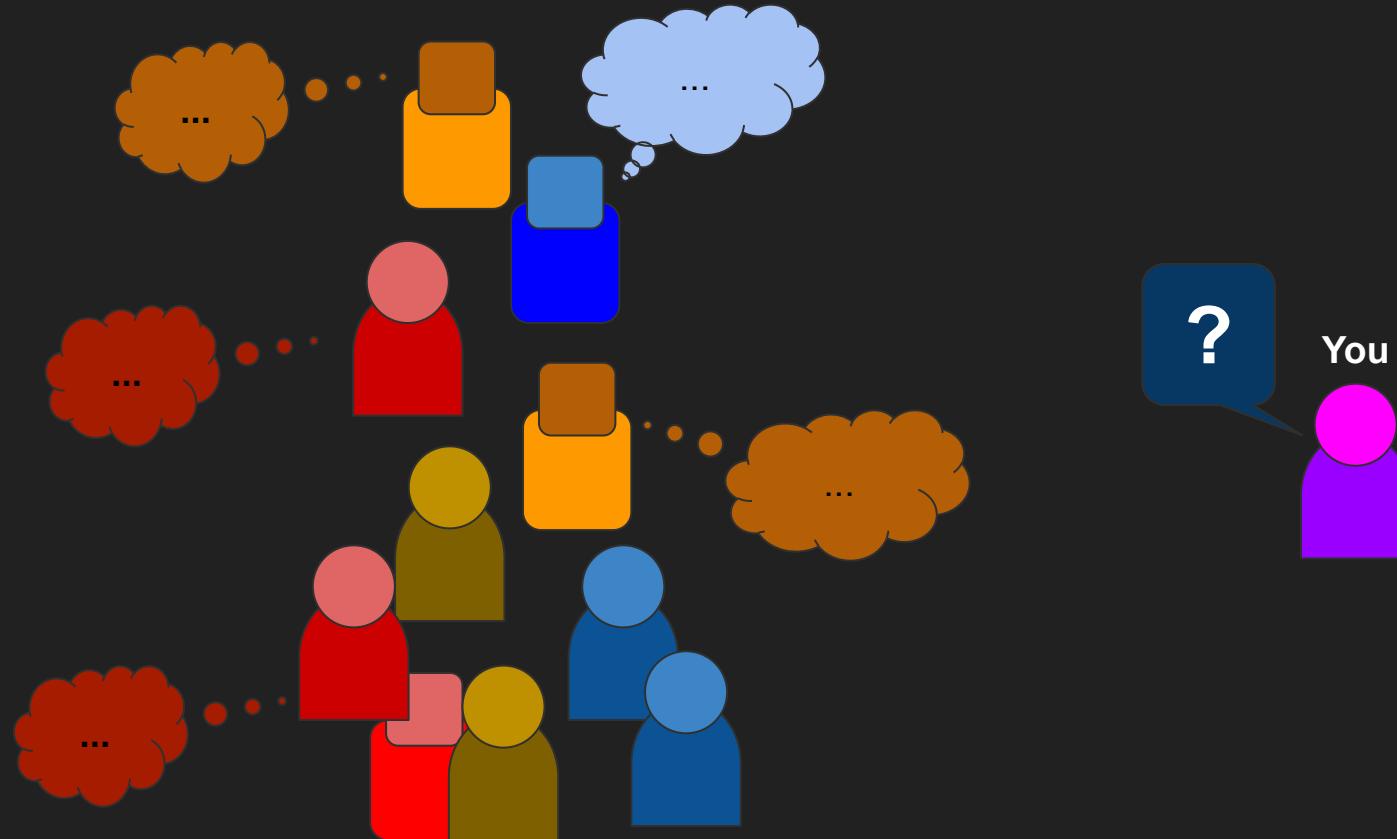
# Audience participation



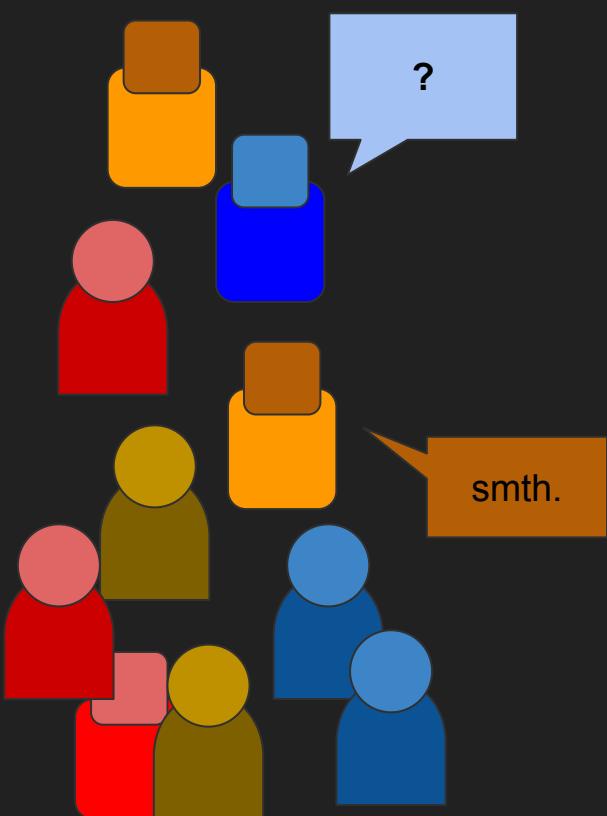
# Audience participation



# Audience participation



# Audience participation



You



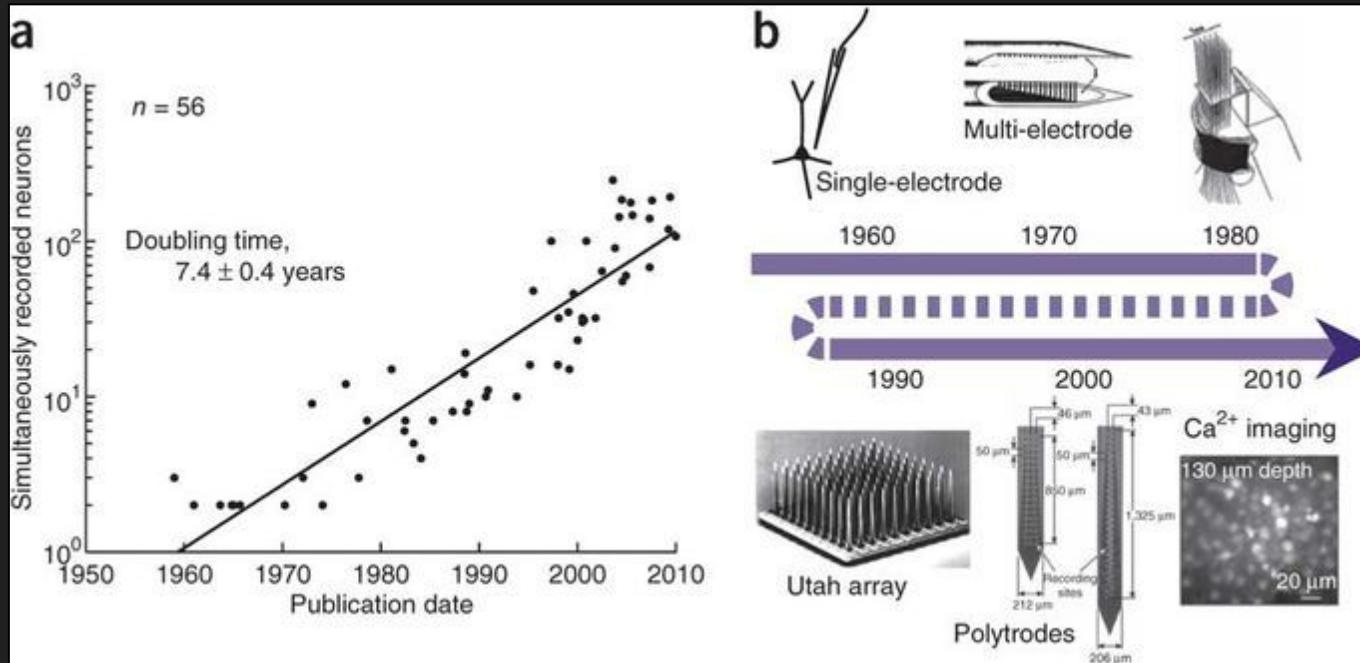


# Using humor in data storytelling

**If you use humor:**

- Make it subtle
- Make it light (don't offend)
- Make it general (don't target a person or group)
- About yourself (be humble)

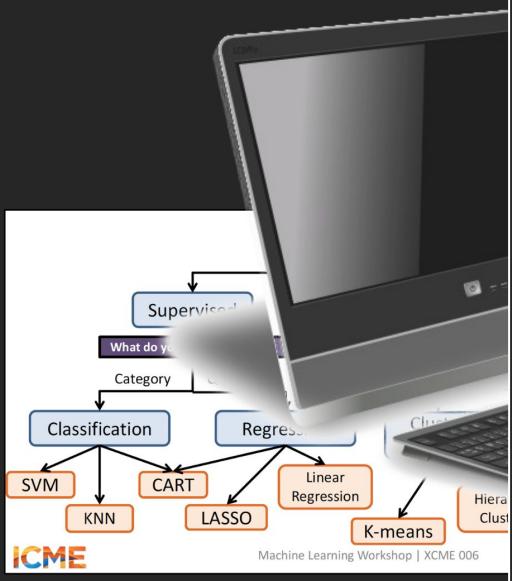
# Using humor in data storytelling



Stevenson and Kording, 2011, NN

# Using humor in data storytelling

The way math is used



# Using humor in data storytelling

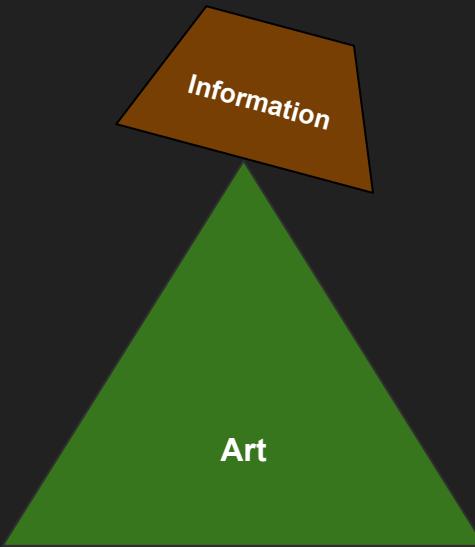
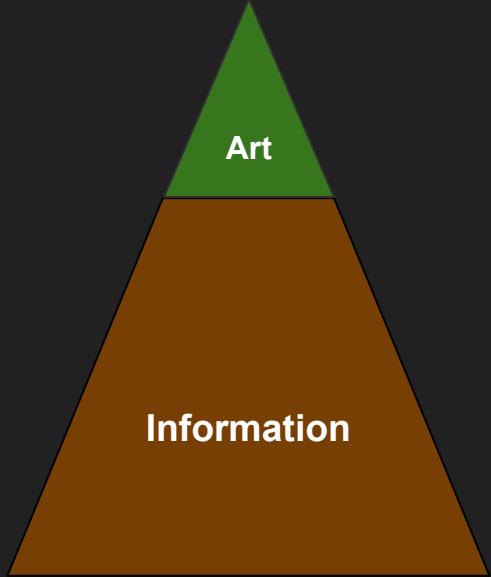
**If you use humor:**

- Make it subtle
- Make it light (don't offend)
- Make it general (don't target a person or group)
- About yourself (be humble)

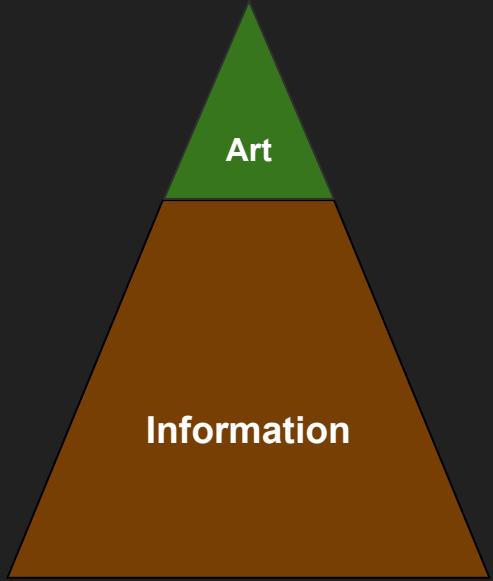




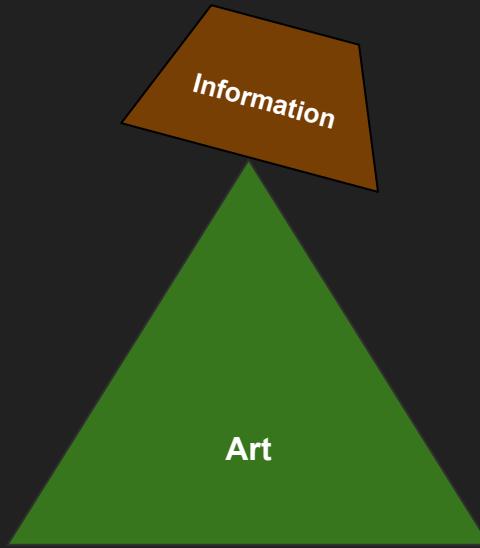
# Information before aesthetics



# Information before aesthetics

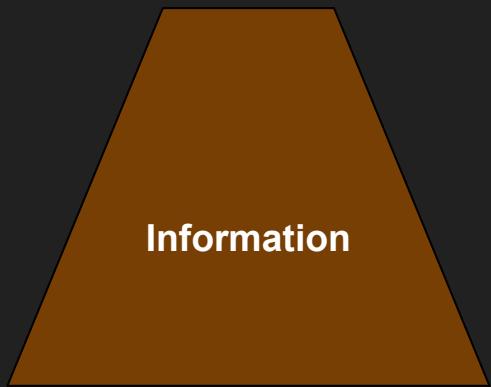


**Message:**  
I care about data,  
discovery, and information.

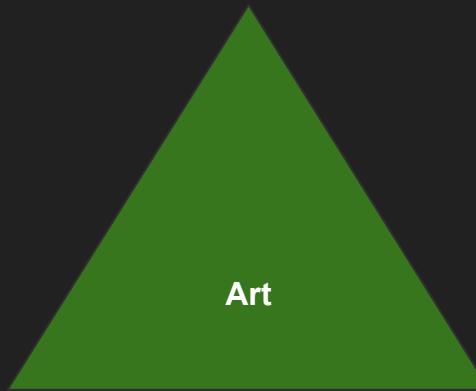


**Message:**  
Focus on the colors;  
I'm unsure about the data.

# Information before aesthetics

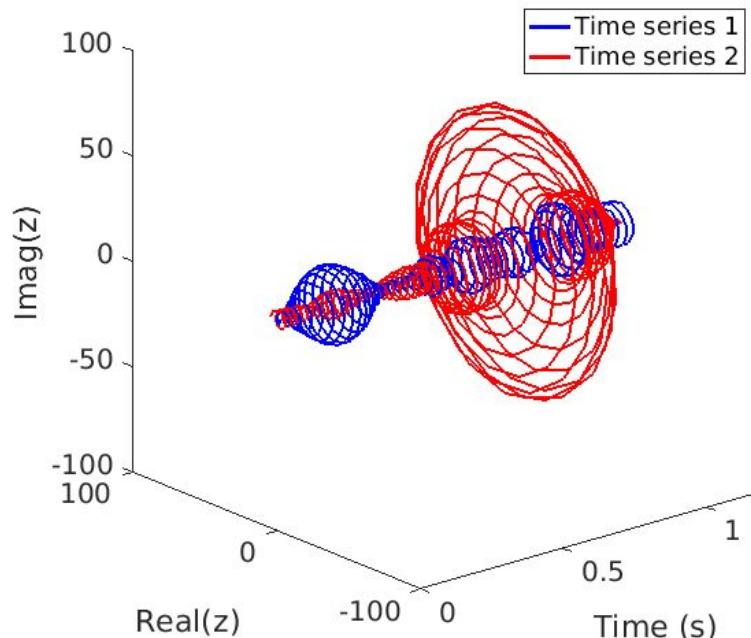
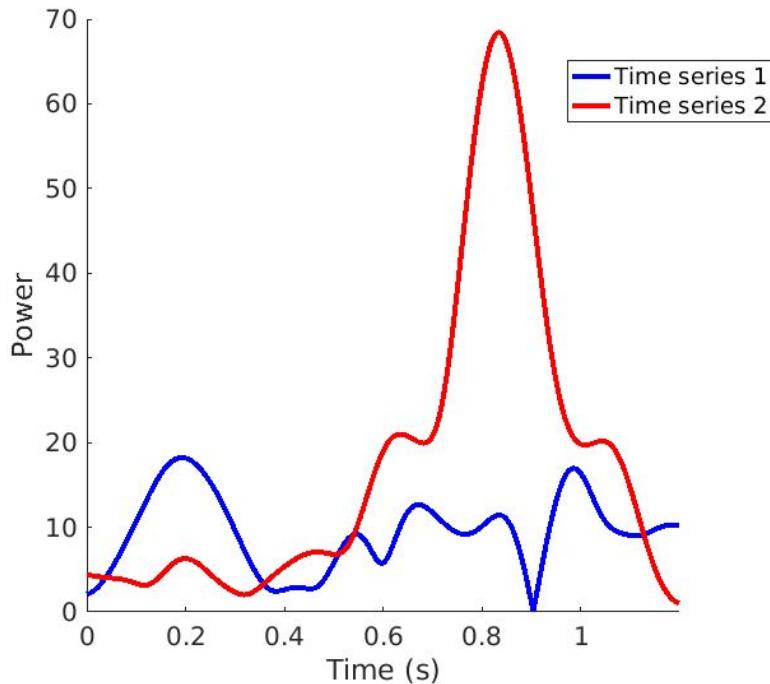


