

CSE 332
INTRODUCTION TO VISUALIZATION
VISUAL BIAS

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Lecture	Topic	Projects
1	Intro, schedule, and logistics	
2	Applications of visual analytics, data, and basic tasks	
3	Data preparation and reduction	Project 1 out
4	Data preparation and reduction	
5	Data reduction and similarity metrics	
6	Dimension reduction	
7	Introduction to D3	
8	Bias in visualization	Project 2 out
9	Perception and cognition	
10	Visual design and aesthetics	
11	Cluster and pattern analysis	
12	High-Dimensional data visualization: linear methods	
13	High-D data vis.: non-linear methods, categorical data	Project 3 out
14	Computer graphics and volume rendering	
15	Techniques to visualize spatial (3D) data	
16	Scientific and medical visualization	
17	Scientific and medical visualization	
18	Non-photorealistic rendering	Project 4 out
19	Midterm	
20	Principles of interaction	
21	Visual analytics and the visual sense making process	
22	Visualization of graphs and hierarchies	
23	Visualization of text data	Project 5 out
24	Visualization of time-varying and time-series data	
25	Memorable visualizations, visual embellishments	
26	Evaluation and user studies	
27	Narrative visualization and storytelling	
28	Data journalism	

WHAT IS BIAS?

Cause to feel or show inclination or prejudice for or against someone or something



"I trust this site to tell the truth."

CONFIRMATION BIAS

Persistence of mindset

- humans tend to stick with an “opinion” for a long time
- how long does it take you to switch?



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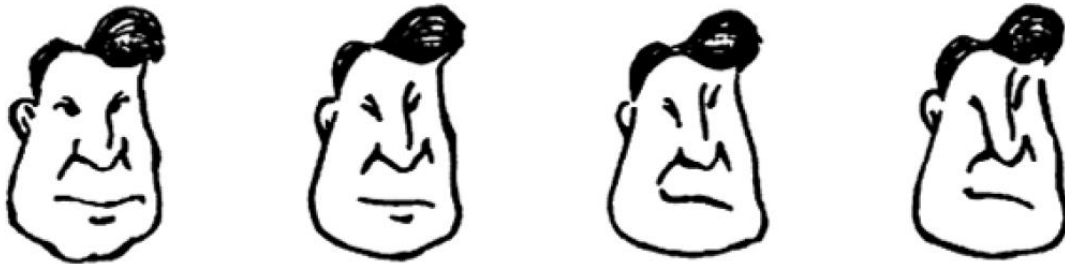
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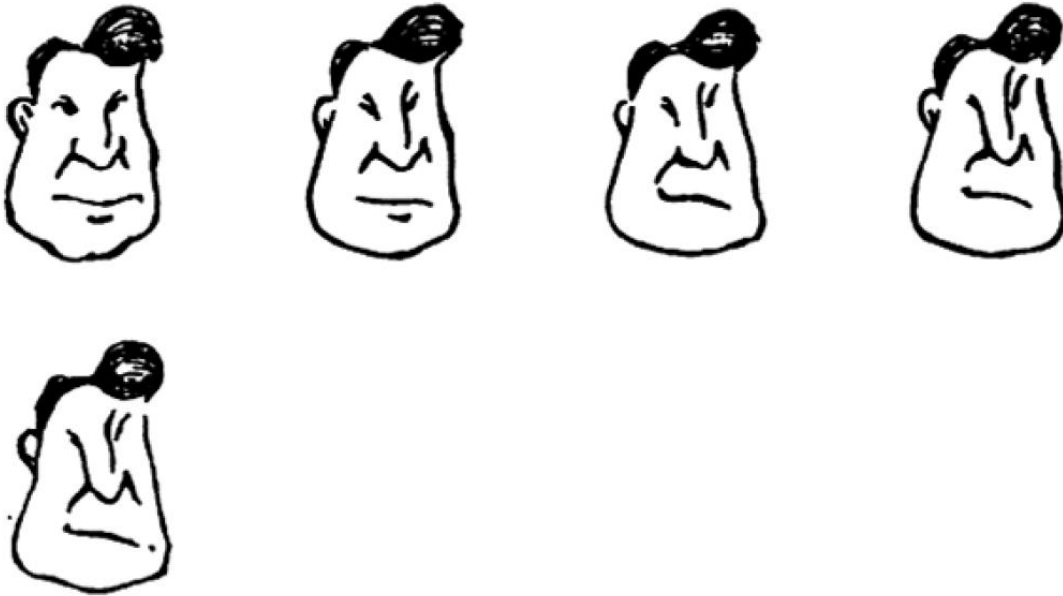
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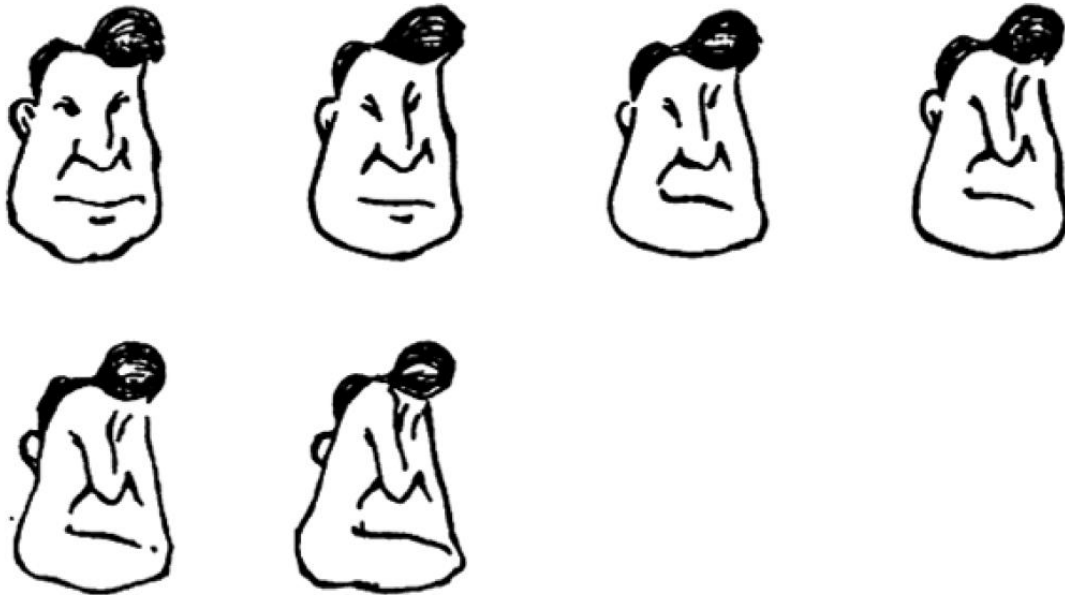
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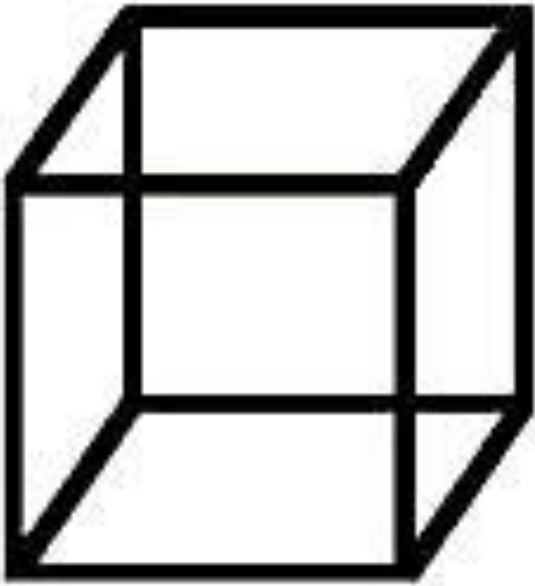


