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	Project 2 out
8	Bias in visualization	
9	Perception and cognition	
10	Visual design and aesthetics	
11	Cluster and pattern analysis	
12	High-Dimensional data visualization: linear methods	Project 3 out
13	High-D data vis.: non-linear methods, categorical data	
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

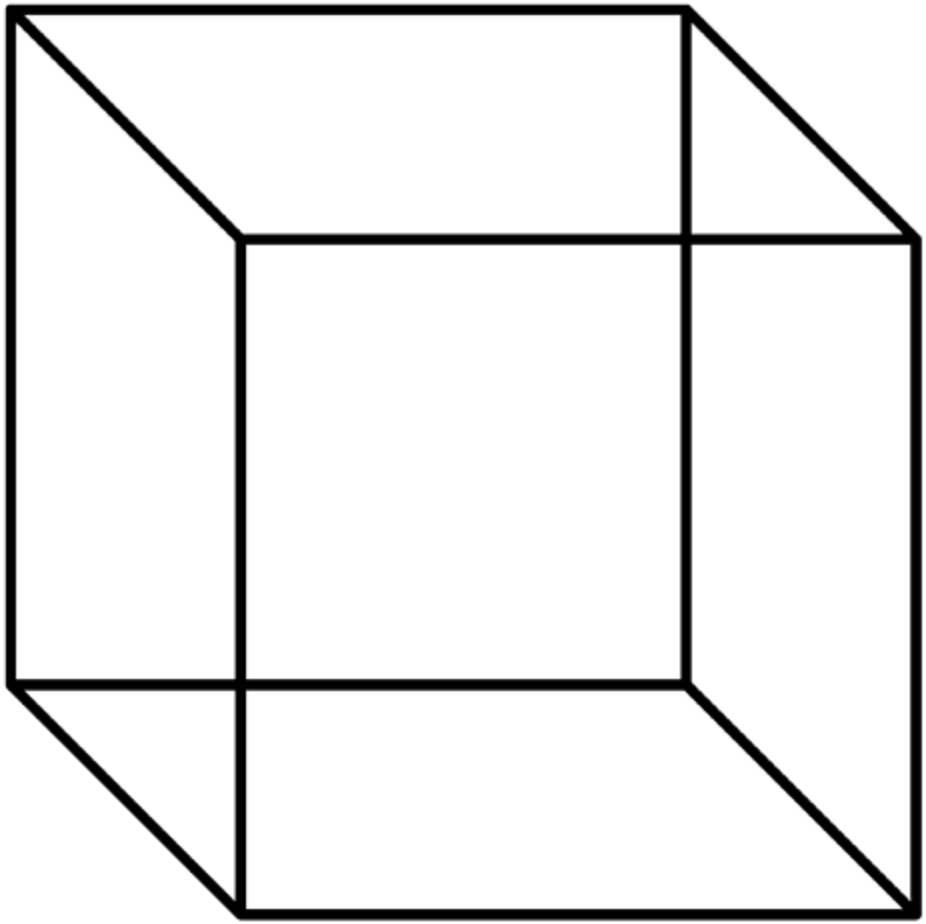
Persistence of mindset

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

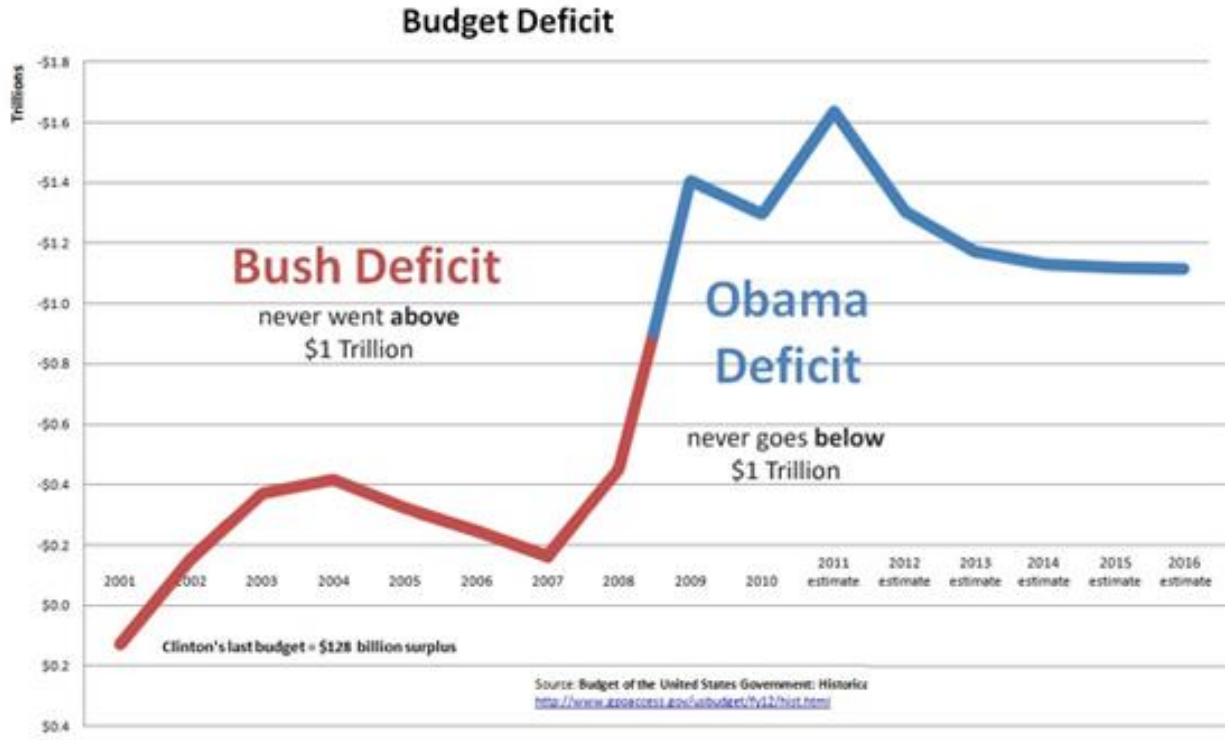
man/woman

Young/old woman

Necker Cube



Visualization Can Support Bias !!