**Message:**  
*I don't care if you  
understand my data.*

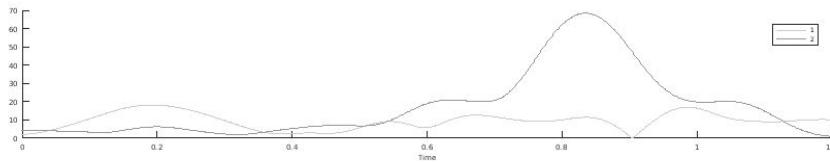
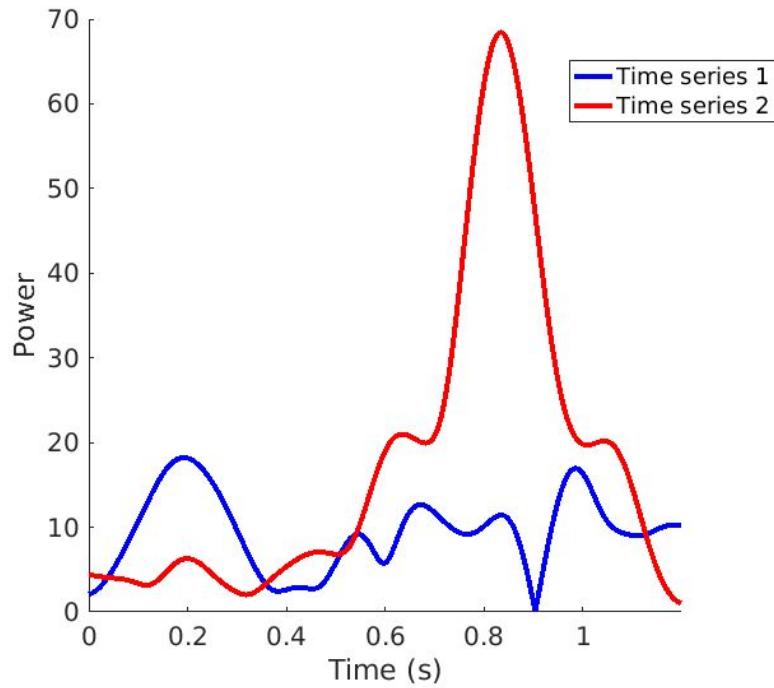


**Message:**  
*I don't care about data or  
information, and I don't  
care if you care.*

# Information before aesthetics

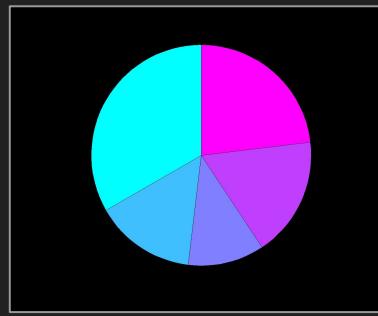
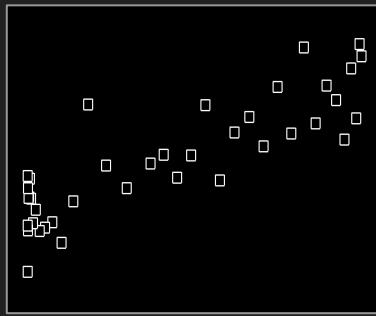
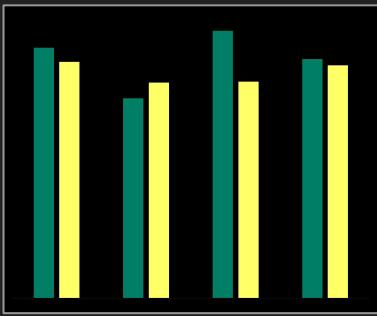
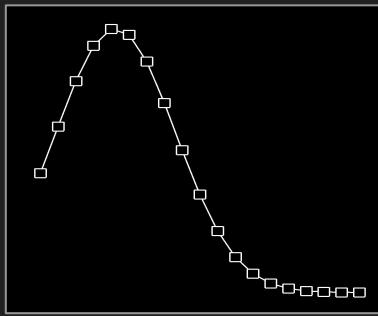


# Information before aesthetics

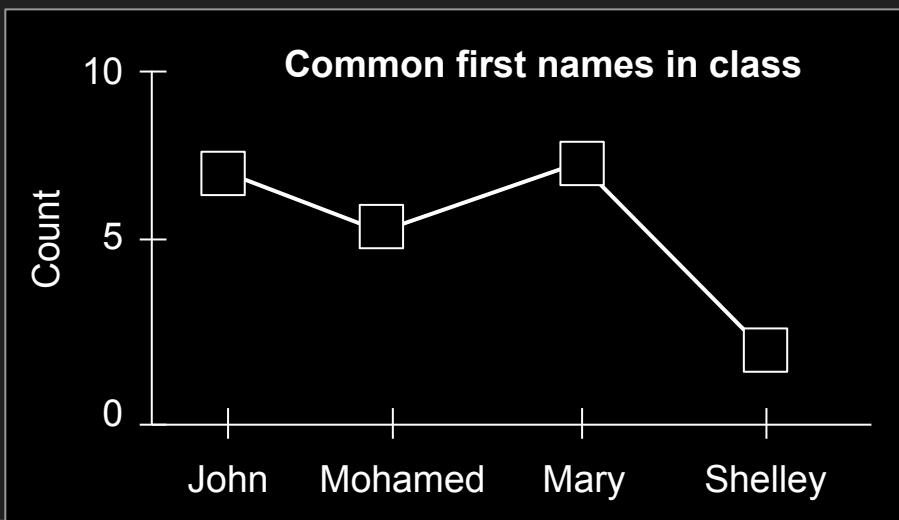
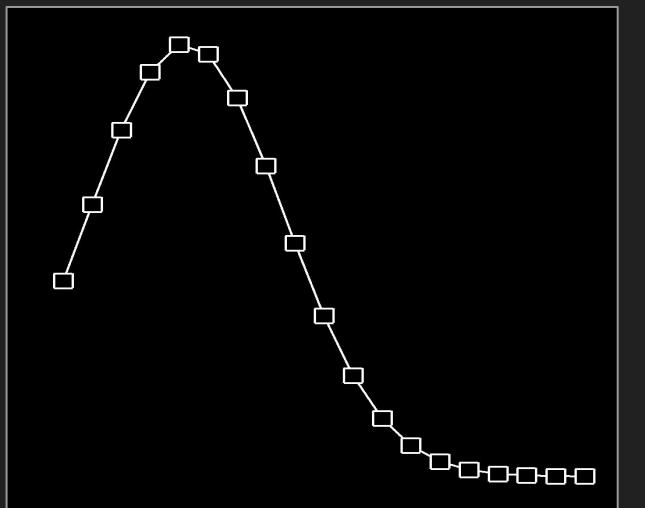
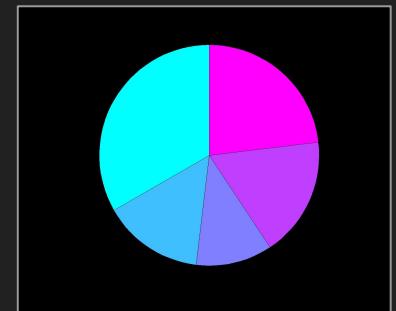
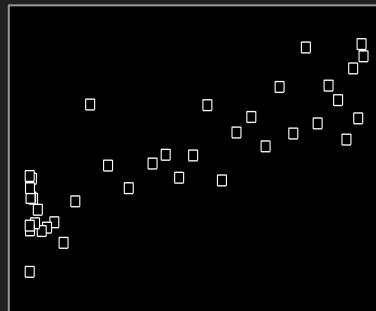
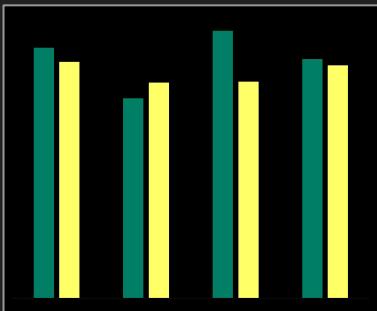




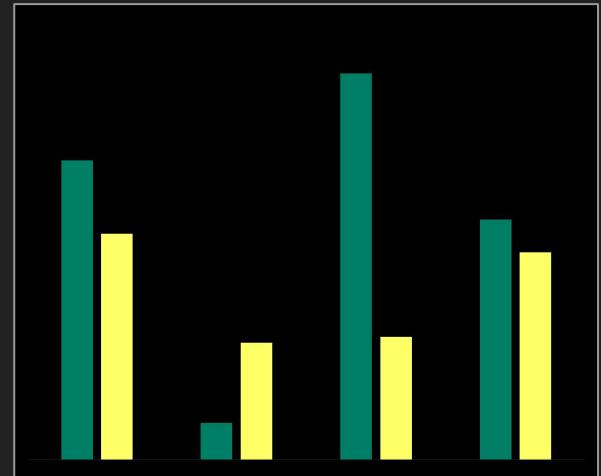
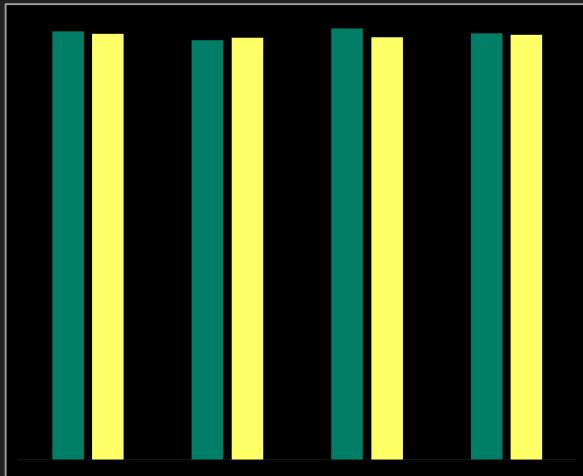
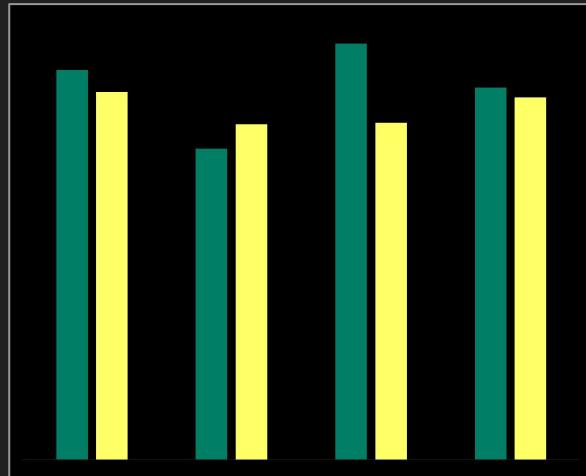
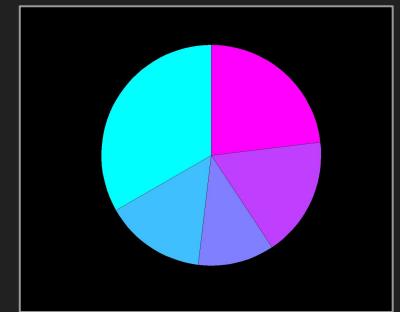
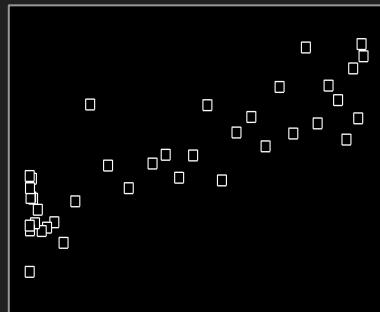
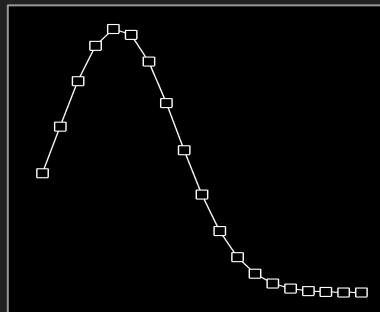
# Lines, bars, dots, pie charts, etc.



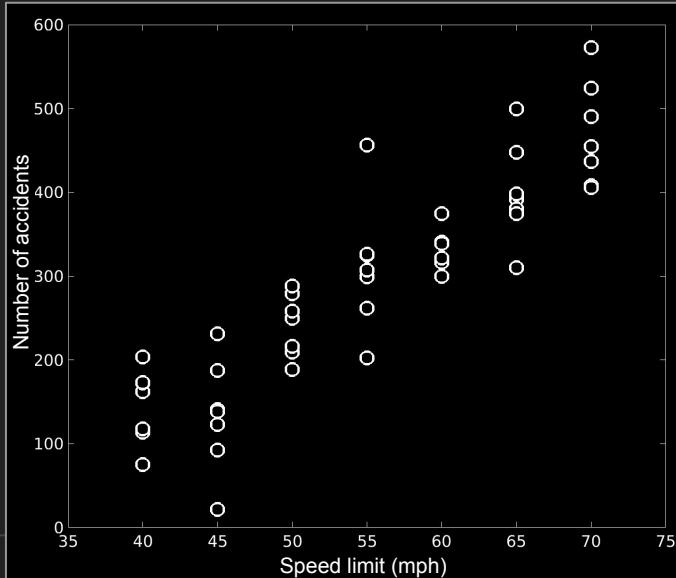
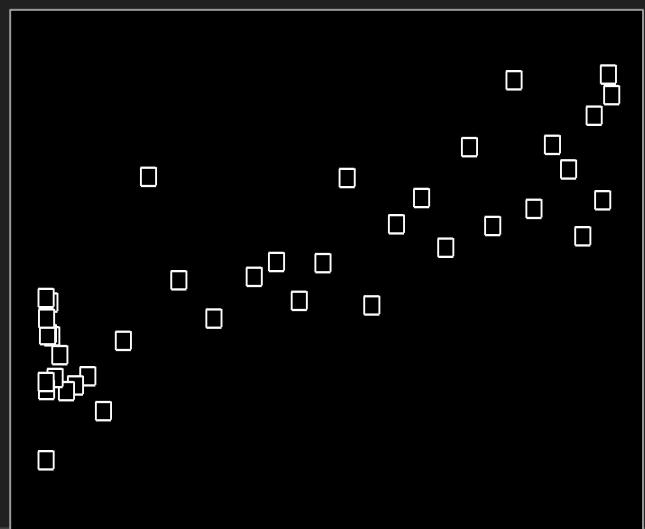
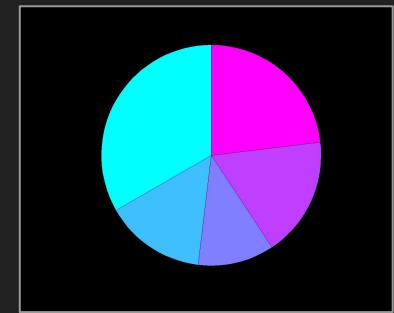
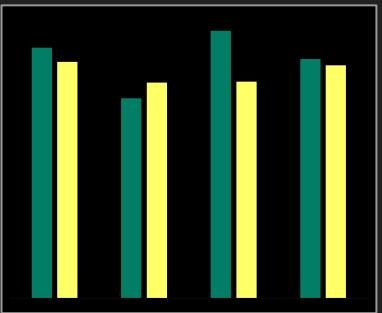
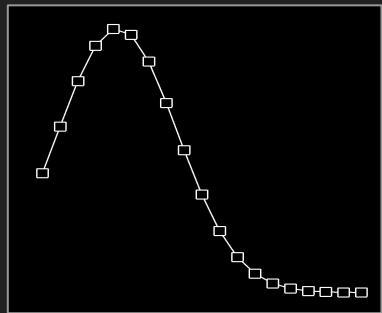
# Lines, bars, dots, pie charts, etc.



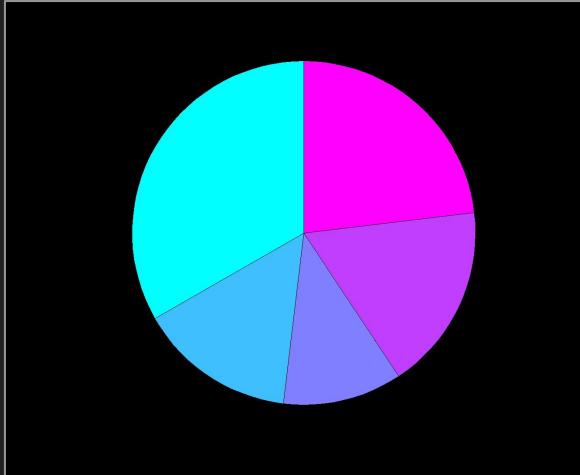
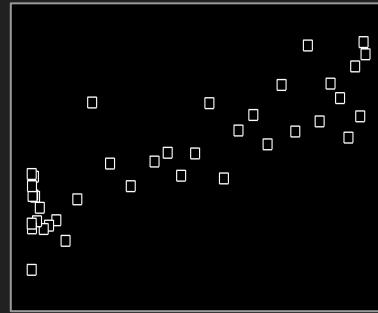
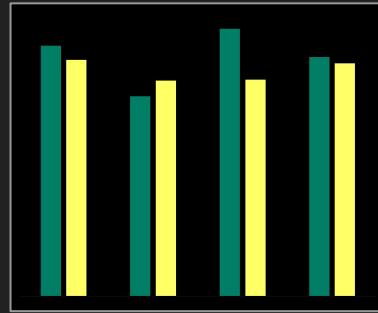
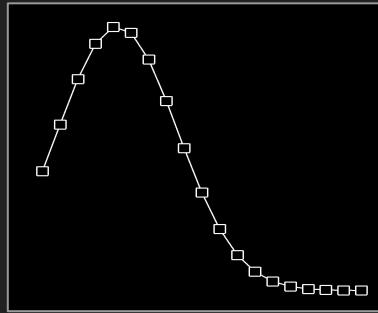
# Lines, bars, dots, pie charts, etc.