man/woman

Young/old woman

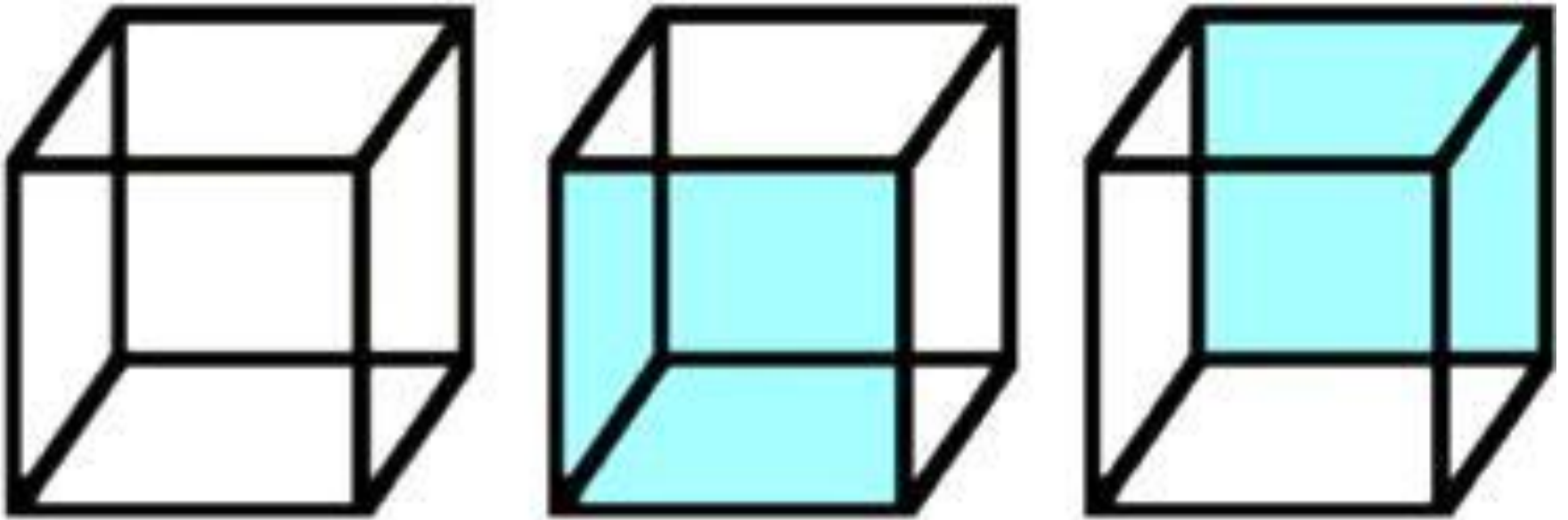


NECKER CUBE



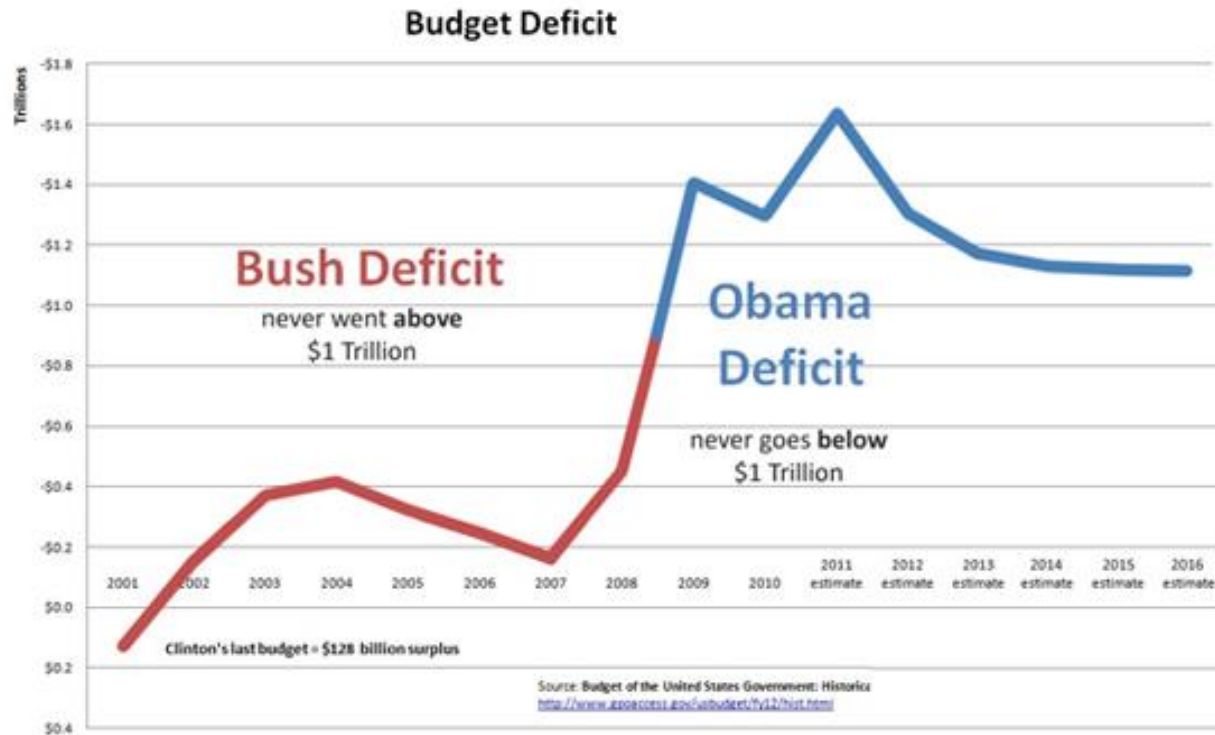
Which is face facing the front?

NECKER CUBE



Which is face facing the front?

VISUALIZATION CAN SUPPORT BIAS !!

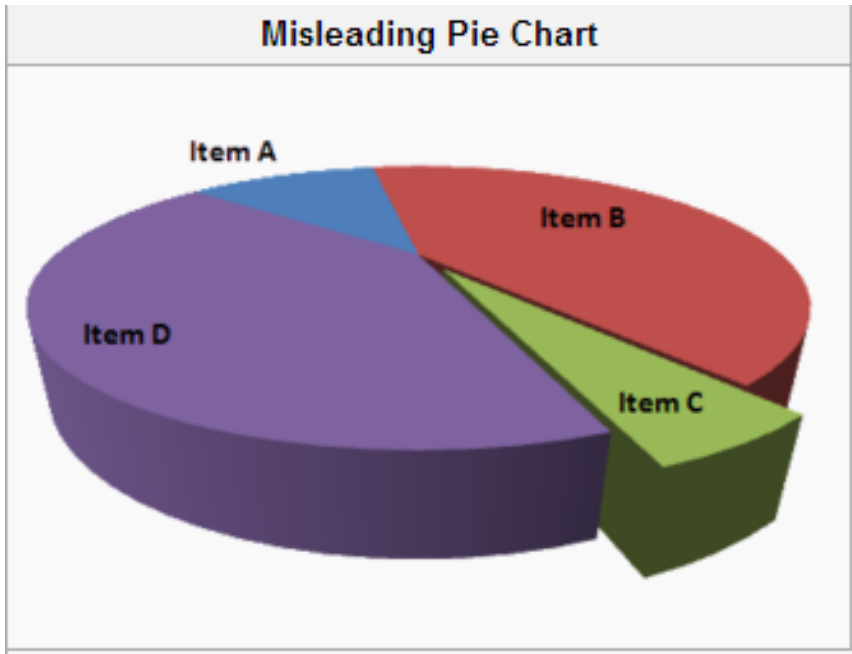


Signal value issues. The red line feels more negative. From <http://www.politicalmathblog.com>

Appeals to **cultural bias**

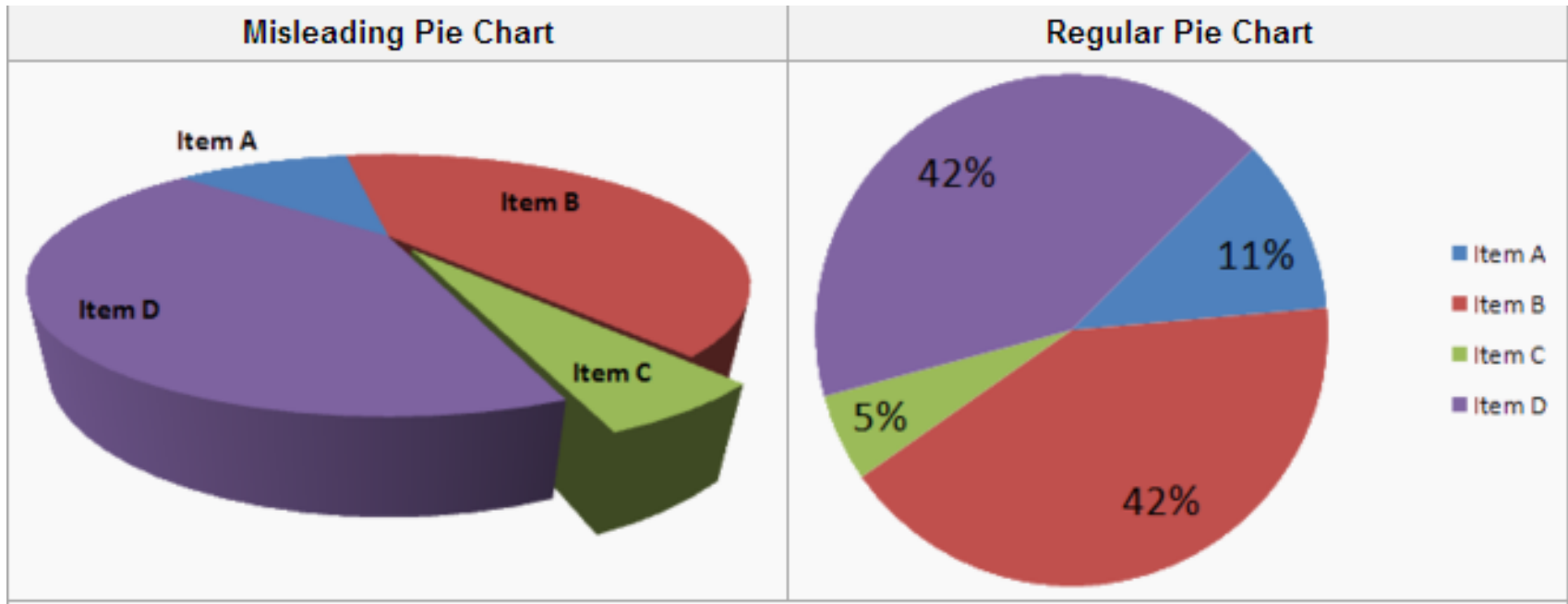
- although Obama's deficit was larger, the color red implies that Bush's deficit was more "negative"

GRAPHICAL BIAS



Which is bigger, A or C?

GRAPHICAL BIAS



Which is bigger, A or C?

Perspective distortion in 3D rendering causes bias

- in the 3D chart. item C appears to be at least as large as Item A
- whereas in actuality, it is less than half as large.