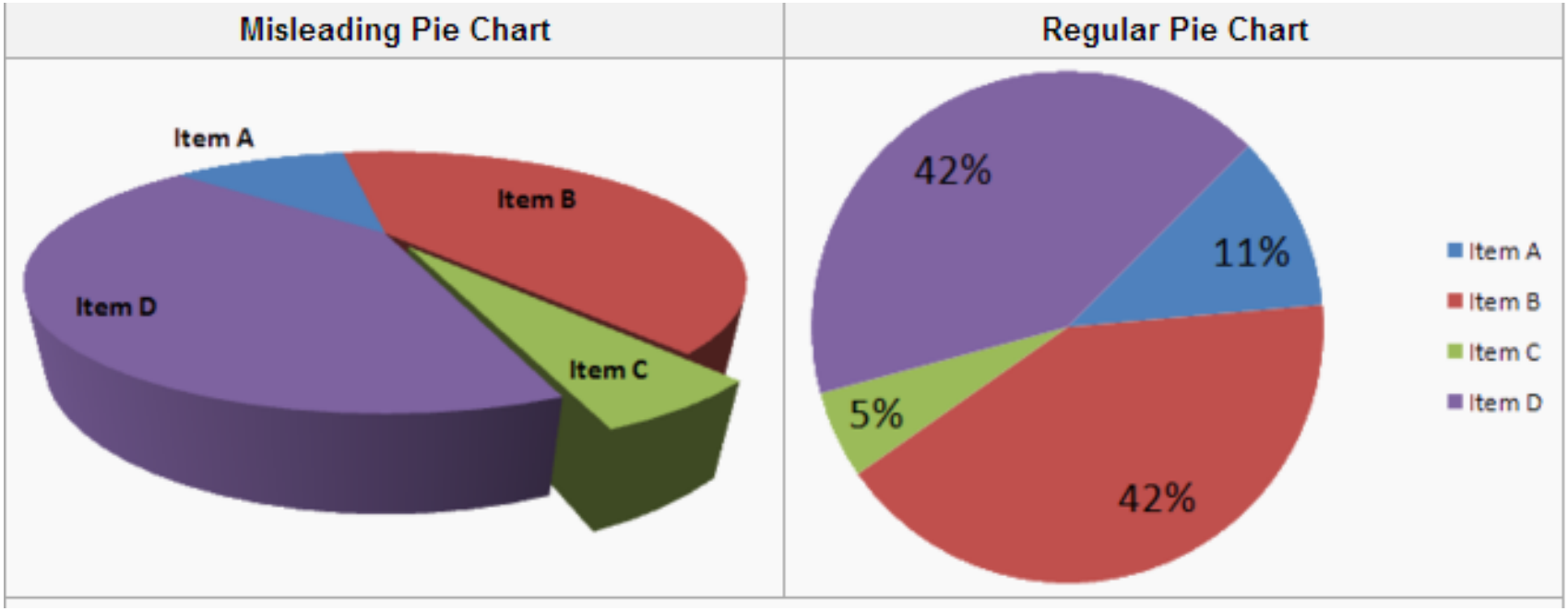


Signal value issues. The red line feels more negative. From http://www.politicalmathblog.com

Appeals to cultural bias

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