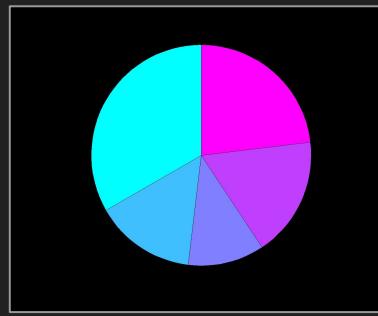
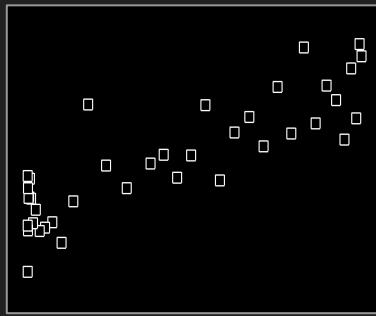
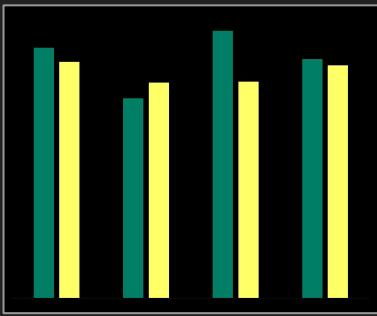
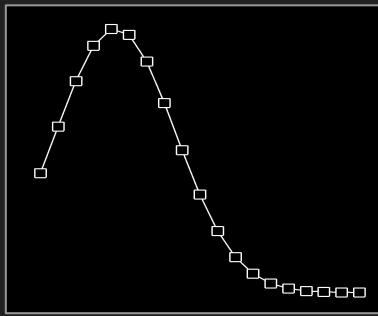
# Lines, bars, dots, pie charts, etc.



# Lines, bars, dots, pie charts, etc.



# Lines, bars, dots, pie charts, etc.





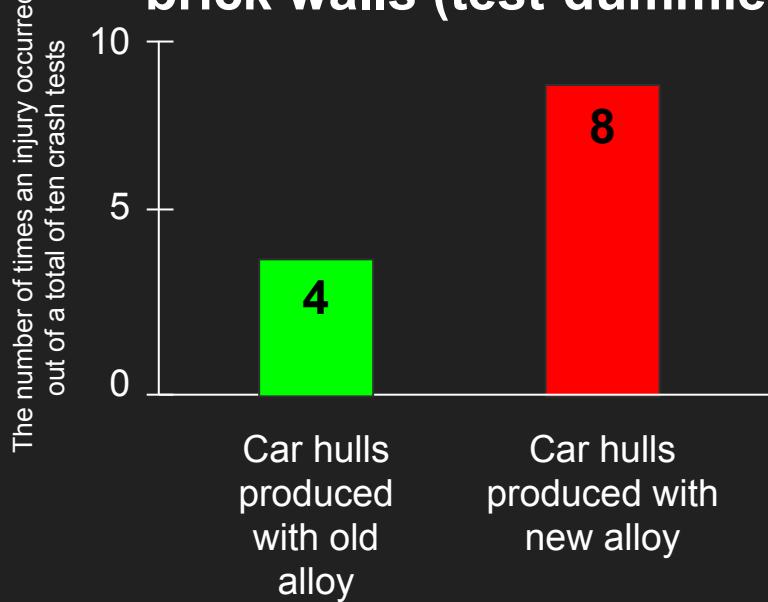
# Labels and legends

Use only when necessary

Use big font

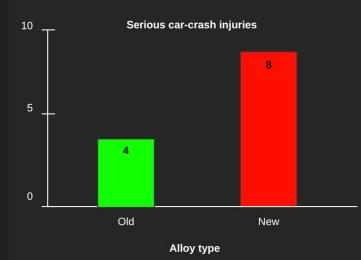
# Labels and legends

**Results of the experiment on driving cars with different body allows into brick walls (test-dummies)**



*Note: made-up data*

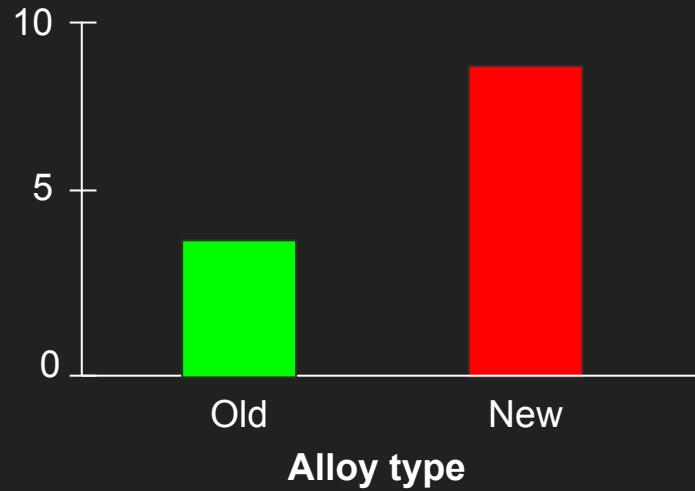
# Labels and legends



*Note: made-up data*

# Labels and legends

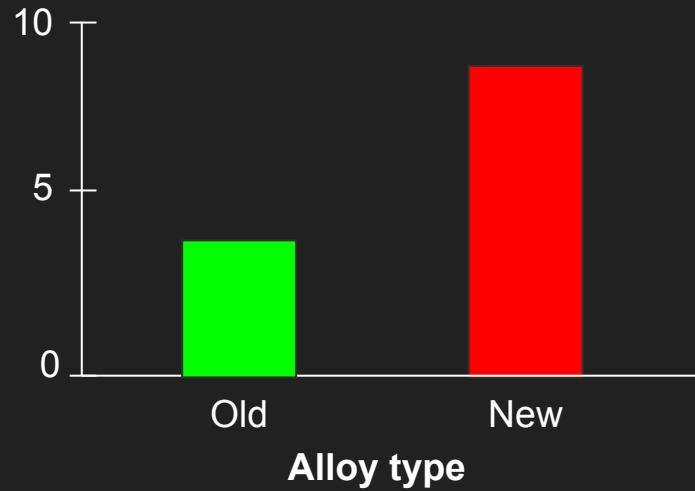
## Serious car-crash injuries



*Note: made-up data*

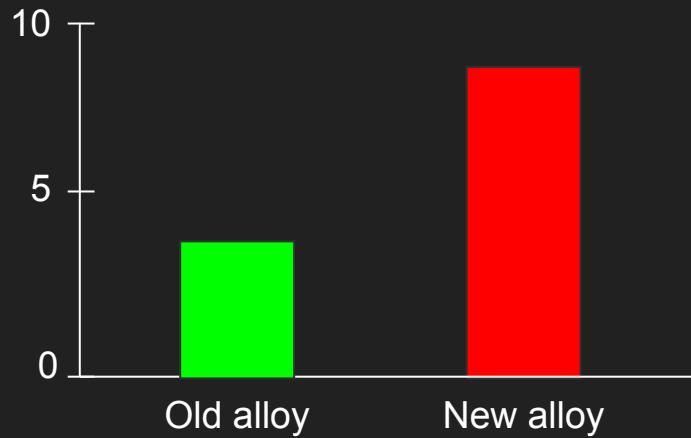
# Labels and legends

## Serious car-crash injuries



*Note: made-up data*

# Labels and legends



**Figure 1.** There were more serious injuries to test-dummies in cars with the new alloy compared to the old alloy.

*Note: made-up data*



# Colors



---

# Colors

---

Which colors to use?

# Colors

Screenshot of [color.adobe.com](https://color.adobe.com)

Adobe Color CC      Create      Explore      My Themes      Sign In       

Most Popular ▾

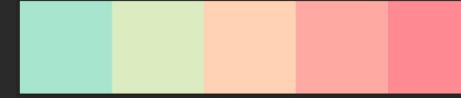
 Circus III      eye icon 150 thumb up icon 184 comment icon 0

 Kopie Aberdeen Reds      eye icon 179 thumb up icon 159 comment icon 0

 Copy of Flat Design Col...      eye icon 118 thumb up icon 121 comment icon 0

 pelican      eye icon 70 thumb up icon 103 comment icon 1

 Copy of Neutral Blue      eye icon 93 thumb up icon 95 comment icon 0

 Pastel Rainbow      eye icon 49 thumb up icon 79 comment icon 0

 PALHETA CLAUDINHA...      eye icon 126 thumb up icon 74 comment icon 0

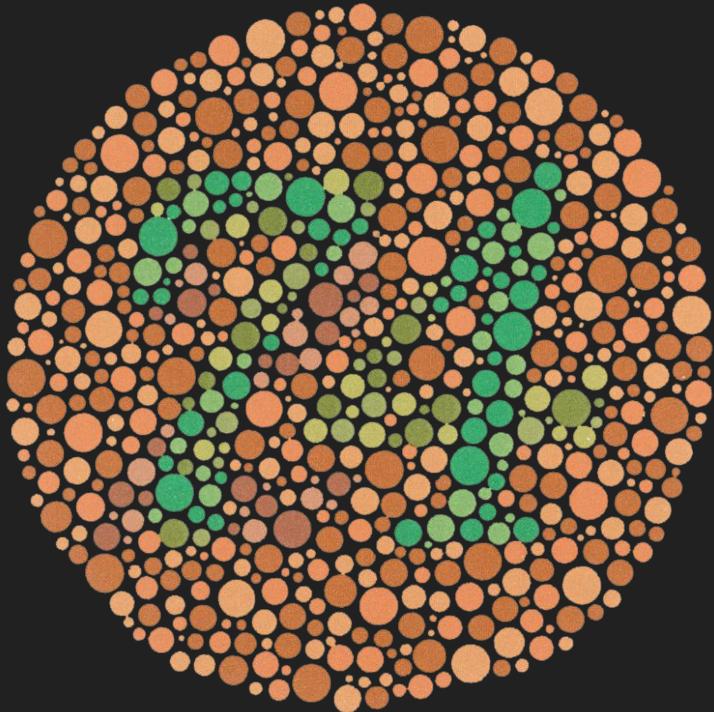
 pastel      eye icon 49 thumb up icon 52 comment icon 0