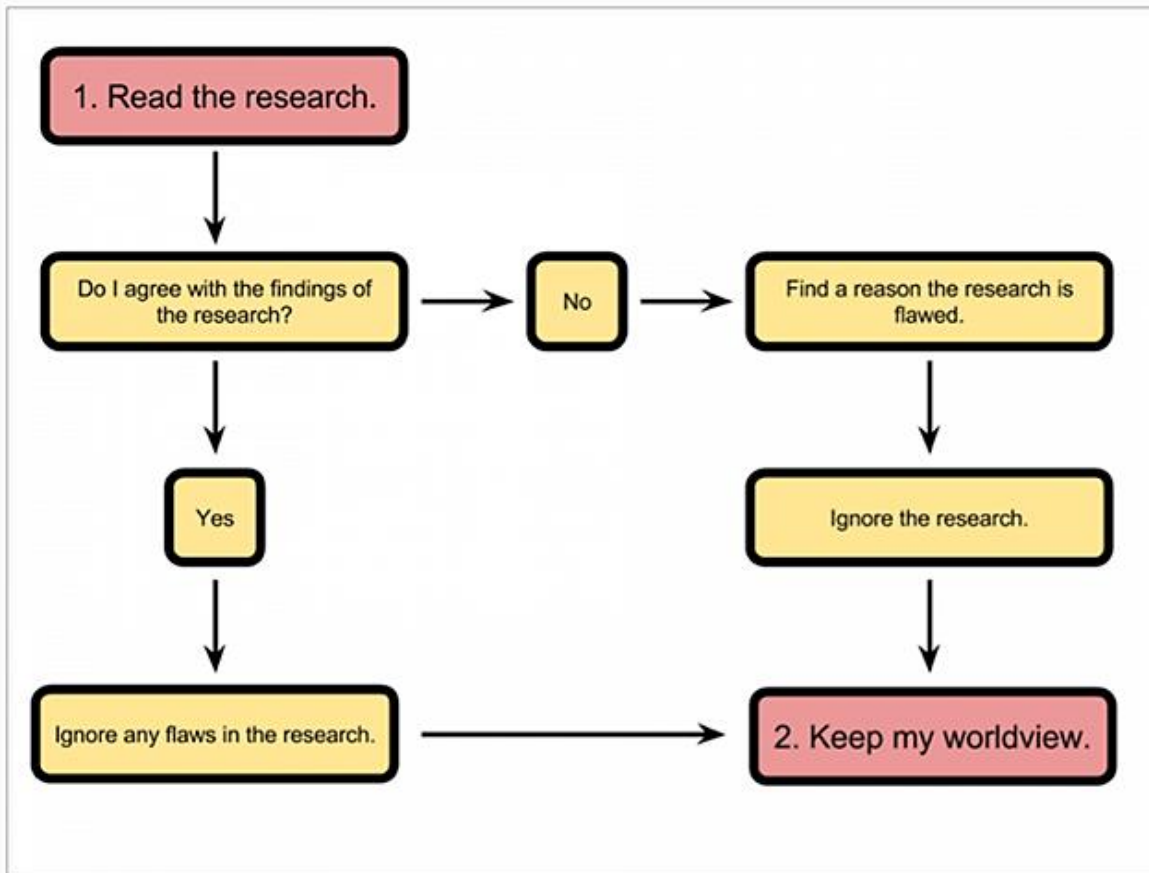
COGNITIVE BIASES

Impede proper decision making

Comes in many guises

CONFIRMATION BIAS

THE CONFIRMATION BIAS CYCLE



Confirmation Bias

Have you ever noticed... that squares are always blue?

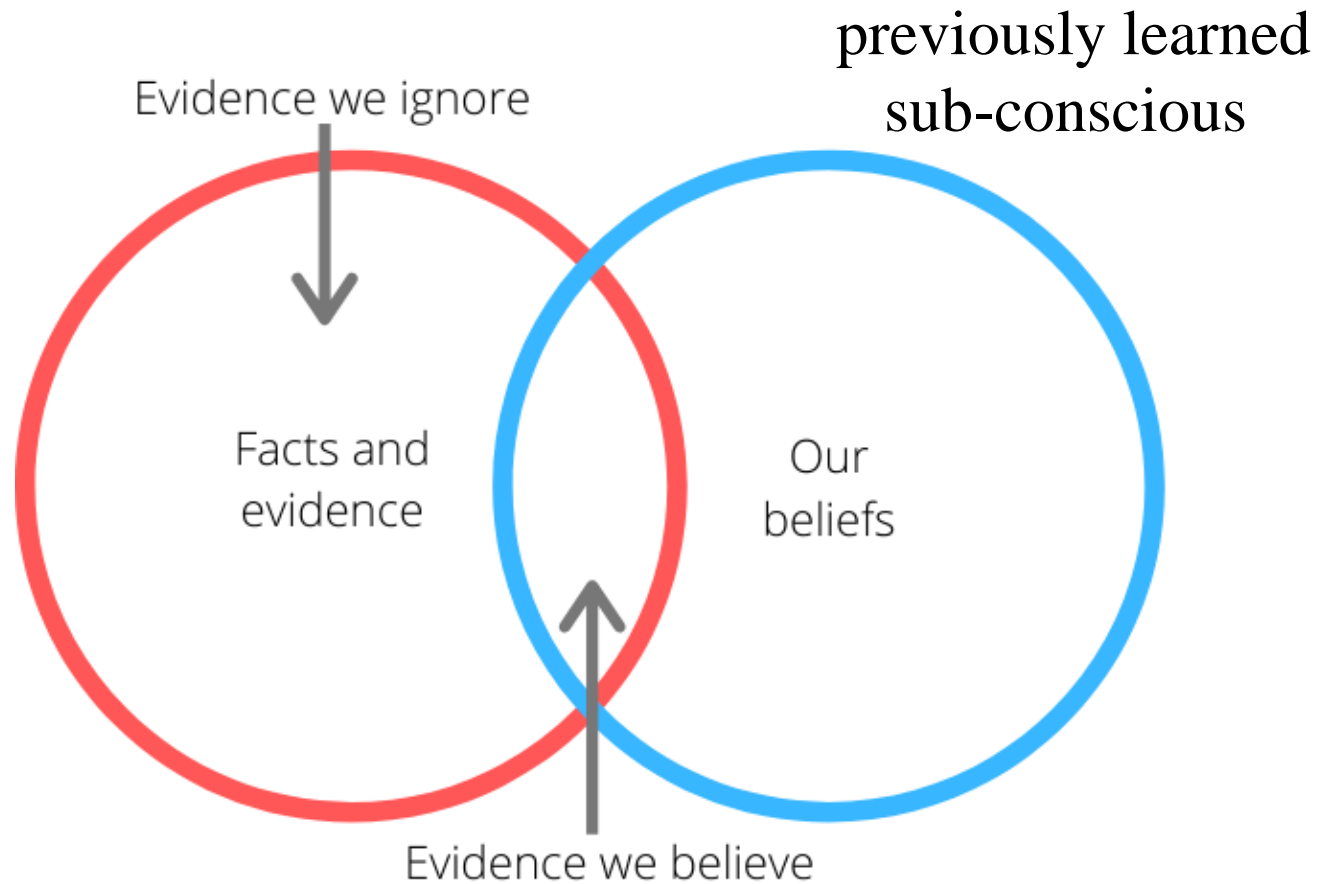


Oh, I know!
It's so weird!



Beatrice the Biologist

CONFIRMATION BIAS



CONFIRMATION BIAS EXAMPLE

A heavy smoker comes across a study that states smoking causes lung cancer. Yet they reject it stating that the study is flawed.

However, they later come across another study stating that smoking can cure lung cancer.

They state that this study is accurate, thereby aligning with their belief that smoking doesn't cause harm.

CONFIRMATION BIAS IN VISUALIZATION

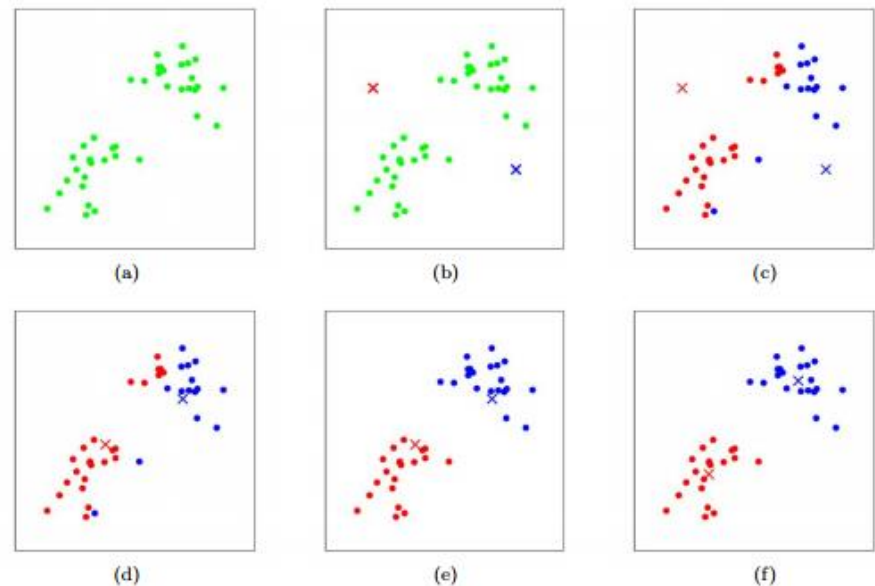
Favor information that confirms previously held beliefs

Which clustering is correct?