Graphical Bias



Perspective distortion in 3D rendering causes bias

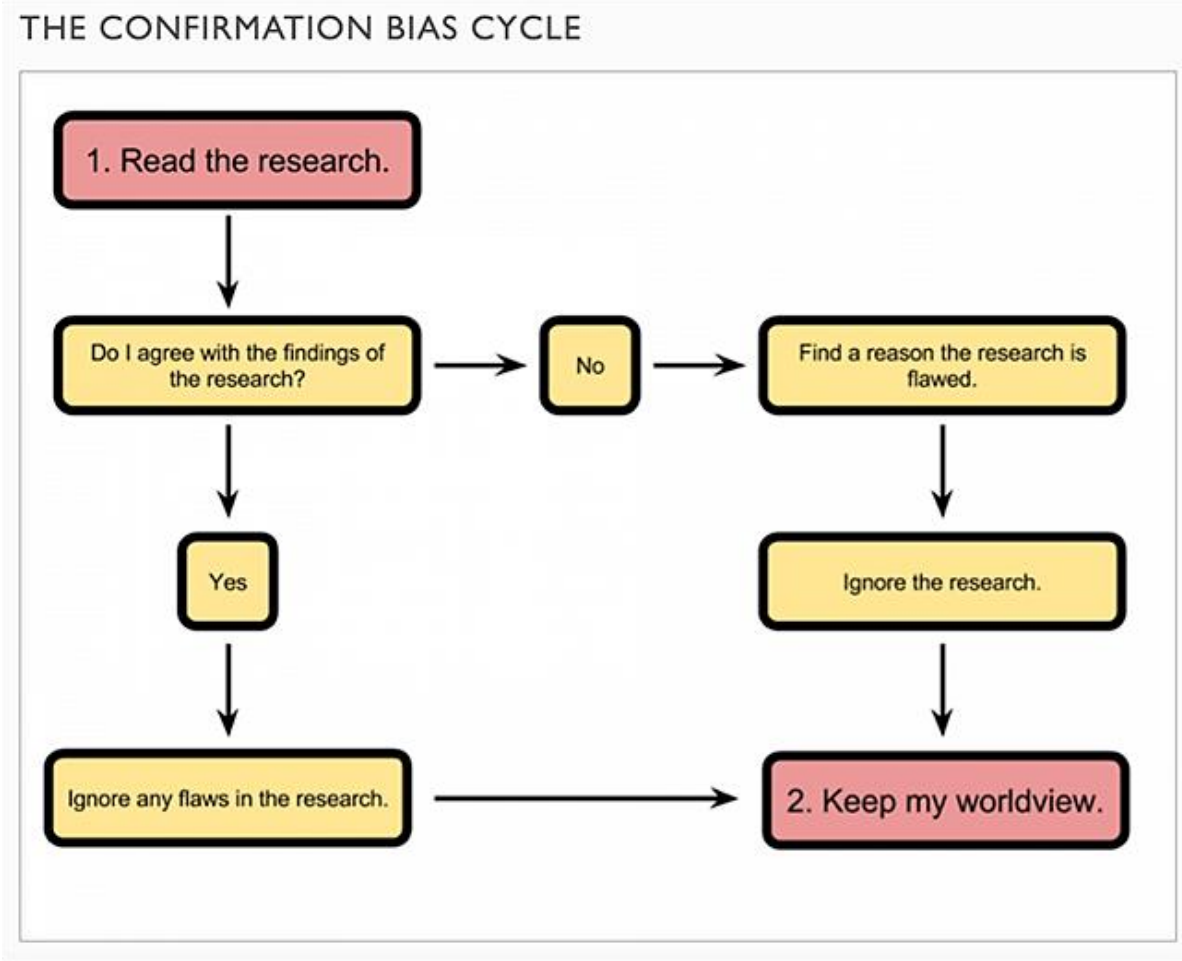
- in the 3D chart. item C appears to be at least as large as Item A
- whereas in actuality, it is less than half as large.