 toutCourt-02      eye icon 35 thumb up icon 48 comment icon 0

---

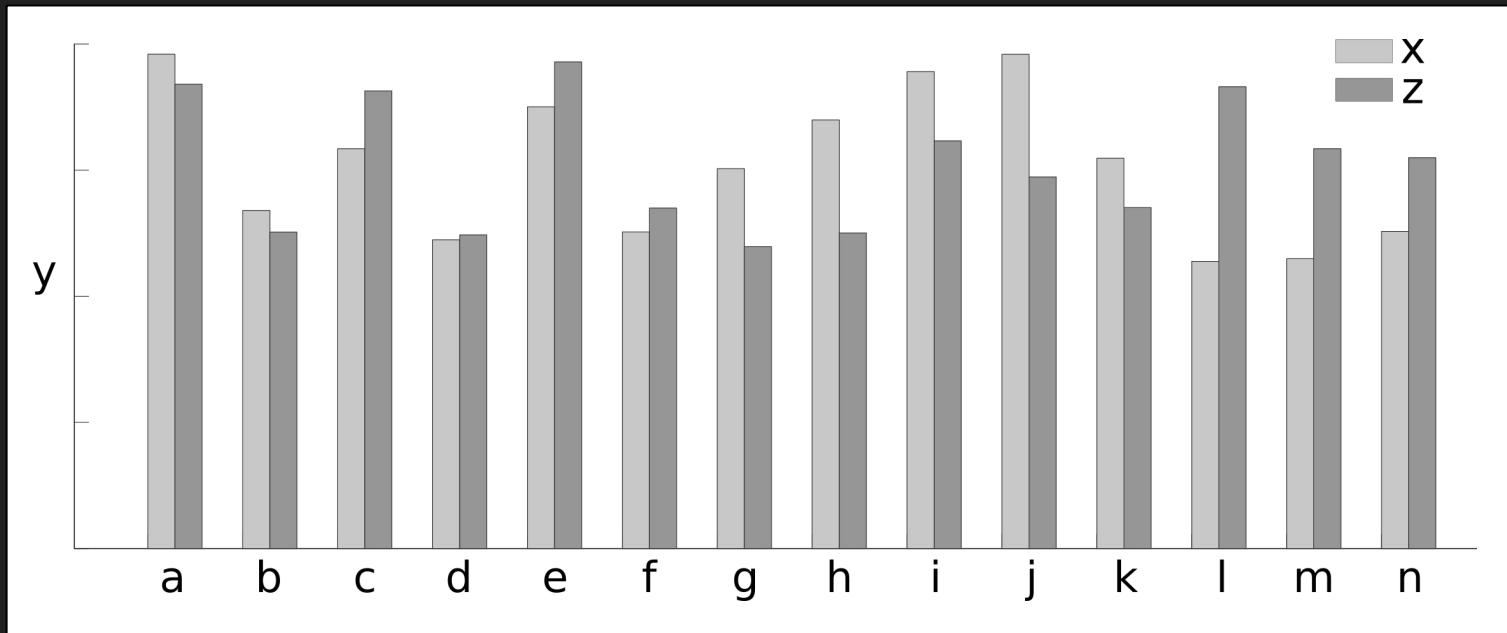
# Colors

---

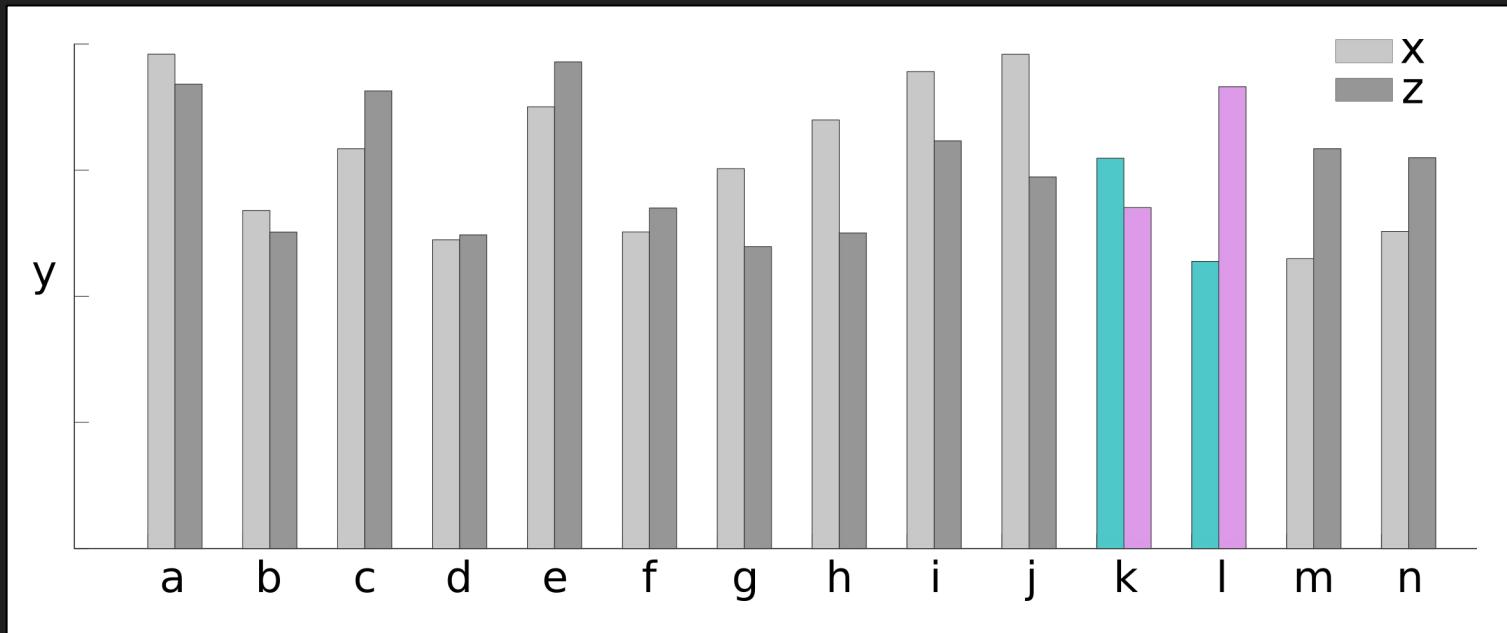




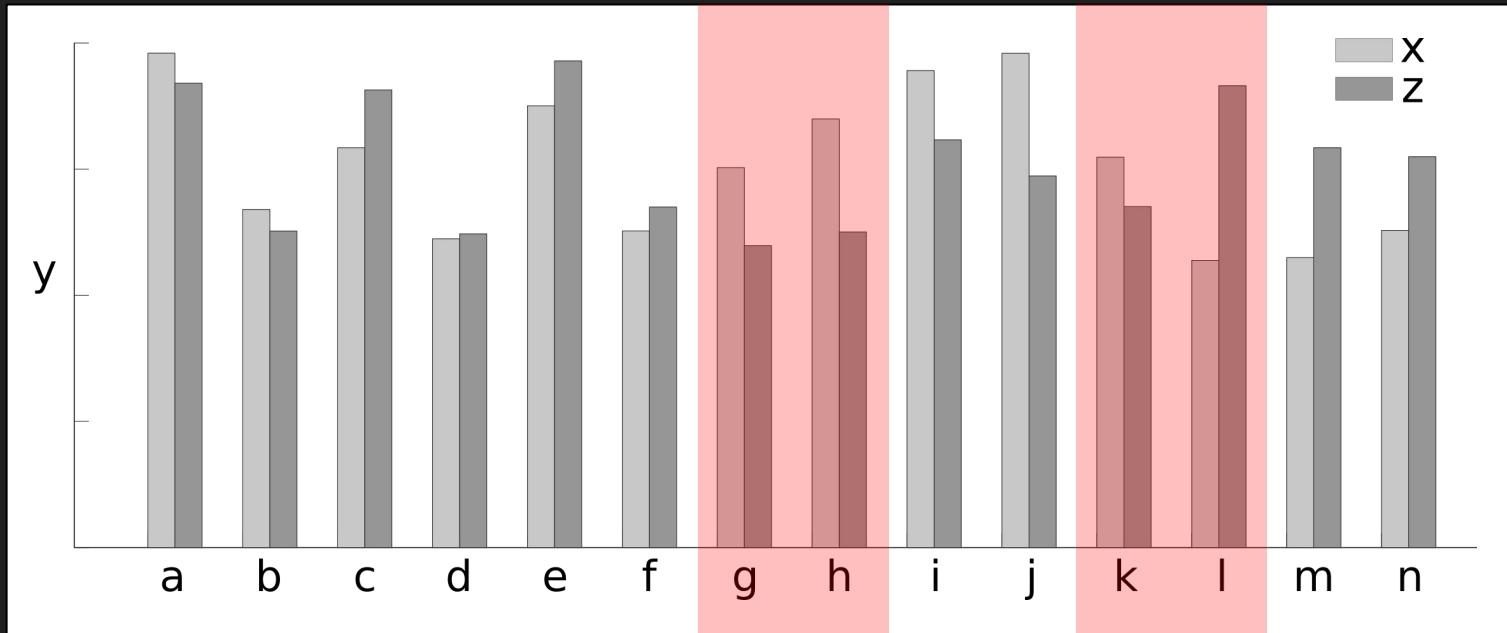
# Use color to highlight importance



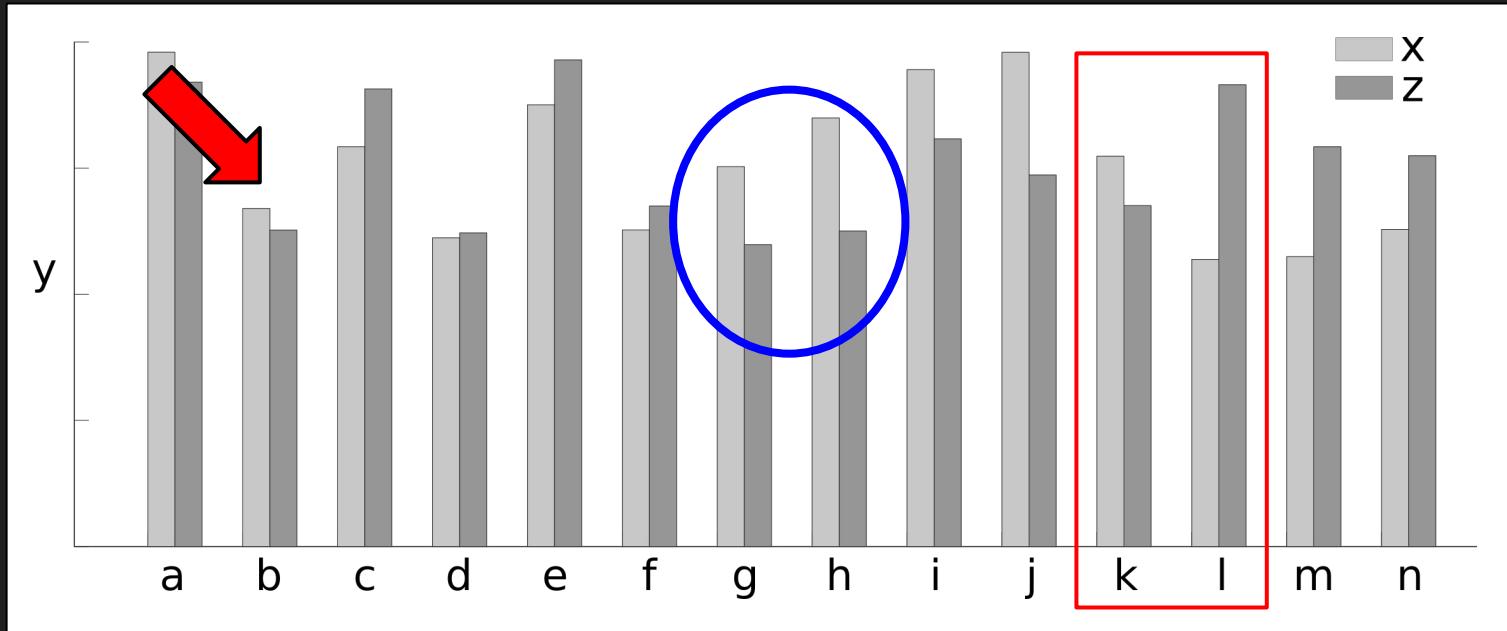
# Use color to highlight importance



# Use color to highlight importance



# Use color to highlight importance





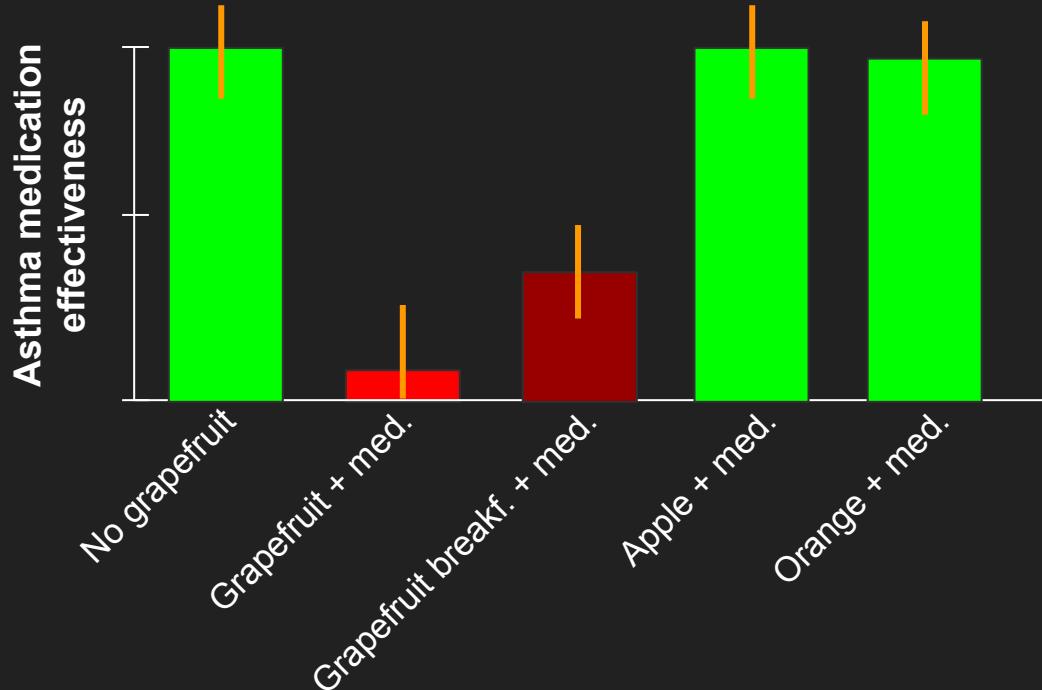
---

One graphic = one message

---

Each data graphic should contain  
exactly one message.

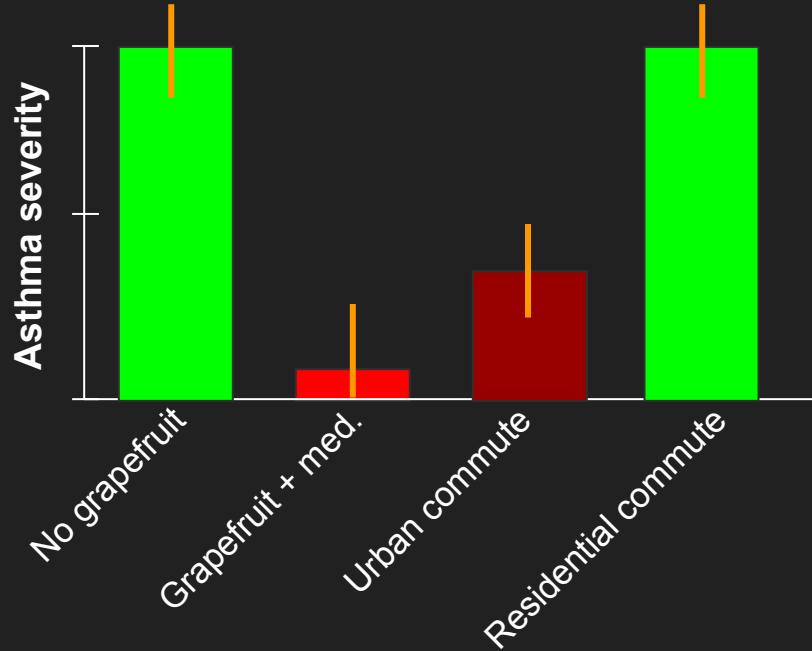
# One graphic = one message



*Note: made-up data*

**Figure 1.** Eating grapefruits decreases effectiveness of asthma medication.

# One graphic = one message



*Note: made-up data*

**Figure 1.** Eating grapefruits decreases effectiveness of asthma medication, and asthma is worse in urban compared to residential commutes.

---

One graphic = one message

---

Each data graphic should contain  
exactly one message.