- the one you did first?
- all clusters must look like that?
- many different clusterings
- all are good (or bad)
- depends on task

Overcome confirmation bias

- remain open
- apply healthy skepticism
- keep statistical metrics
- avoid generalization



THE HINDSIGHT BIAS



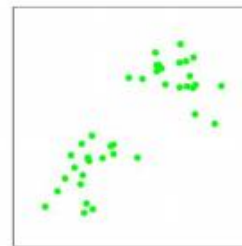
THE HINDSIGHT BIAS

See events, even random ones, as more predictable than they are

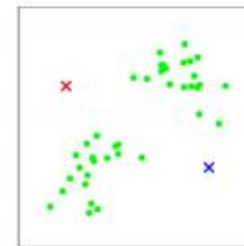
- look back on events and believe that we “knew it all along”

Which clustering is correct?

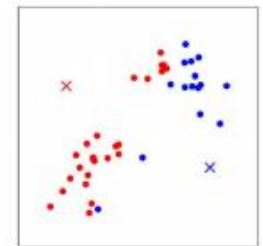
- of course (b) once you ran it
- or is it (d)?



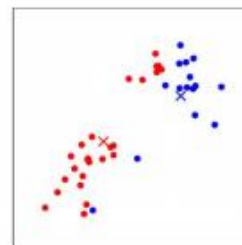
(a)



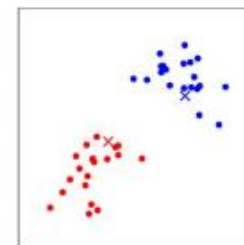
(b)



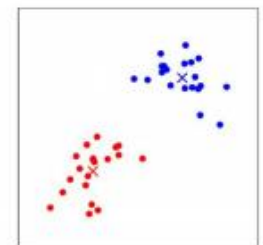
(c)



(d)



(e)



(f)

THE ANCHORING BIAS

Participants were given only 5 seconds to solve either of the following problem

- the estimates they made are very different

Median Estimates

$$1 \times 2 \times 3 \times 4 \dots \times 8$$

512

$$8 \times 7 \times 6 \times 5 \dots \times 1$$

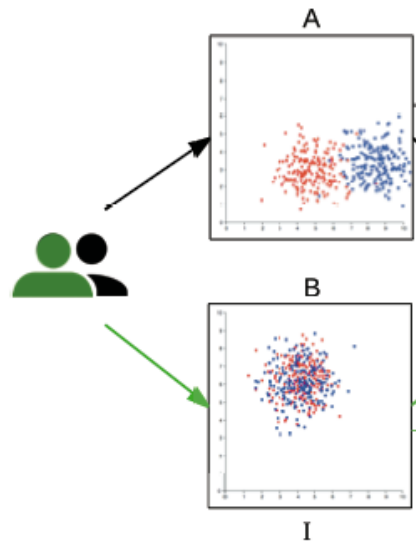
2,250

Answer: 40,320

THE ANCHORING BIAS

Tendency to be overly influenced by the first piece of information that we hear or see

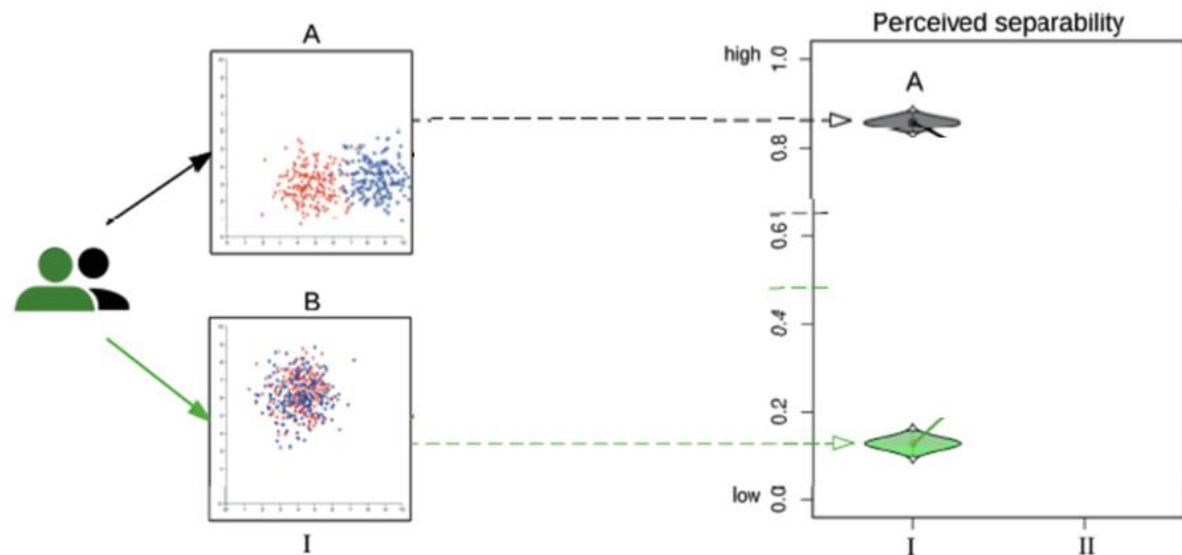
- also called priming
- example: first number heard in pricing negotiations
- example: separability study by Valdez et al.



THE ANCHORING BIAS IN VISUALIZATION

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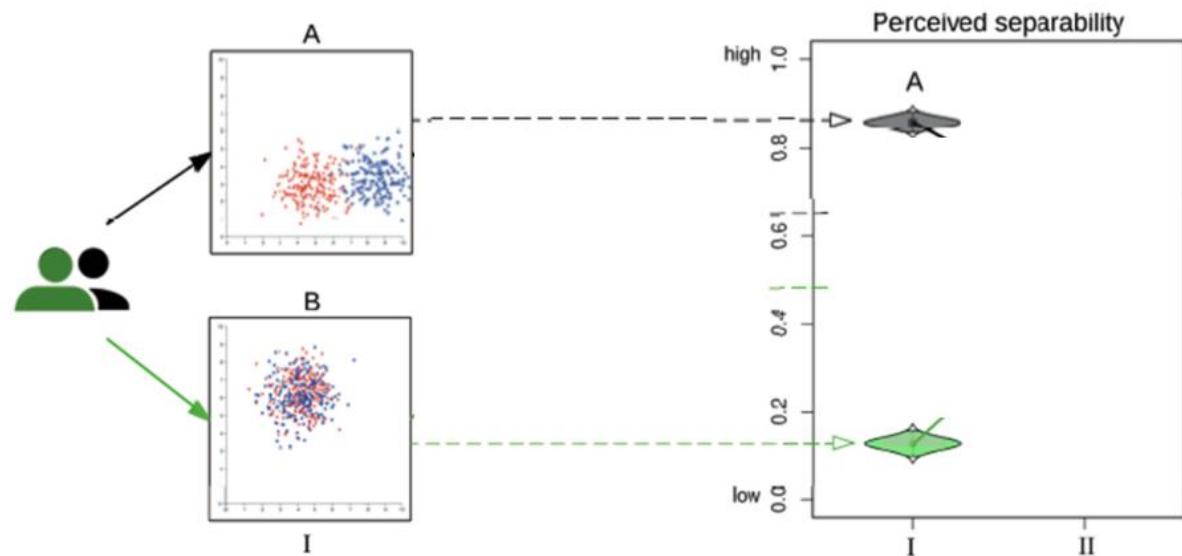
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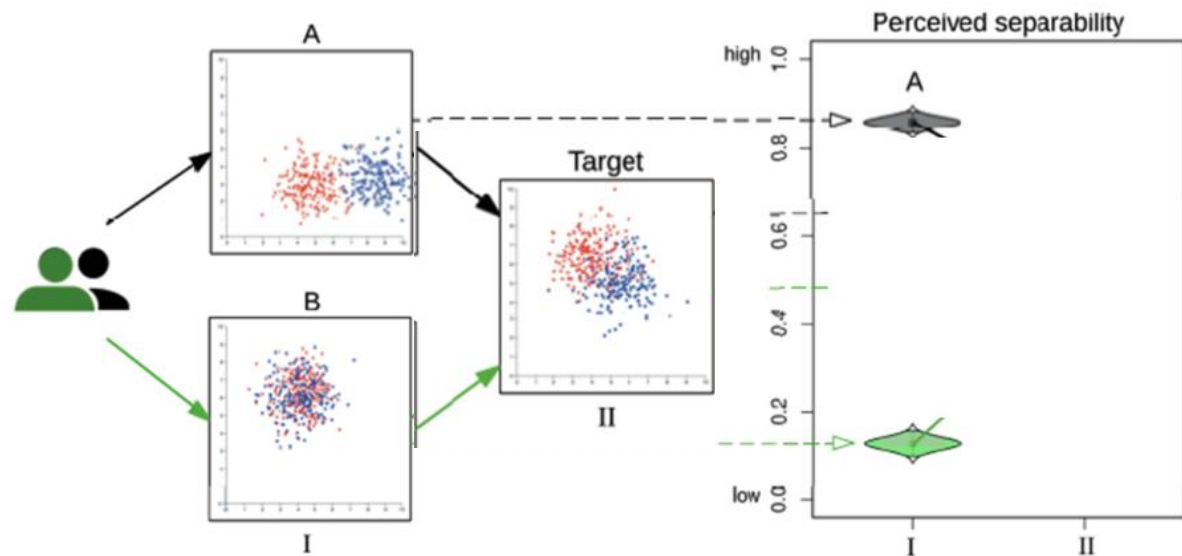
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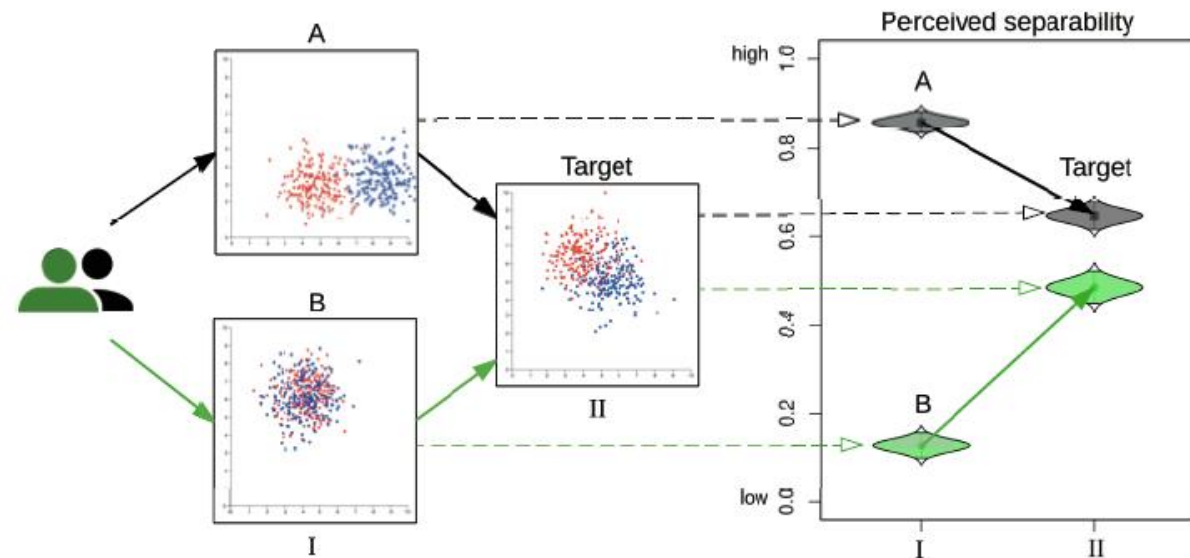
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THE AVAILABILITY HEURISTIC

A strategy that people use to make quick decisions but often lead to systematic errors

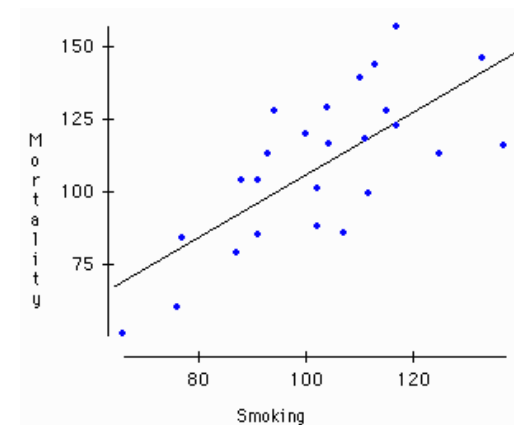
- this can lead to misconceptions and prejudices

Examples:

- smokers who have never known someone to die of a smoking-related illness might underestimate the health risks of smoking

Visualization can help overcome this problem

- can alter the way our memory stores the events for later recall
- can improve a person's long-term intuition



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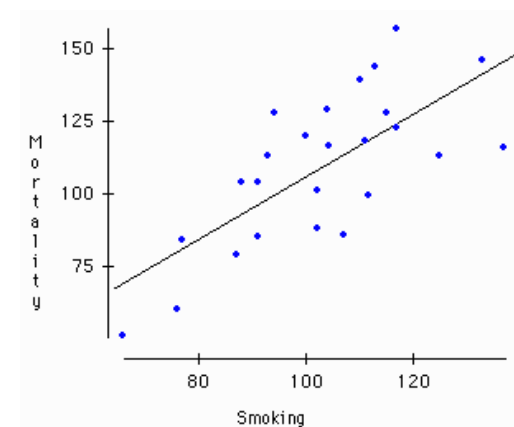
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Examples:

- smokers who have never known someone to die of a **COVID-19** related illness might underestimate the health risks of **COVID-19**

Visualization can help overcome this problem

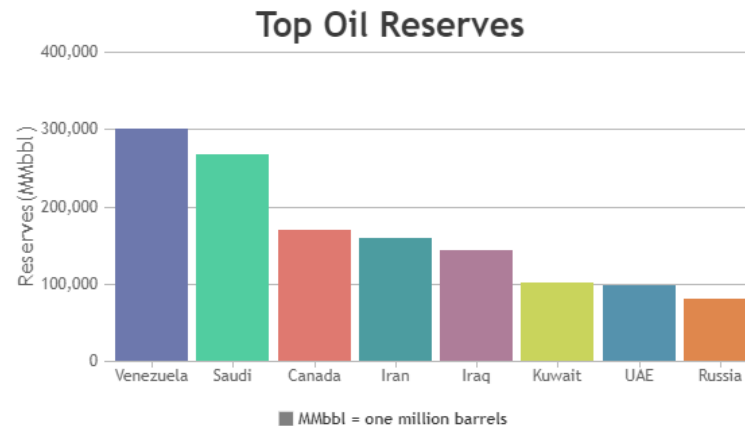
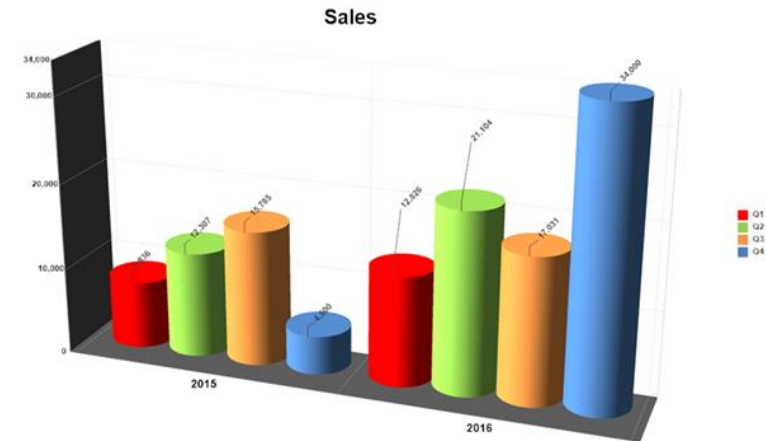
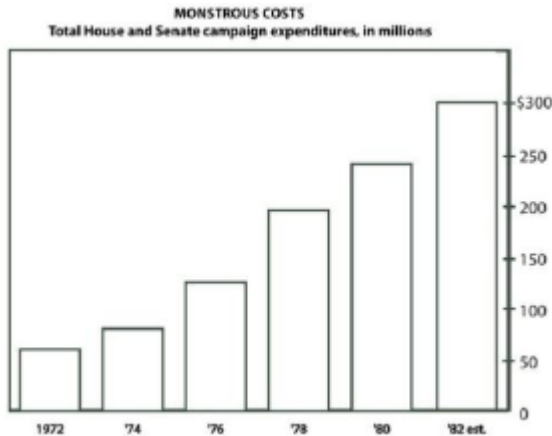
- can alter the way our memory stores the events for later recall
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THE HALO EFFECT

Also known as the "physical attractiveness stereotype" or the "what is beautiful is 'good' principle"

Plain chart vs fancy vs really fancy



OTHER BIASES

The Optimism Bias

- overestimate the likelihood that good things will happen while underestimating the probability that negative events will occur

The Self-Serving Bias

- give yourself credit for successes but lay the blame for failures on outside causes

The False-Consensus Effect

- spend too much time with like-minded people (echo chamber bias)

Solution for all of these (in the context of data science & vis)

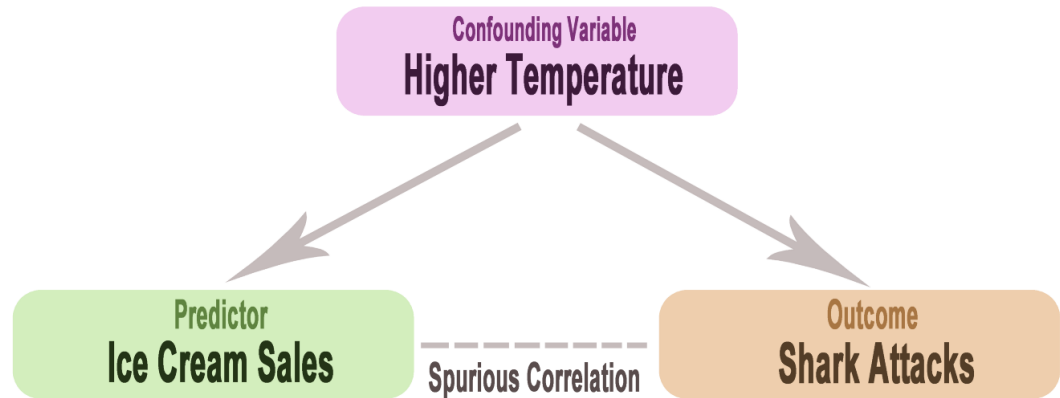
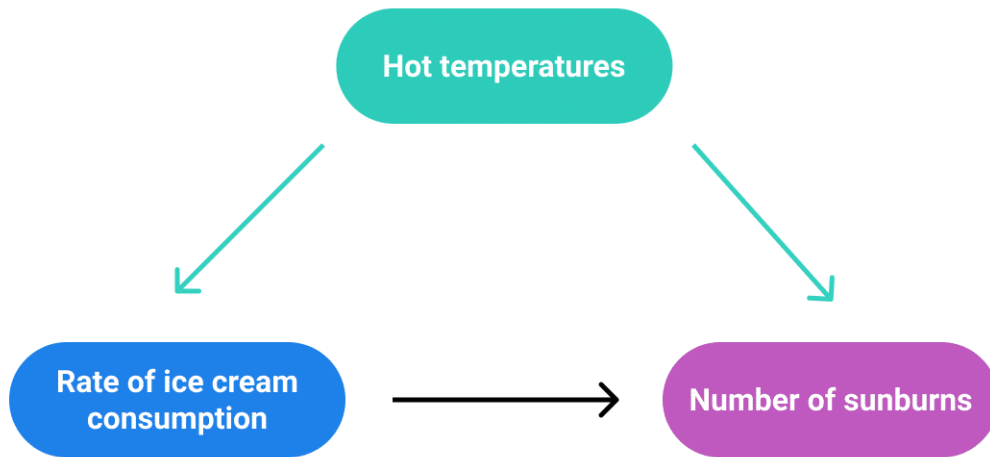
- look at data in several ways
- visualize different metrics computed from the data