# Software for data graphics

**Scientific programming**

**Statistical packages**

**Vector-based graphics**

**Pixel-based graphics**

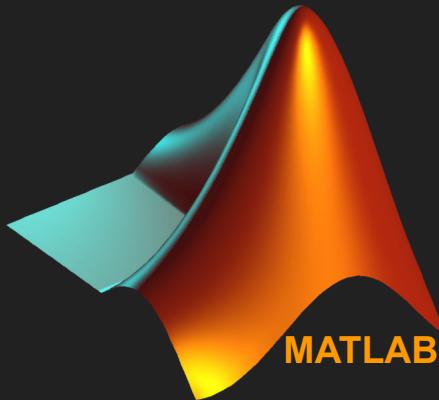
# Software for data graphics

**Scientific programming**

**Statistical packages**

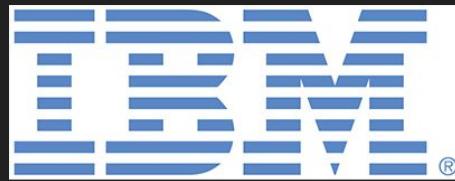
**Vector-based graphics**

**Pixel-based graphics**



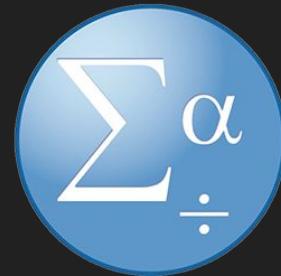
# Software for data graphics

Scientific programming



SPSS

Statistical packages



MS Excel



Vector-based graphics



Google  
Sheets

Pixel-based graphics

# Software for data graphics

Scientific programming

Statistical packages

Vector-based graphics

Pixel-based graphics



Adobe Illustrator



CorelDRAW®



INKSCAPE

# Software for data graphics

Scientific programming

Statistical packages

Vector-based graphics

Pixel-based graphics



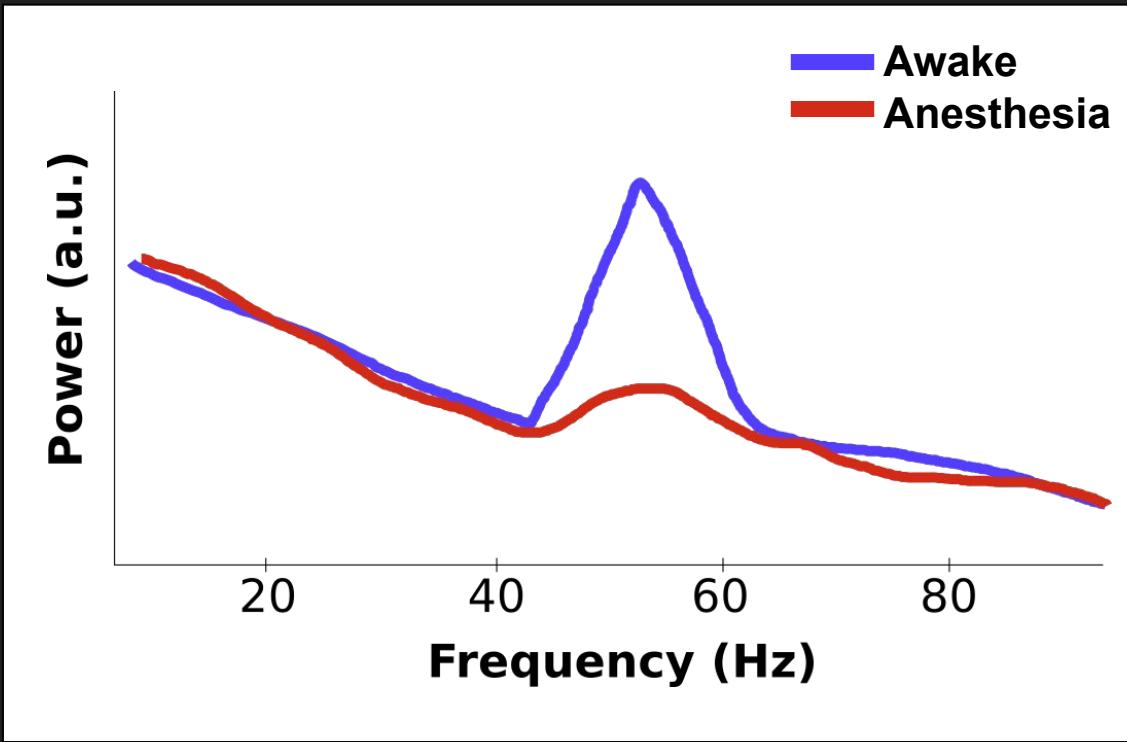
Photoshop



# Guide the audience through the plots



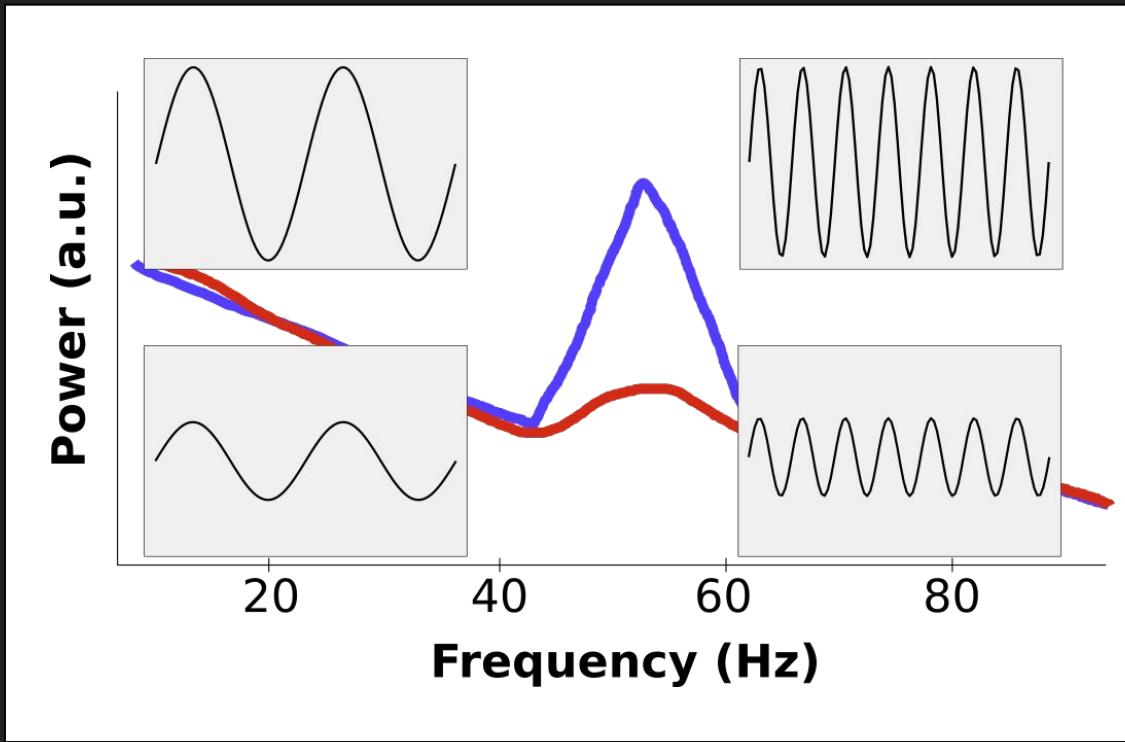
# Guide the audience through the plots



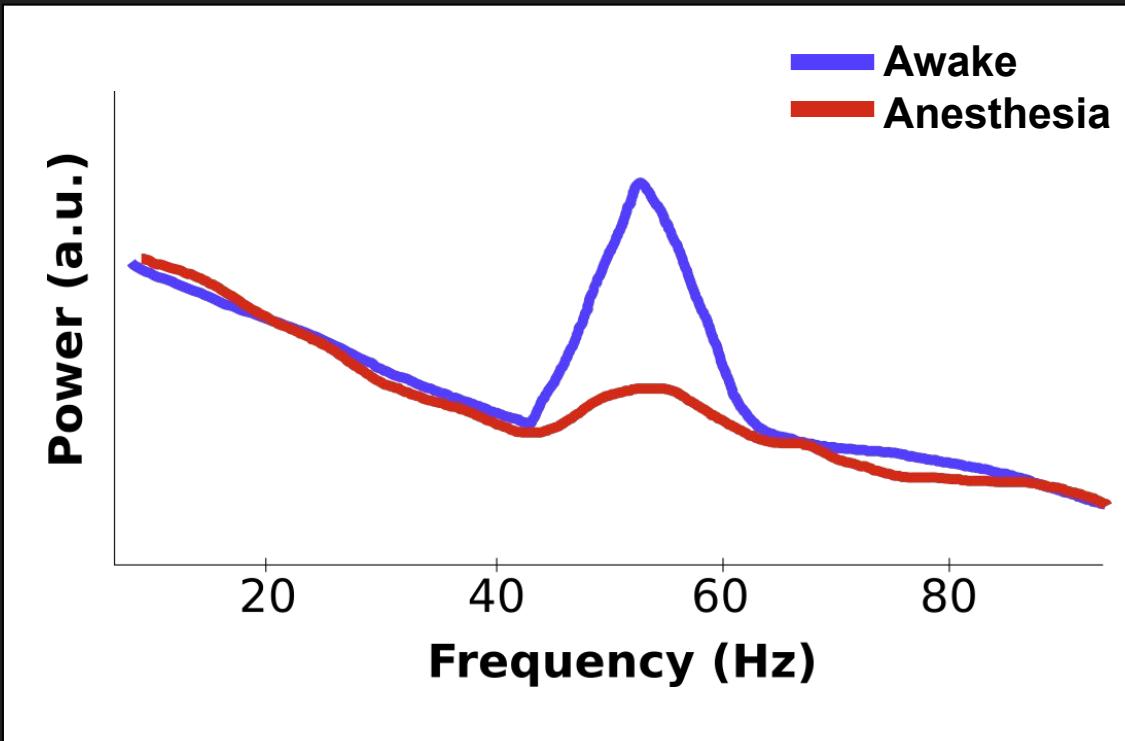
# Guide the audience through the plots



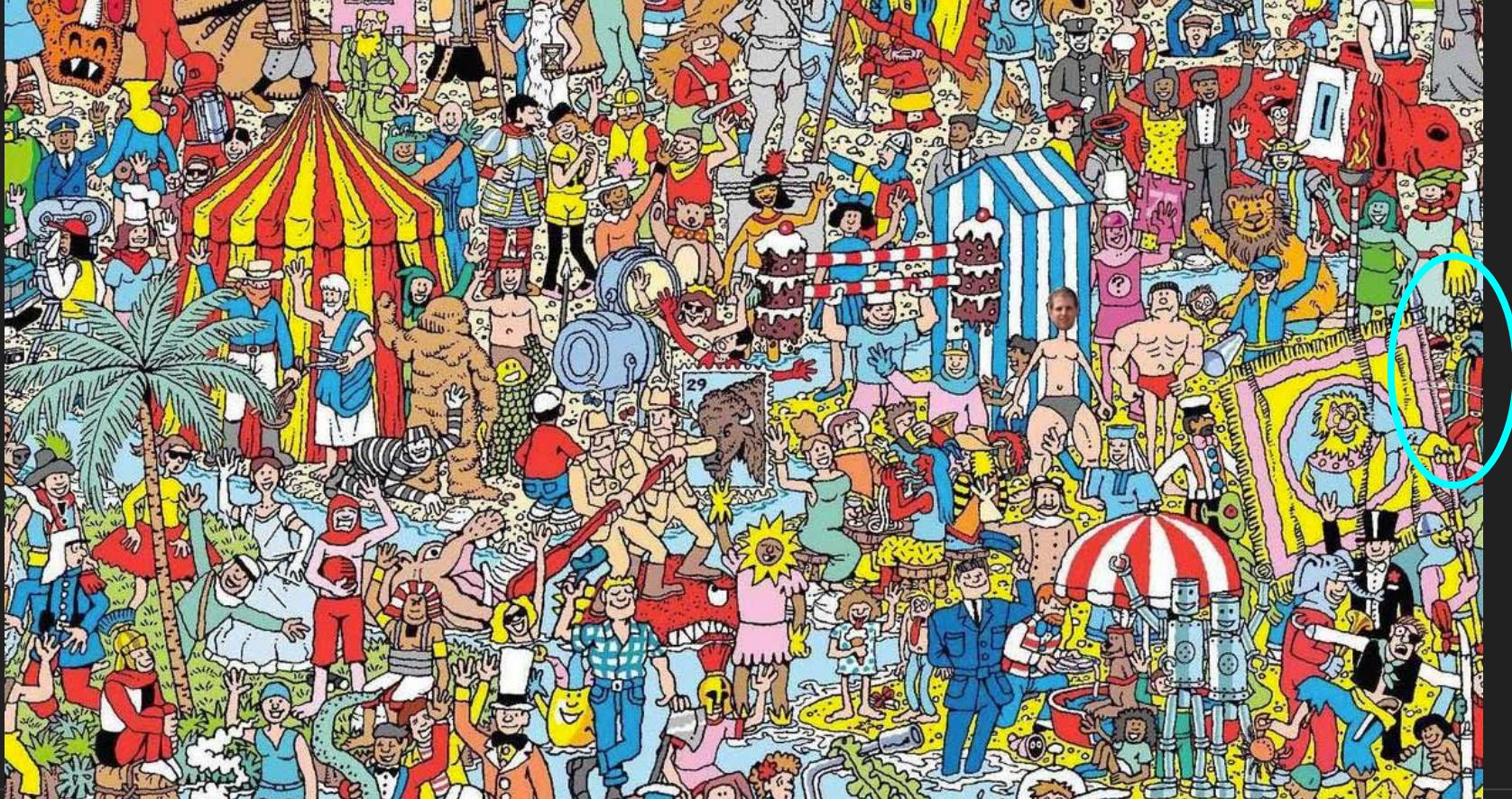
# Guide the audience through the plots



# Guide the audience through the plots



# Guide the audience through the plots

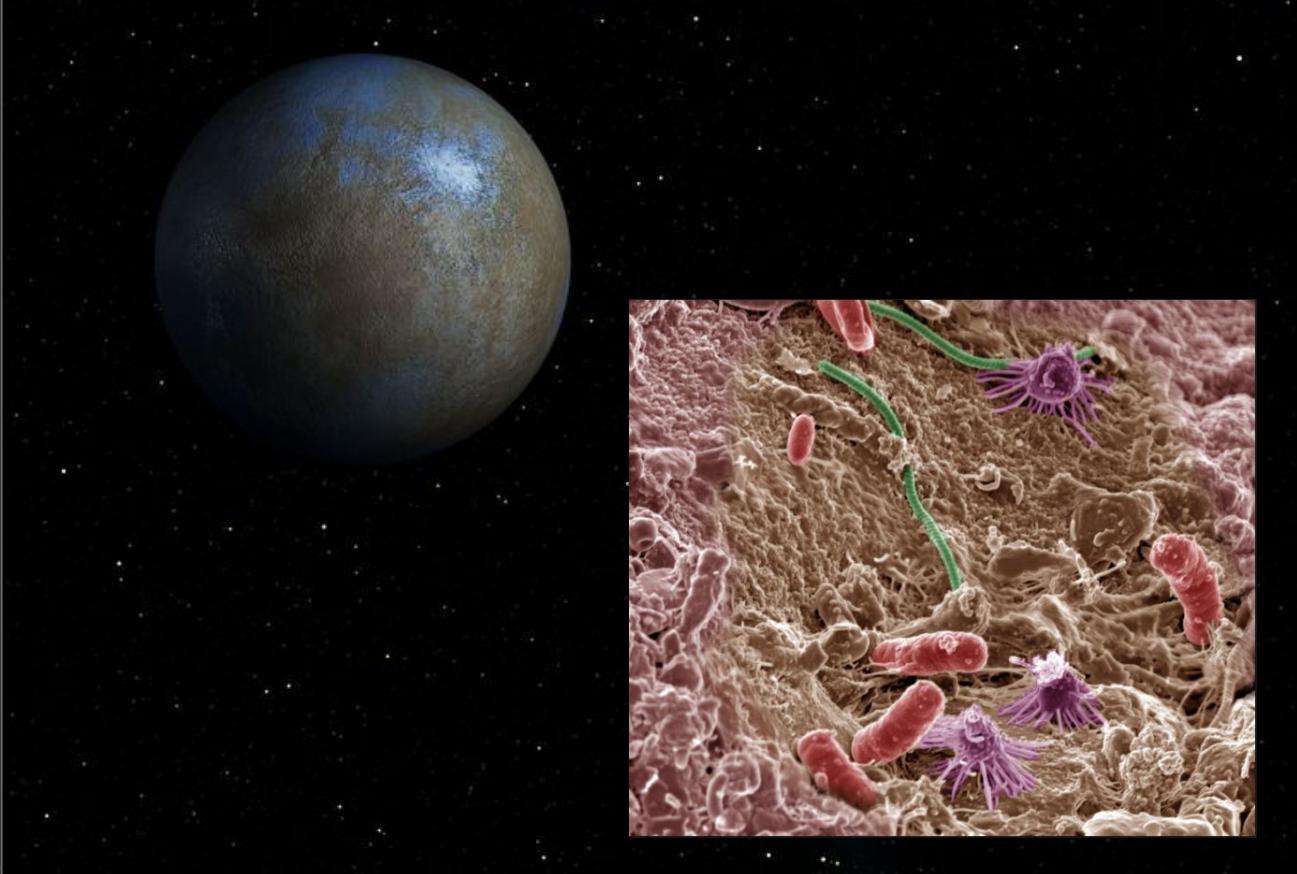




---

# Big picture first, details as appropriate

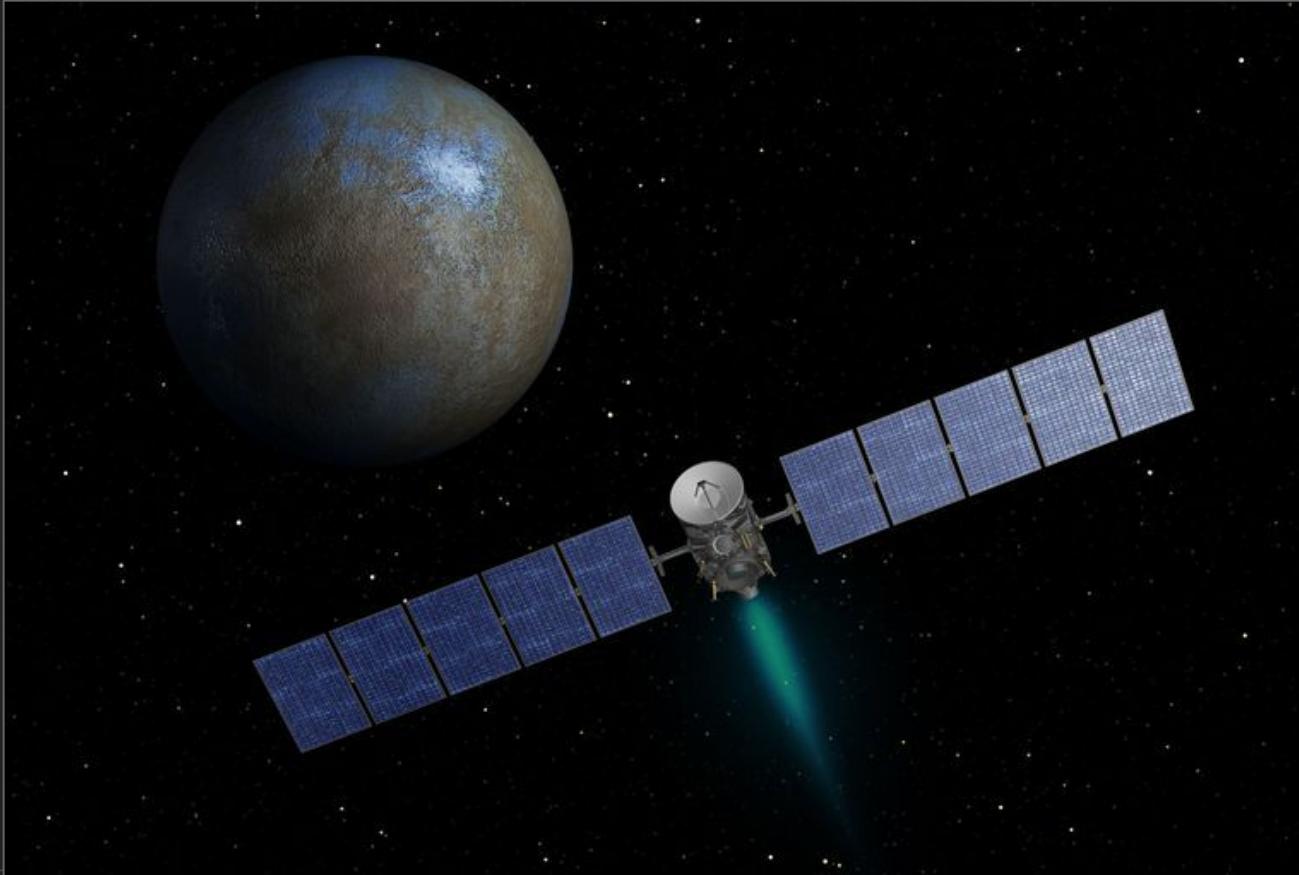
---



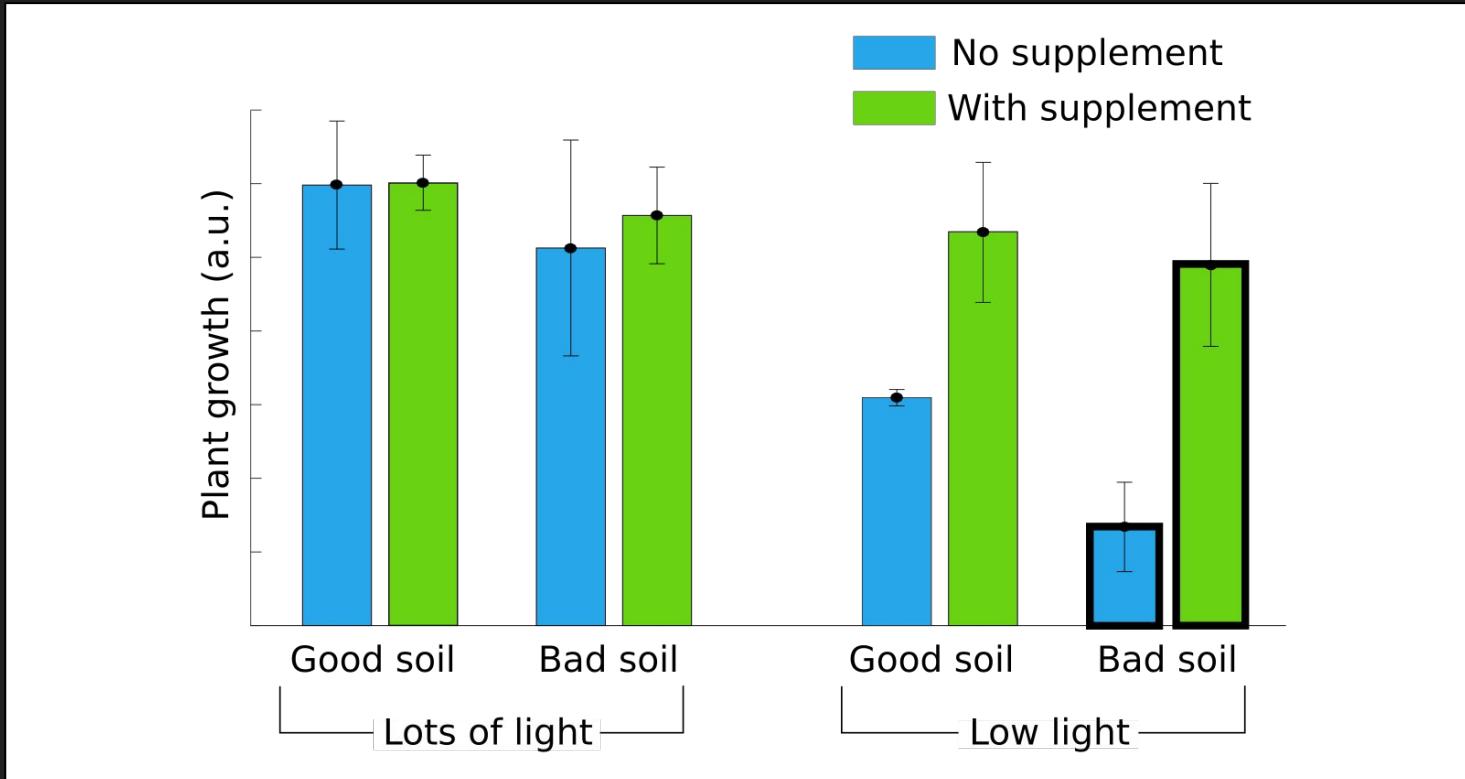
---

Big picture first, details as appropriate

---



# Big picture first, details as appropriate



---

# Big picture first, details as appropriate

---

Reminder of the main purpose of the data.