SELECTION BIAS

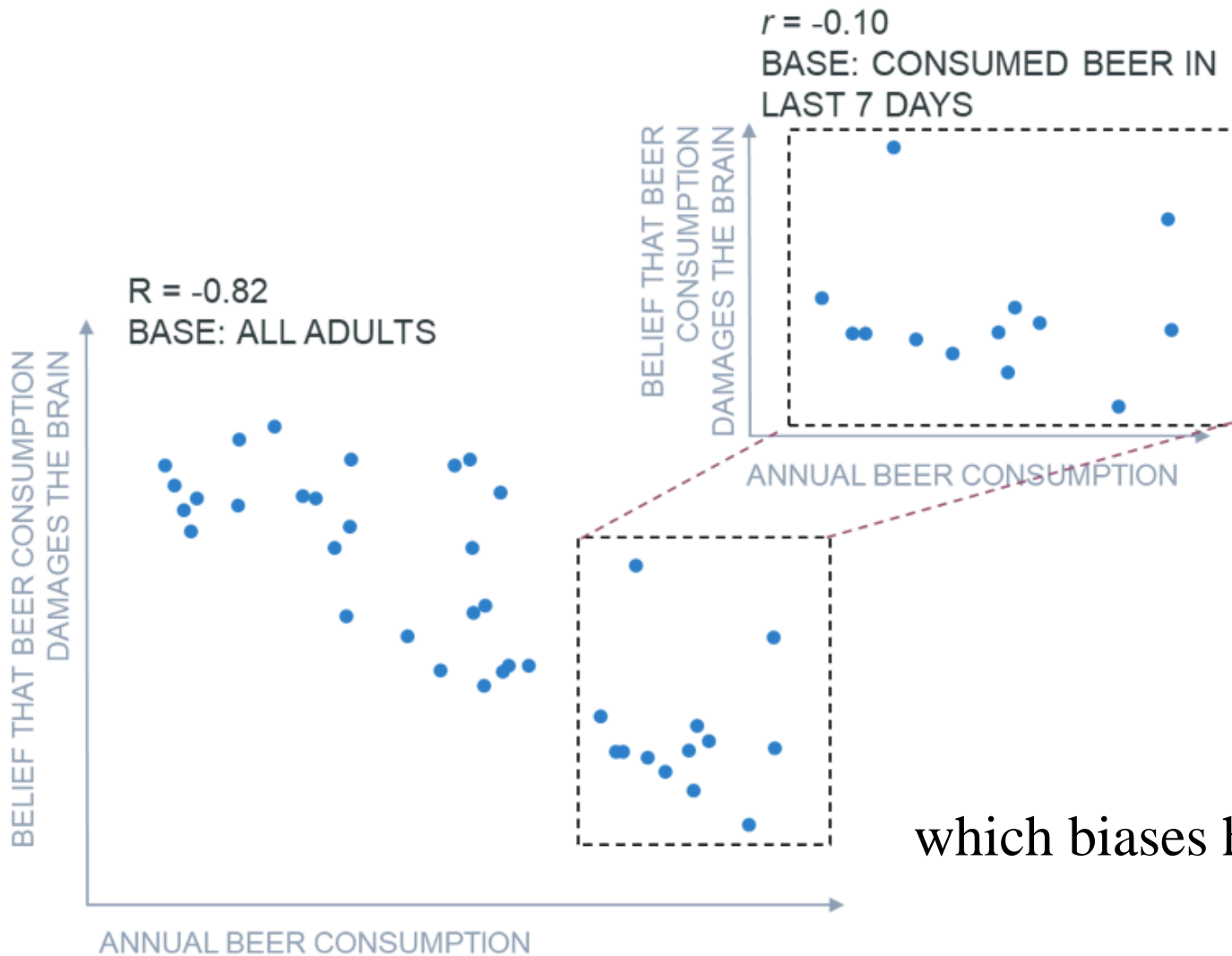
Occurs when the data sample is not an accurate representation of the population

- sampling bias – recall stratified sampling from last lecture as a good way to avoid this
- time bias – can occur when sampling is terminated too early
- attrition bias – loss of participants over time (sample hardening)
- cherry picking – when only uses the favored samples
- rejection of data considered bad (loss of objectivity)

CONFOUNDING

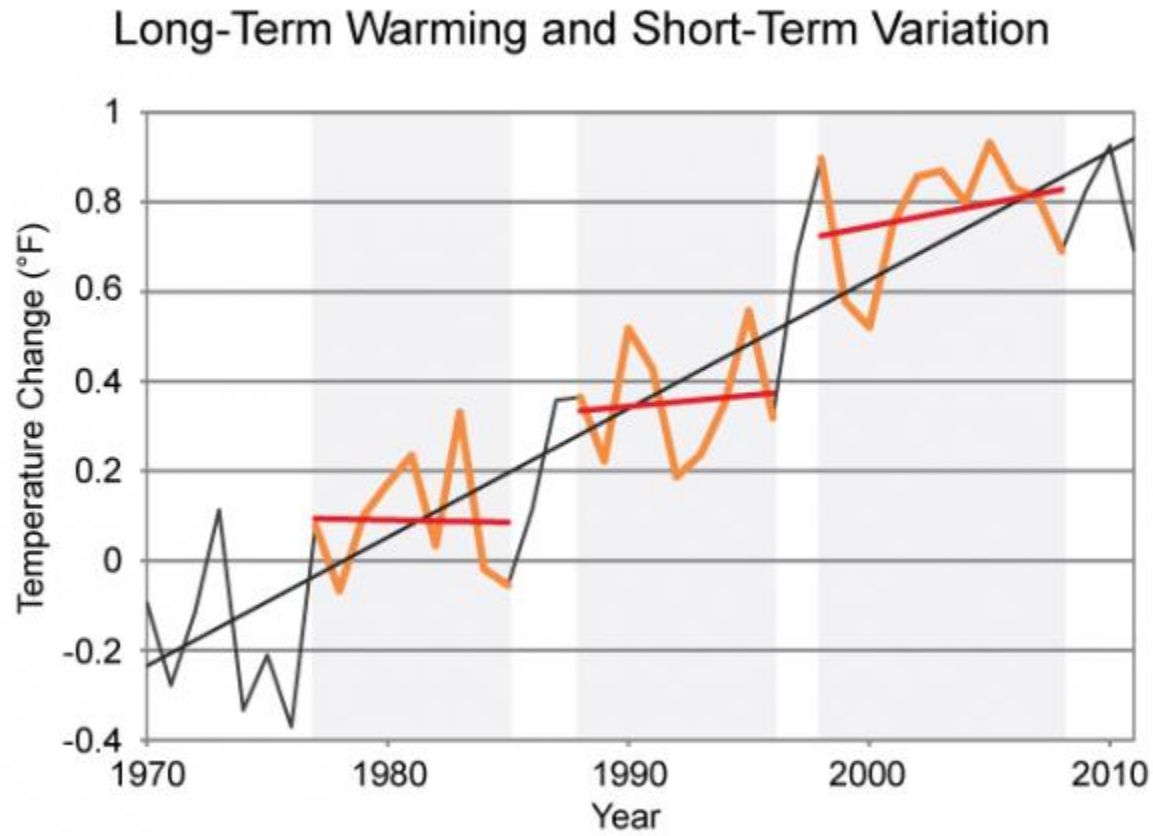


SELECTION BIAS – EXAMPLE 1



which biases have occurred?

SELECTION BIAS – CLIMATE CHANGE



SELECTION BIAS – EXAMPLE 2



[video link](#)

ONE MORE

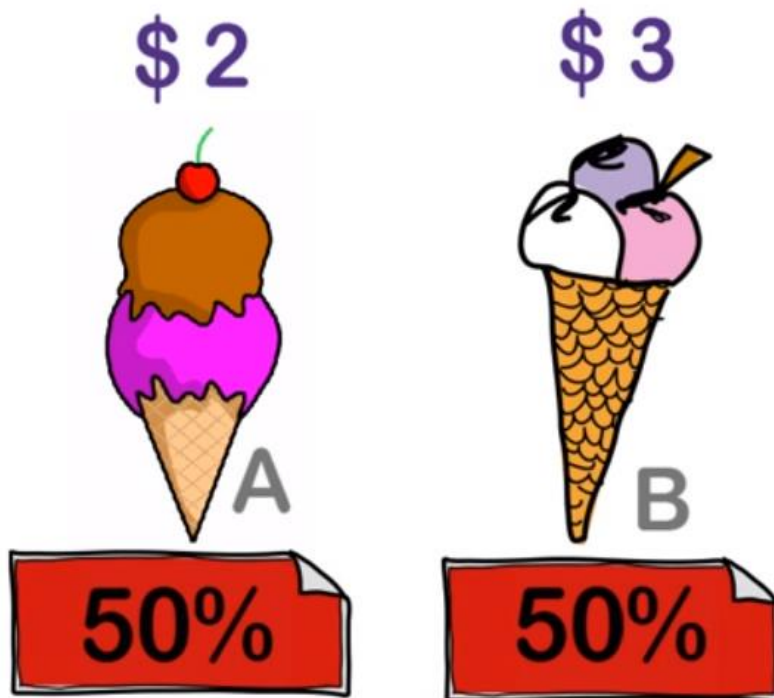
The attraction bias

- exploited in marketing
- can affect visualizations as well
- let's learn first about the attraction effect

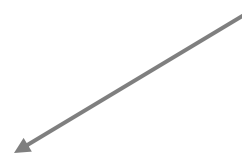
THE ATTRACTION EFFECT (1)

Assume you can choose among two ice cream cones

- one has a higher price but offers more scoops
- the other has fewer scoops but also a lower price
- depending on how you feel you will pick either one of them

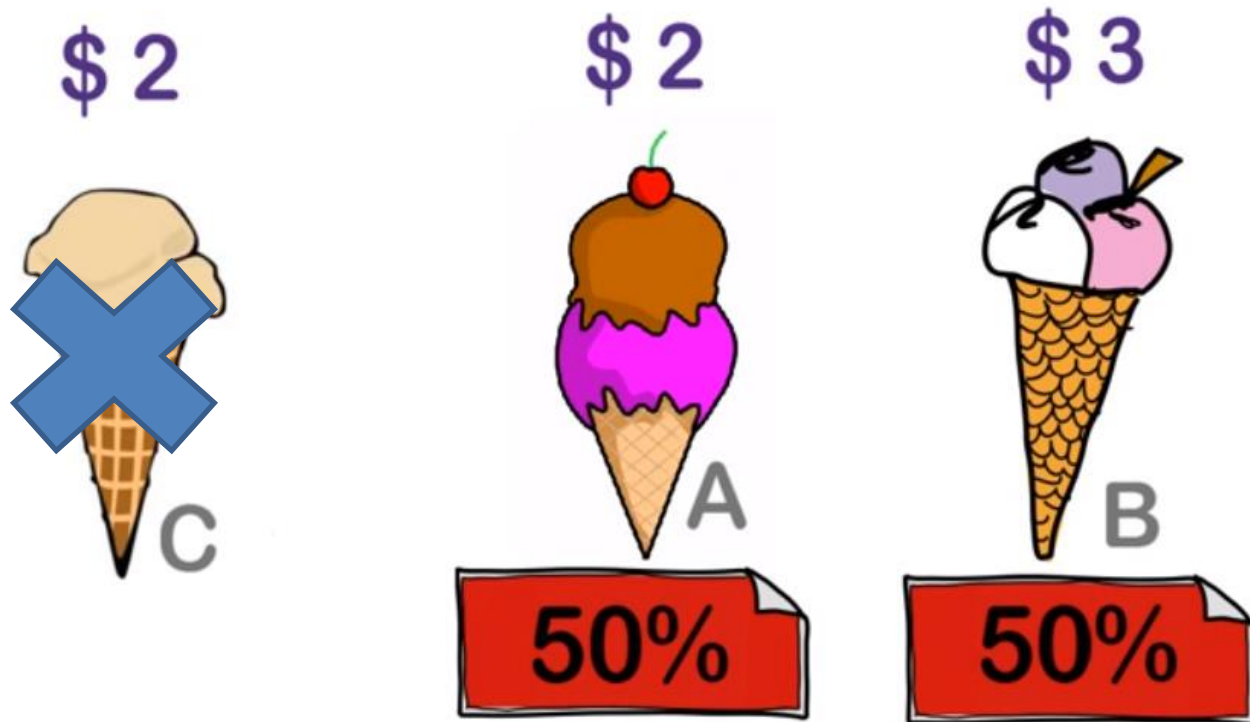


ice cream cone
A and B have the
same market share



THE ATTRACTION EFFECT (2)

Now suppose there was a third ice cream cone available



- nobody would pick it

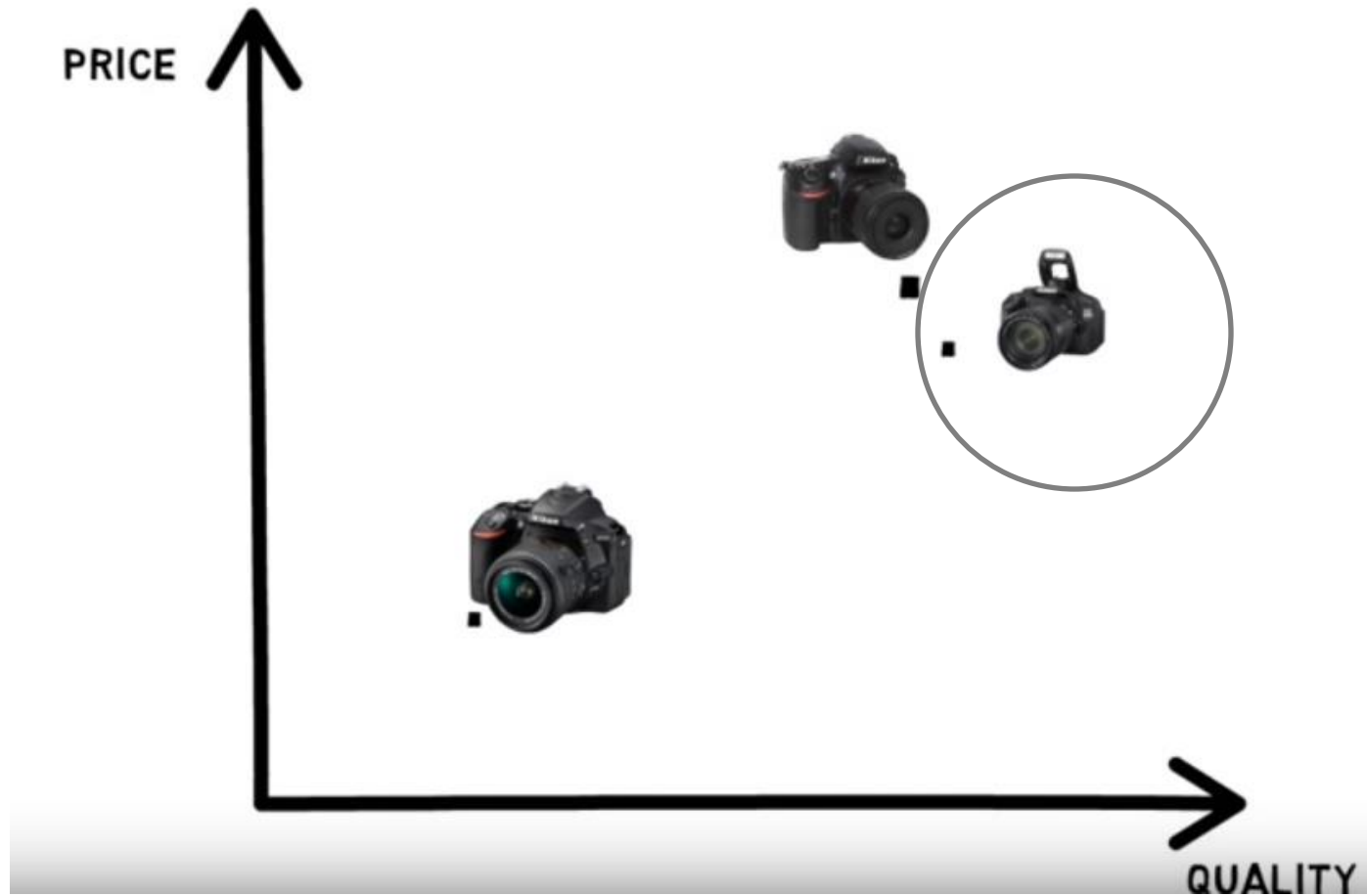
THE ATTRACTION EFFECT (3)

ADDING A THIRD OPTION CAN INCREASE SALES!