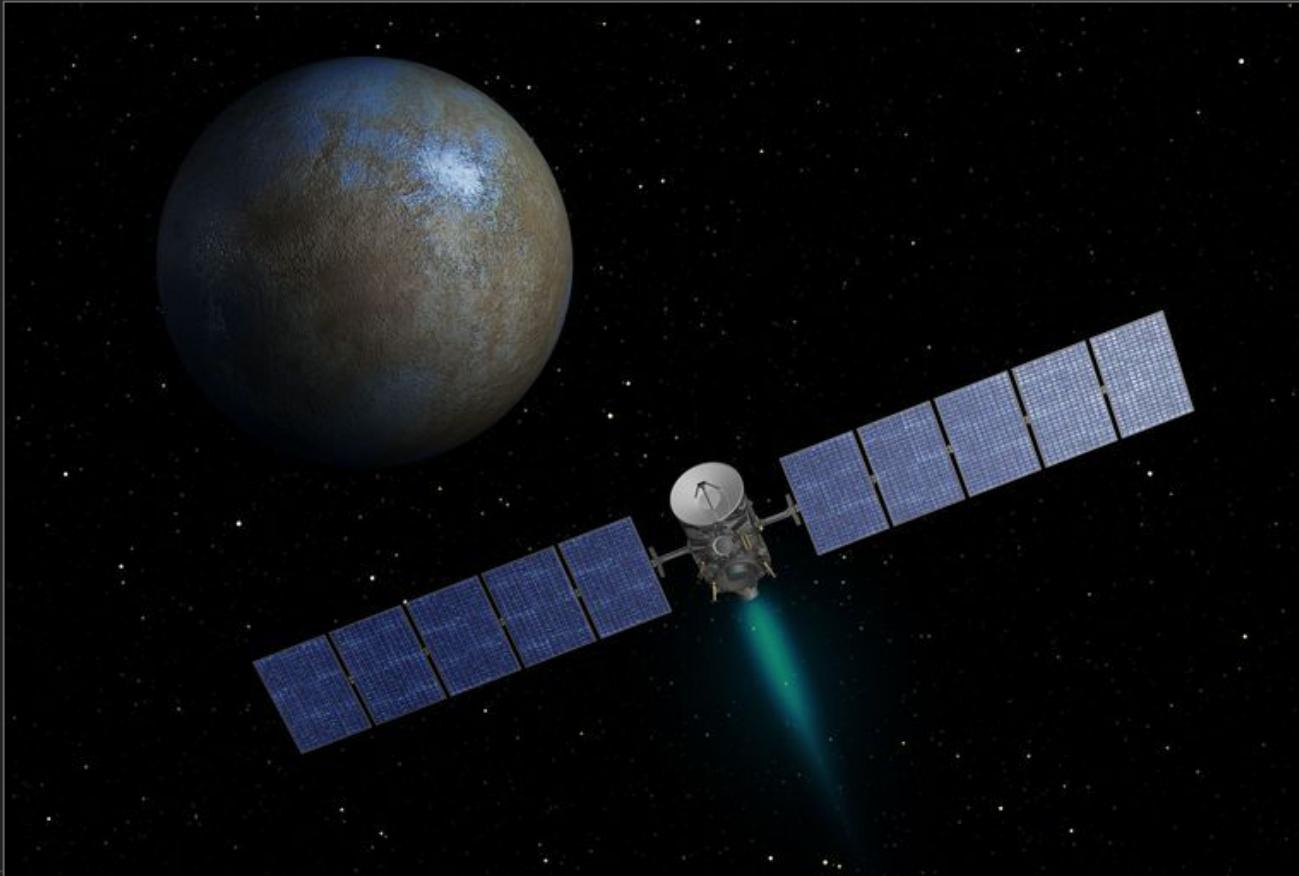
Interpret axes or colors.

Direct attention to the relevant data.

---

Big picture first, details as appropriate

---





# Impress with simplicity and clarity

**Written storytelling** Lasting presentation for bigger audience into the future.  
Audience more distracted by style or little mistakes.

**Spoken storytelling** One-time presentation for smaller audience.  
Audience more forgiving of style or little mistakes.

# Impress with simplicity and clarity

**Amateur**

“The audience will think I am an expert if I use big words and long sentences, and show-off how many details I know.”

**Expert**

“The audience will understand me if I present in a clear and comprehensible way that non-experts will understand.”

**Audience**

“I want to understand the data, but I’m not an expert and I need some guidance.”

# Impress with simplicity and clarity

## Be direct

- Use active voice  
(*I did this*, not *this was done by me*)
- Write important things first

In order for the data to be analyzed without concern of contamination from potentially artifactual data values, they had to be cleaned properly, which was done by the author, who used algorithms that follow established protocols for identifying unusually large data values.

I cleaned the data using established procedures. This was done to prevent artifacts from contaminating the results.

# Impress with simplicity and clarity

## Explanatory language

- Summarize the key finding in simple language.
- Explain what it means.  
*This means* or *this indicates*



# Impress with simplicity and clarity

## Use simple language

- Use simple grammar.
- Avoid technical terms and abbreviations.

Generalized eigendecomposition (GED) — a multivariate data-reduction method that was first developed for solving systems of differential equations and is implemented by computer libraries such as LAPACK — was applied to the sensor-by-time data matrix. GED results indicate that the data can be compressed into four feature dimensions using optimized eigenvectors, down from 80 dimensions of the original sensor space.

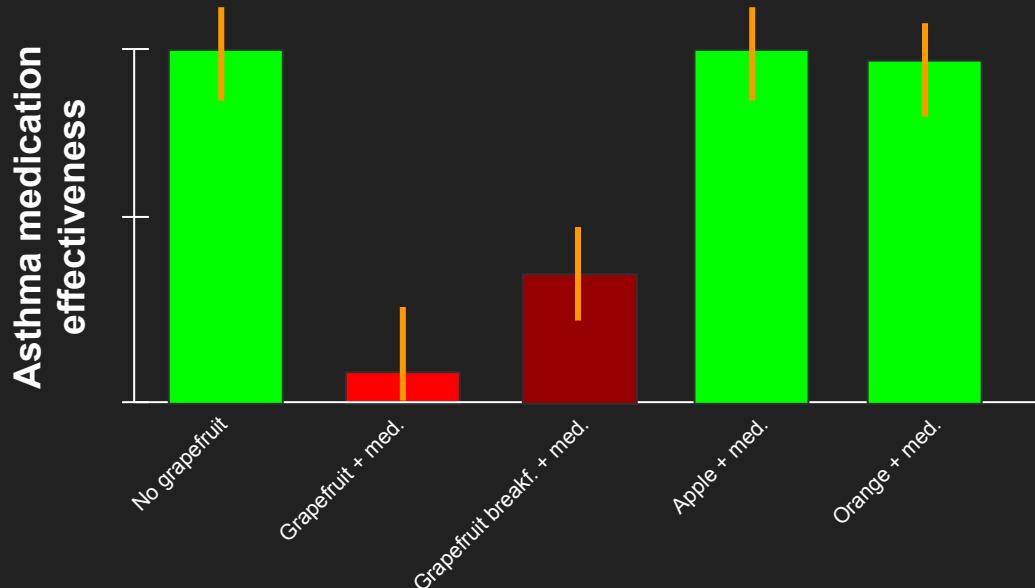
We used multivariate data analysis methods to determine that there are four important features in the data that were measured by the 80 sensors.



# Write for your grandmother



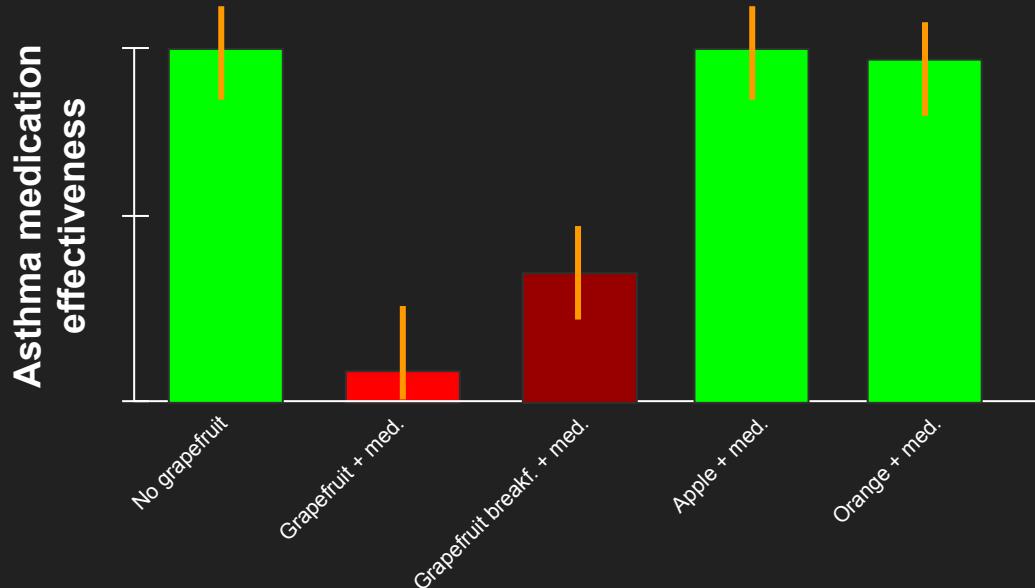
# Write for your grandmother



**Figure 1.** Outcomes of multiple case-controlled experimental trials (mean + stderror) of the univariate impacts of citrus variety as well as consumption time relative to medication ingestion on medically efficacious effects of standard treatment dosage of asthma-ameliorative compounds. Note that dose-response curves were not evaluated.

*Note: made-up data*

# Write for your grandmother

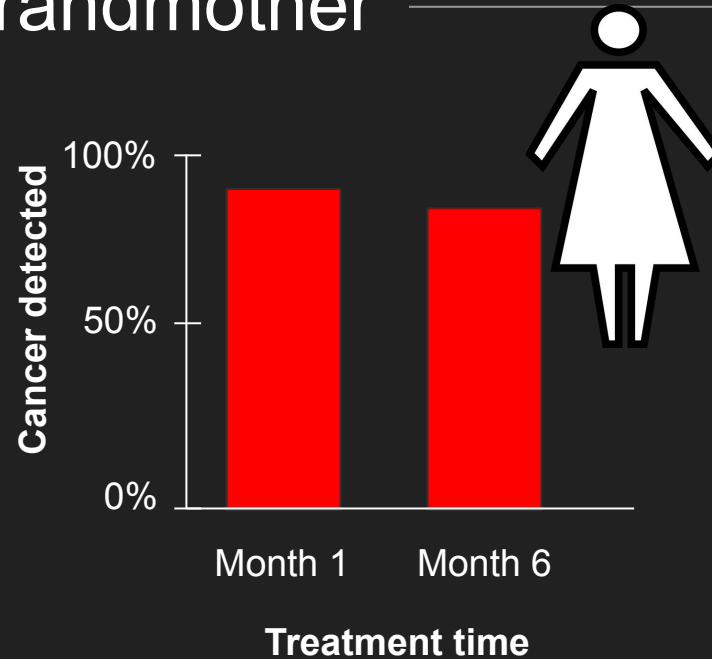
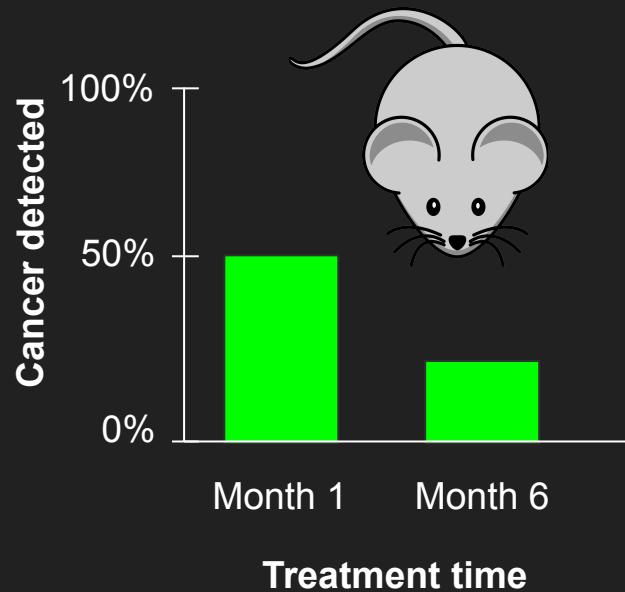


**Figure 1.** Eating grapefruits decreases effectiveness of asthma medication.

*Note: made-up data*

# Write for your grandmother

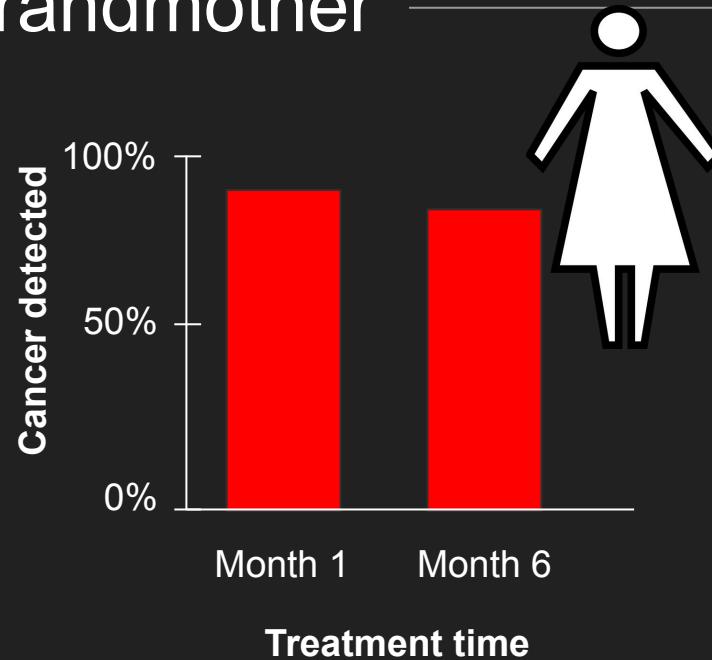
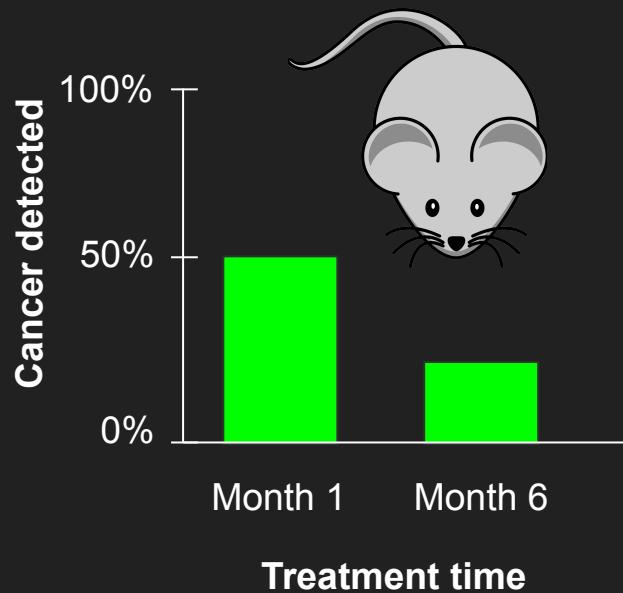
Note: made-up data



**Figure 1.** A new medication was developed in a research lab, with the goal of treating (ideally, curing) liver cancer. After initial lab tests, the scientists tested the treatment in mice (left bar plot). The experiment was a success, in that most mice tested cancer-free with 6 months of treatments. The scientists were still trying to understand why the remaining mice did not respond to treatment. With approval from the FDA, the scientists teamed up with a research hospital in the same city as the research lab, and began testing the treatment in humans. The results were disappointing, however, and most patients did not respond to the treatment. The scientists are trying to understand if this result is due to differences in dosage, other factors that could be considered, or if mouse liver physiology is too different from human liver physiology. They are currently trying to get more funding to continue the research; however, some politicians are cutting funding due to decreased federal budgets resulting from tax cuts.

# Write for your grandmother

Note: made-up data



**Figure 1.** A liver cancer treatment that seemed promising from studies in mice is not as effective as hoped in humans.

# Write for your grandmother

Dry, detailed, technical writing can be appropriate in some situations (e.g., internal technical report).