Adding the third (inferior) option stole $50\% - 33\% = 17\%$ market share from ice cream cone B and gave it to A

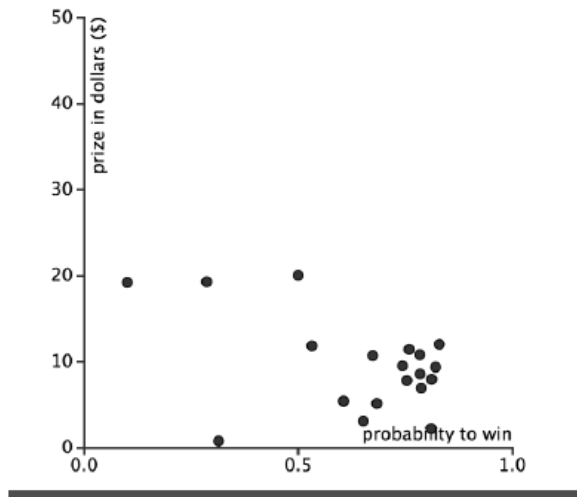
ONE MORE EXAMPLE



APPLICATION TO VISUALIZATION

Decision making with conflicting goals

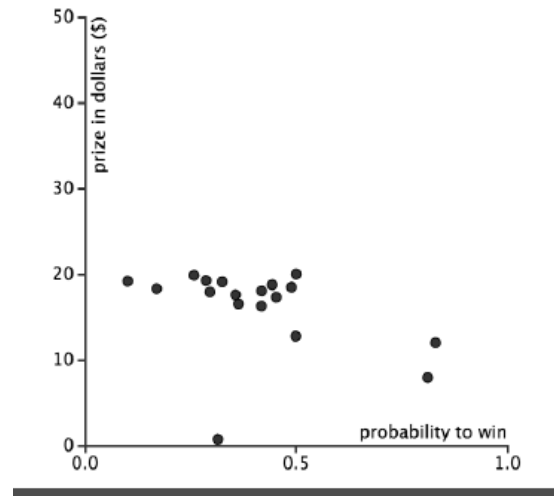
- here: lottery prize vs probability of winning – which ticket will you buy?



APPLICATION TO VISUALIZATION

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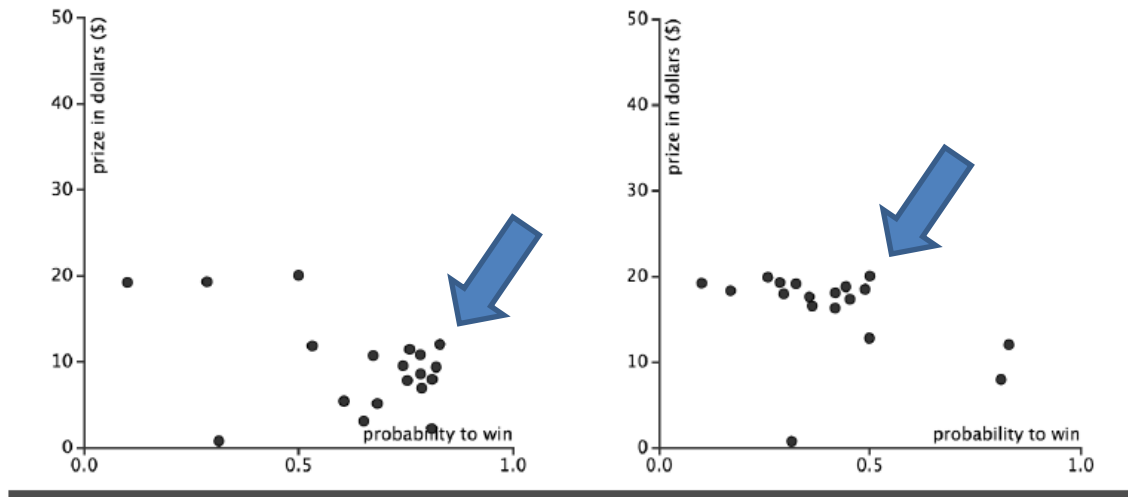
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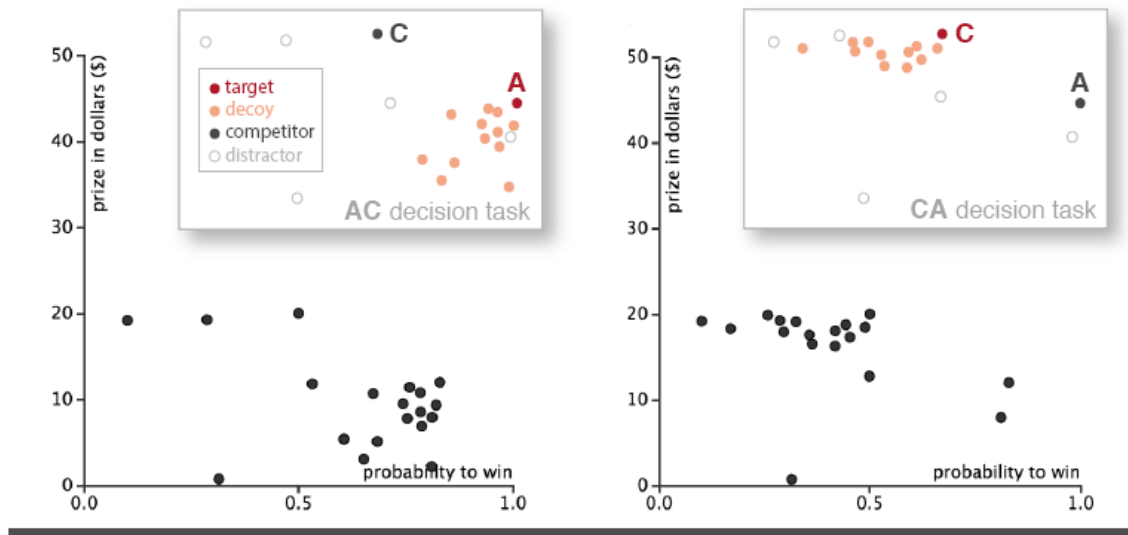
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APPLICATION TO VISUALIZATION

Decision making with conflicting goals

- here: lottery prize vs probability of winning – which ticket will you buy?



Placement of decoys will always make A or C most attractive in selection and attention tasks

- note, the bottom plots were used in the experiment
- the top plots are just for illustration

A MITIGATION TECHNIQUE

Allow user to delete data points

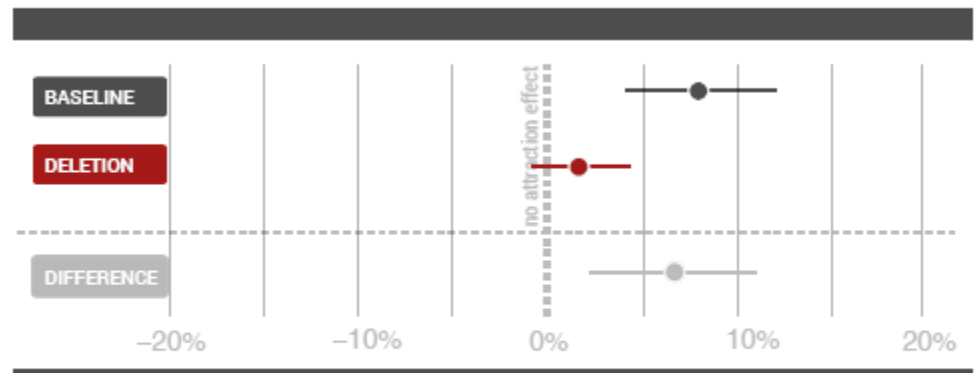
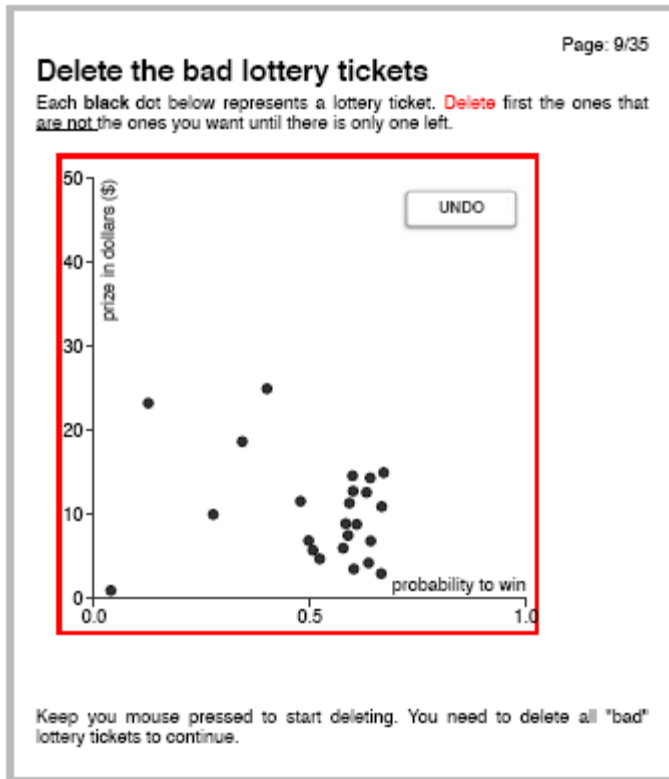


Fig. 8. Point estimates and 95% confidence intervals for the attraction effects in *baseline* and *deletion* conditions.

indeed allowed users to overcome the bias

REFERENCES

Dimara E, Bailly G, Bezerianos A, Franconeri S. [Mitigating the attraction effect with visualizations](#). IEEE Transactions on Visualization and Computer Graphics. 2019 Jan;25(1):850-60.

Valdez AC, Ziefle M, Sedlmair M. [Priming and anchoring effects in visualization](#). IEEE Transactions on Visualization & Computer Graphics. 2018 Jan 1(1):584-94.

The Attraction Effect Explained – [Whiteboard video](#)

20 Cognitive Biases That Screw Up Your Decisions – [weblink](#)

10 Cognitive Biases That Distort Your Thinking - [weblink](#)