---

Make the audience care about the data

---



---

Make the audience care about the data

---

**Make the audience  
connect to the data.**

---

Make the audience care about the data

---



Study: **Does broccoli prevent memory decline?**

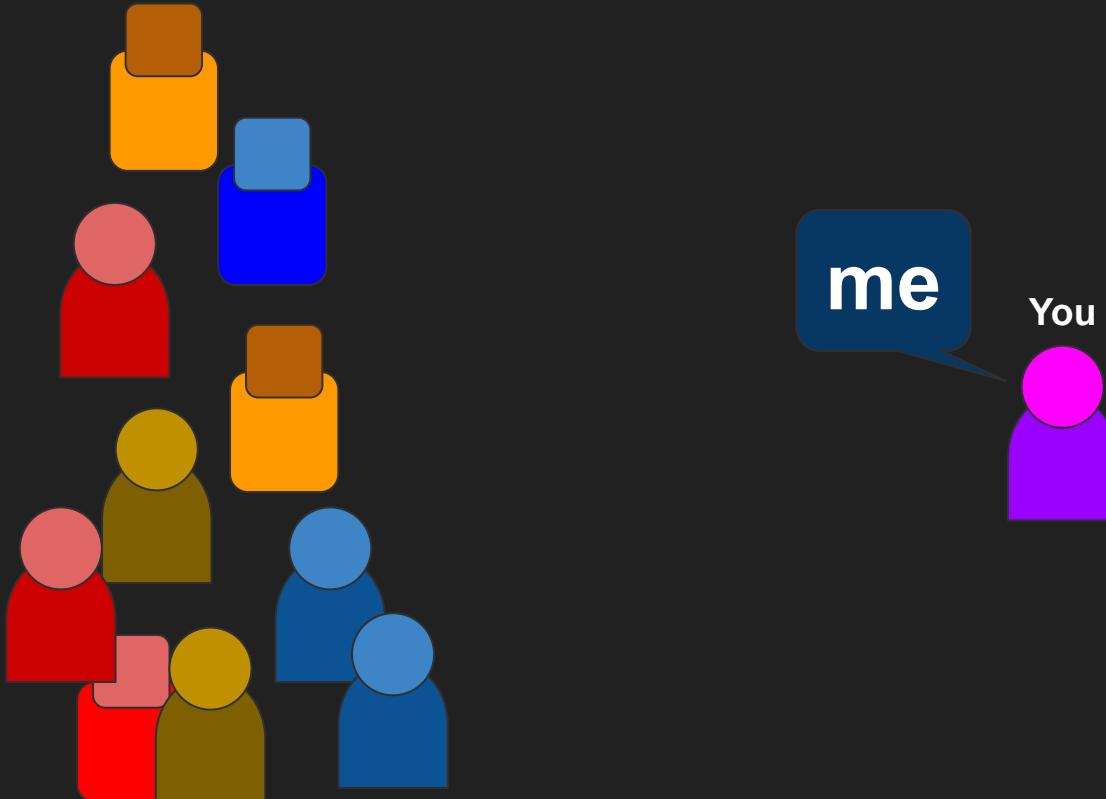
---

# Make the audience care about the data

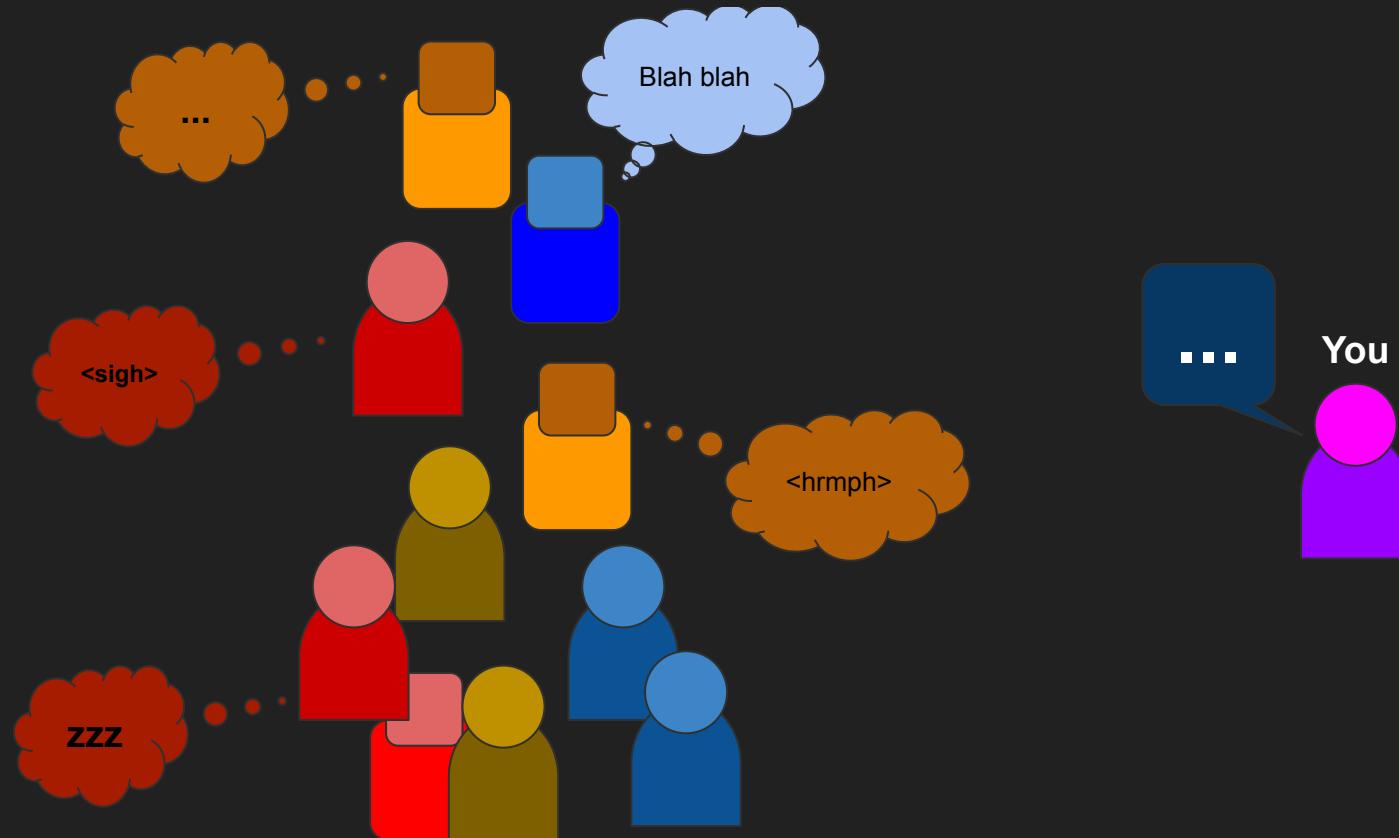
---



# Make the audience care about the data



# Make the audience care about the data

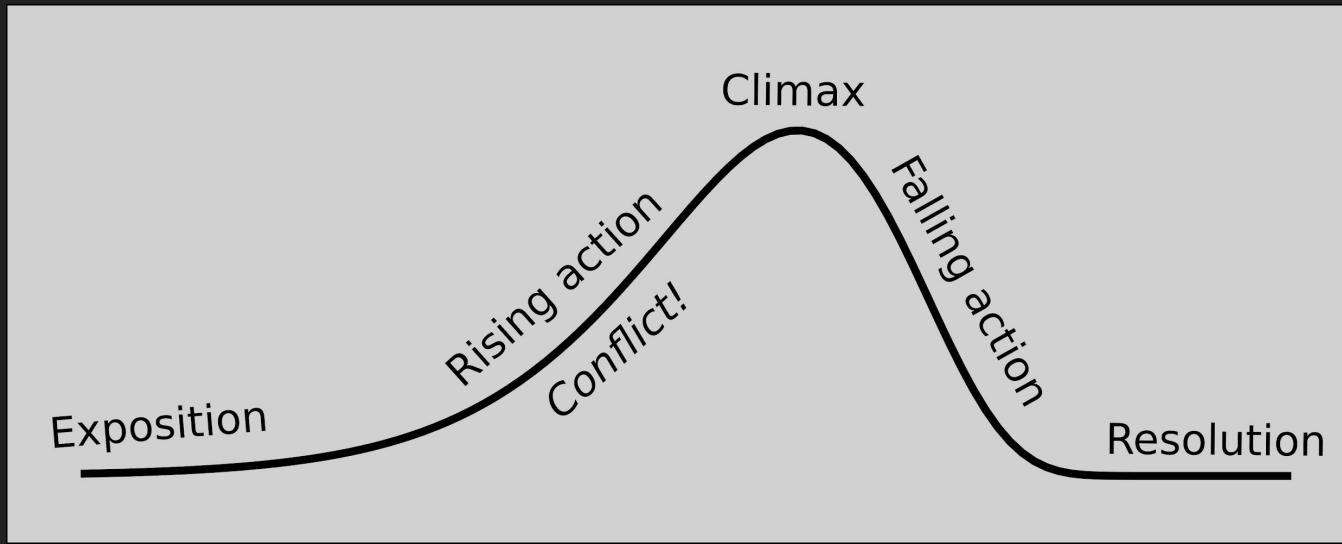




---

# Keep the audience engaged

## How to maintain audience engagement?



---

Keep the audience engaged

## How to maintain audience engagement?

Enthusiastic tone

---

Keep the audience engaged

## How to maintain audience engagement?

Eye contact

---

# Keep the audience engaged

## How to maintain audience engagement?

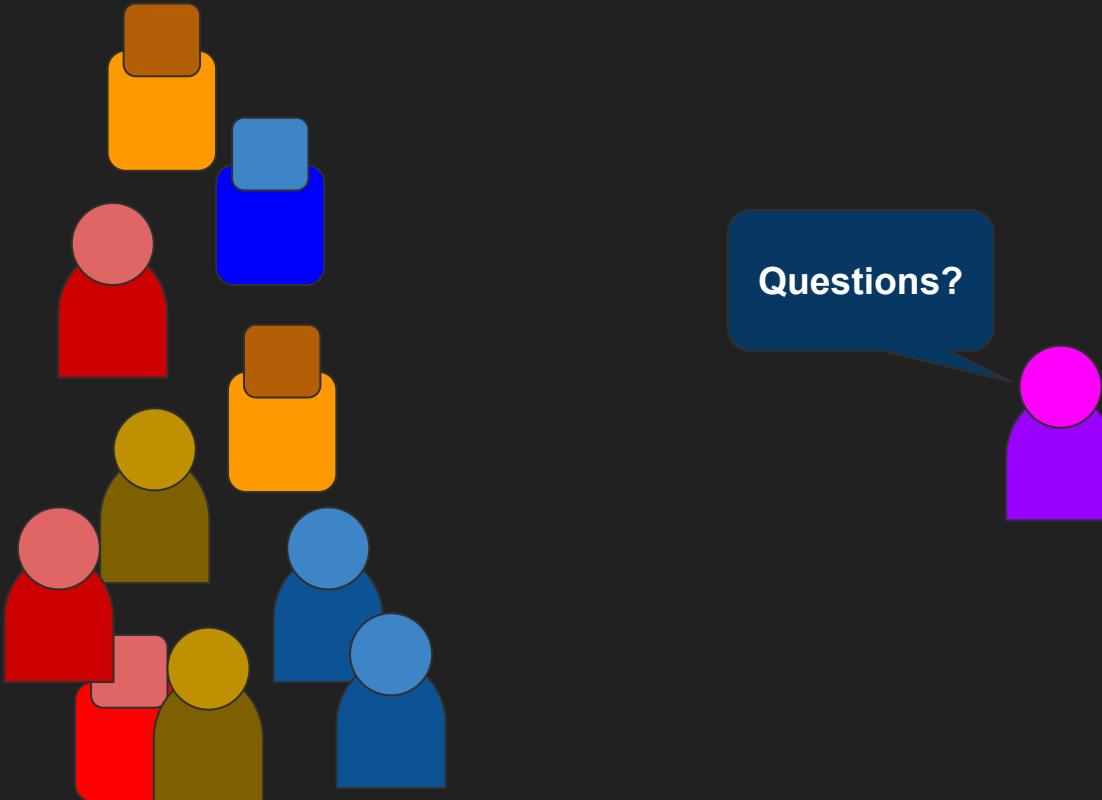
Eye contact

Audience participation

Humor

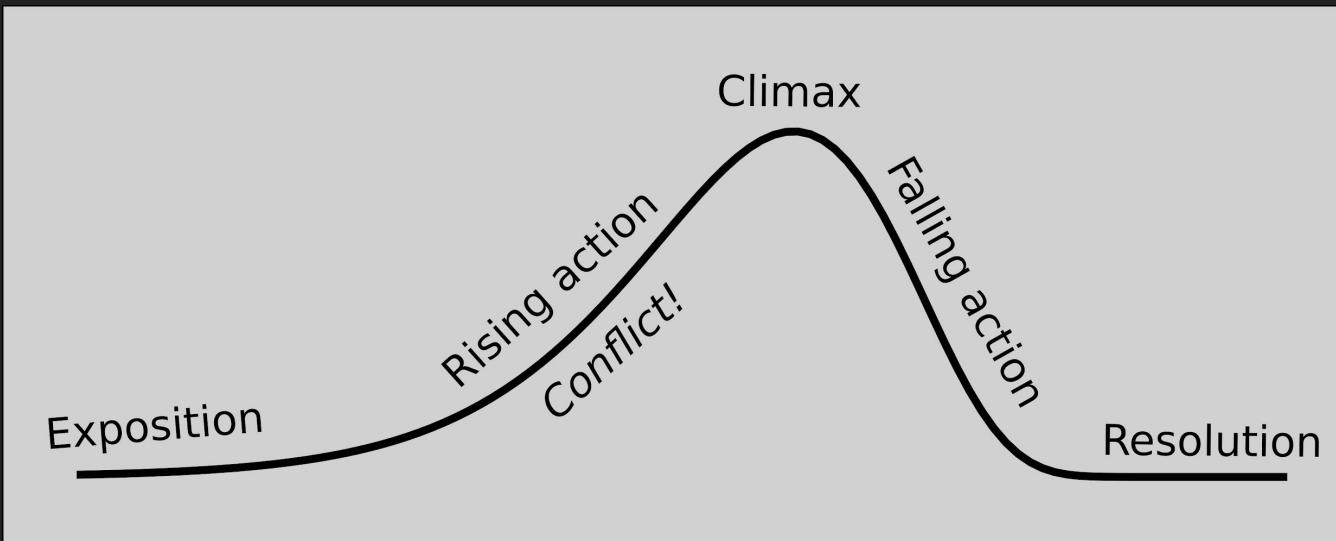
Anecdotes

# Keep the audience engaged





# Create from the end; present from the beginning



# Create from the end; present from the beginning





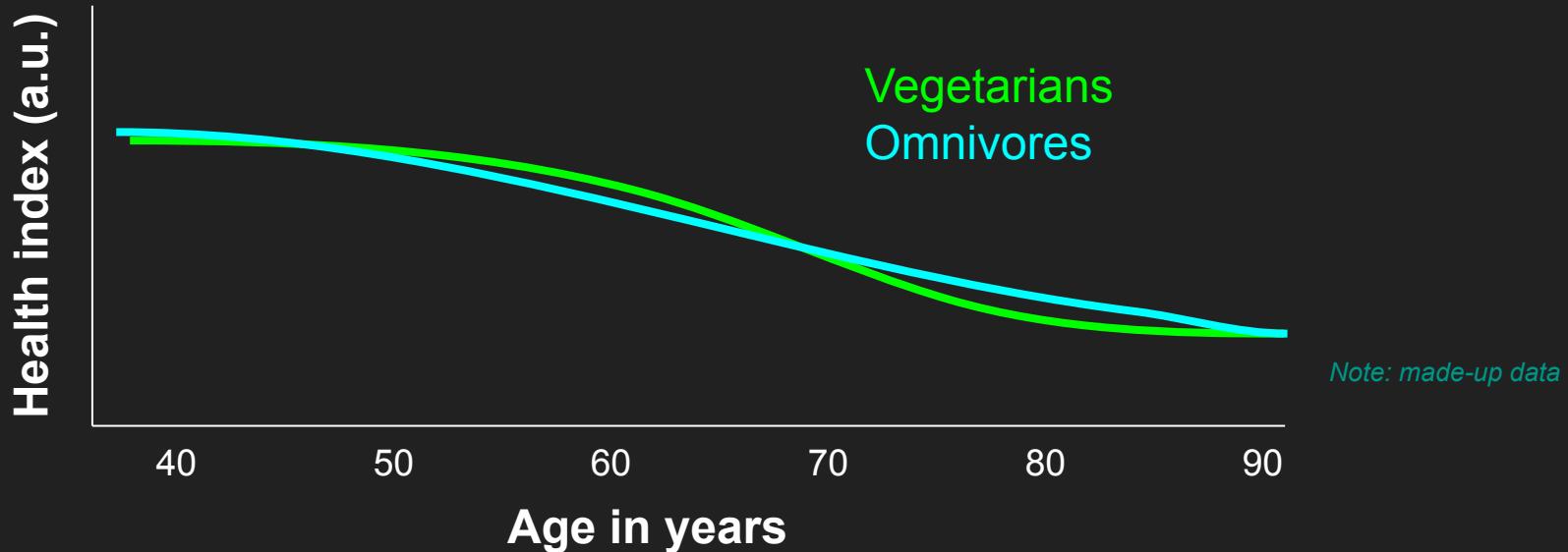
---

# Start with an anecdote, end with data

---



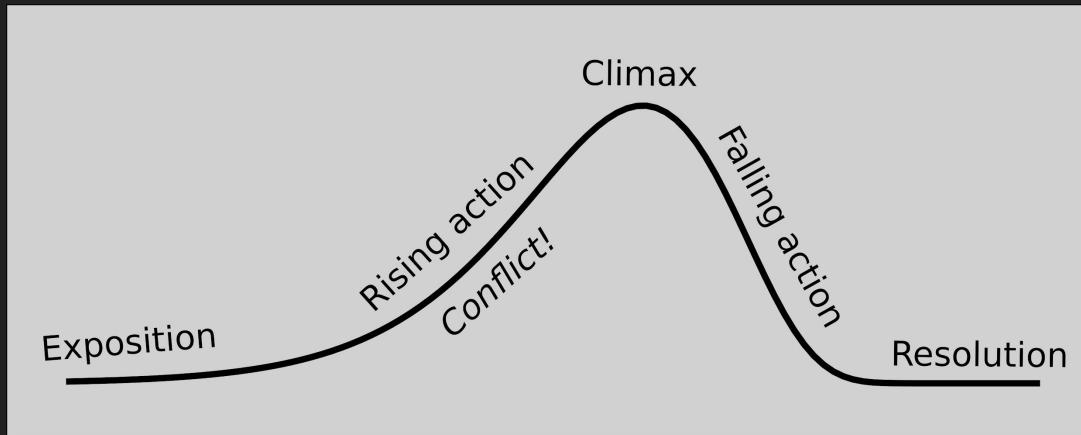
# Start with an anecdote, end with data



**Figure 1.** Health decreases with age, but this is not affected by eating meat. Effects of economic status, education, and urbanicity were removed. Data are from 80,000 hospital records.

# Start with an anecdote, end with data

**Anecdote**  
(build excitement) → **Conflict**  
(question intuition) → **Data**  
(resolve conflict)





# Build suspense, not surprise



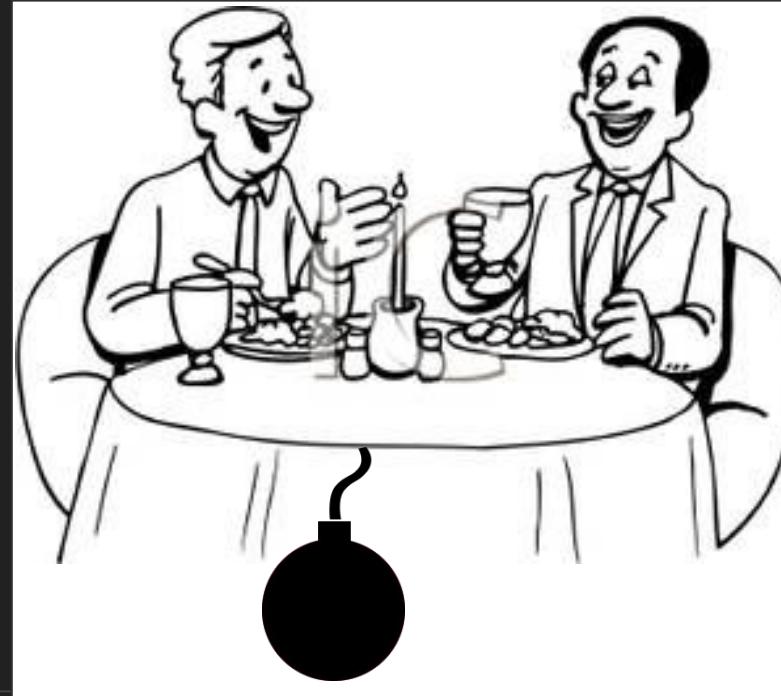
Alfred Hitchcock



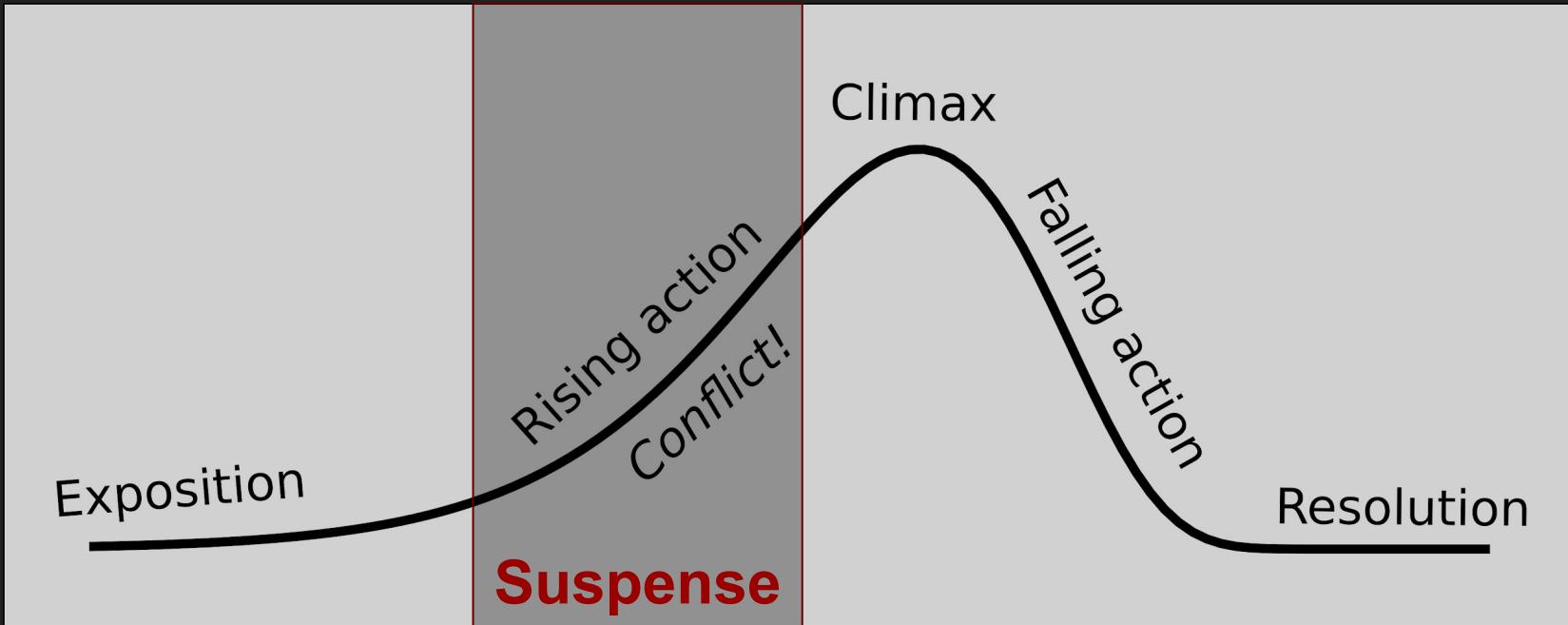
# Build suspense, not surprise



Alfred Hitchcock



# Build suspense, not surprise







---

Ethics: don't falsify or manipulate data

---

With great **data** come  
great **responsibility**.

**Data ethics:**

- a. Making up data
- b. Misrepresenting data

---

Ethics: don't falsify or manipulate data

---

Faking data:

DON'T DO IT!

DON'T DO IT!

# Ethics: don't falsify or manipulate data

## Honest mistakes



Difference:

Mistakes are *unintentional*

Manipulating data is *intentional*

---

# Ethics: don't falsify or manipulate data

---

## Making up data:



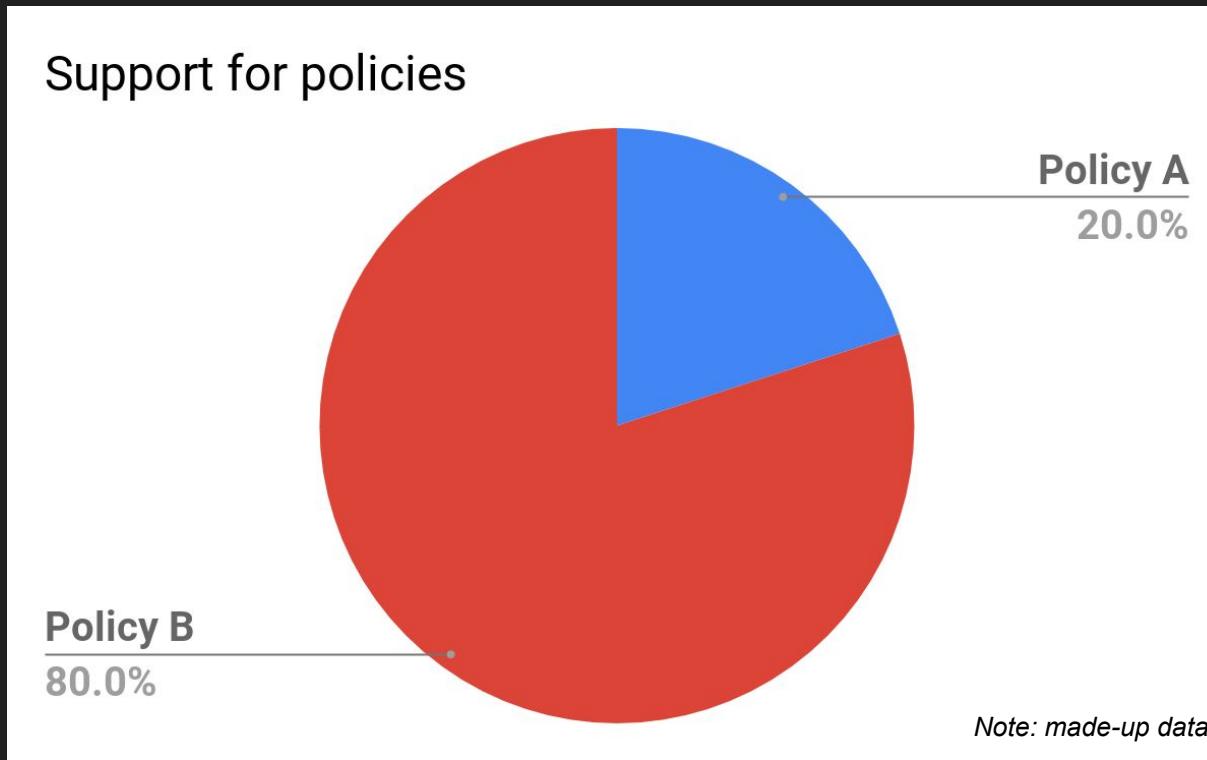
If:

Good reason to use fake data.

Tell the audience  
the data are fake!



# Ethics: Don't mislead or misrepresent

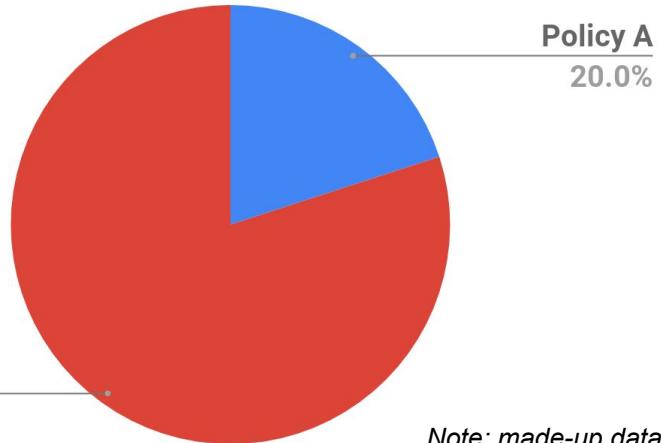


# Ethics: Don't mislead or misrepresent



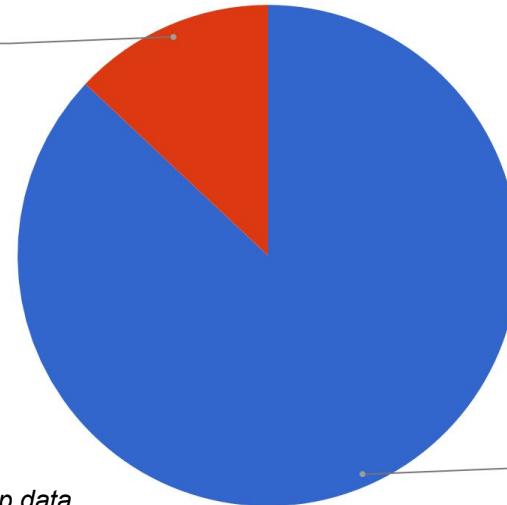
# Ethics: Don't mislead or misrepresent

Support for policies



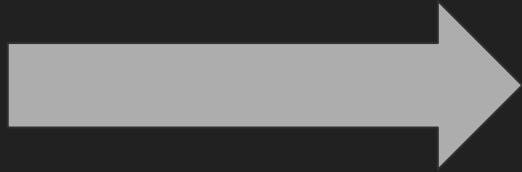
Policy B

13.0%



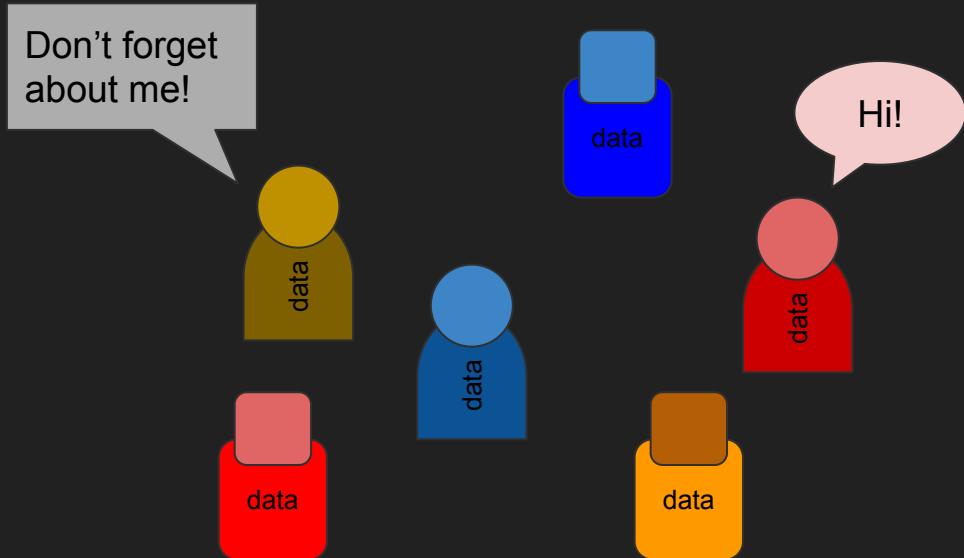
# Ethics: Don't mislead or misrepresent

**Lie**



**Fired**

# Ethics: Don't mislead or misrepresent



# Ethics: Don't mislead or misrepresent

Would an expert approve of your analysis or presentation?

Would you approve if someone else did the analysis or presentation?

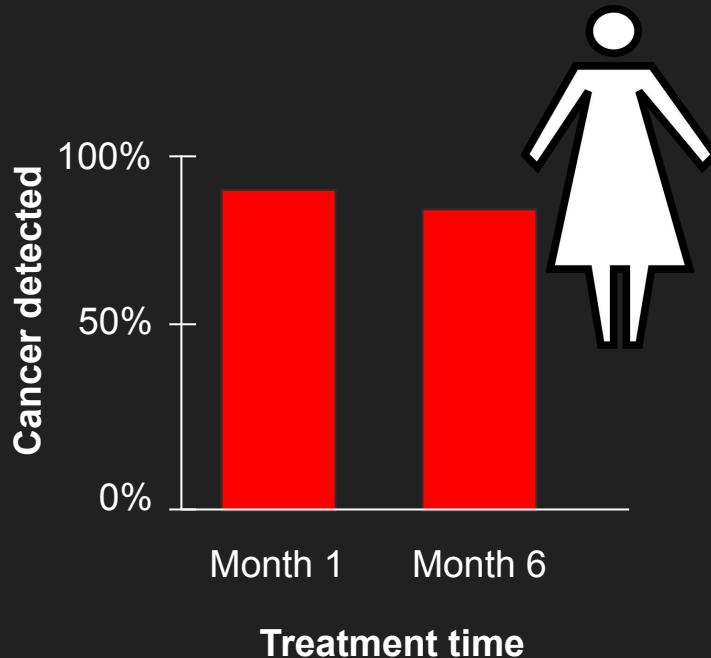
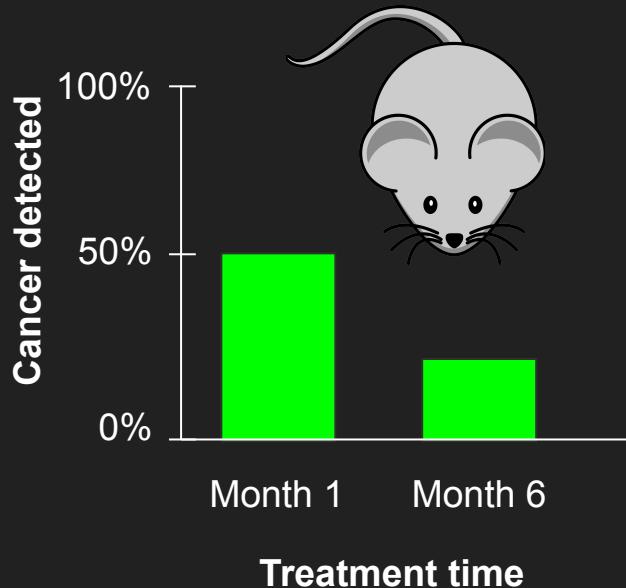


# How to be an ethical data storyteller

Be honest.

Be interesting.

# How to be an ethical data storyteller



*Note: made-up data*

# How to be an ethical data storyteller

Be honest.

Be interesting.

Reflect.

Ask for help.