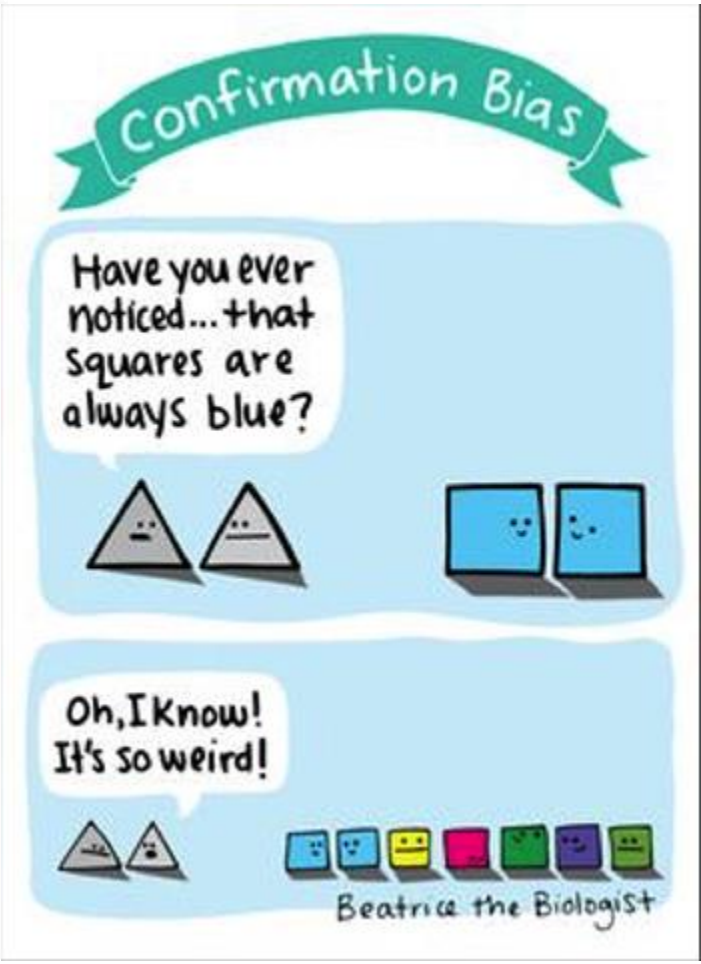
Cognitive Biases

Impede proper decision making

Comes in many guises

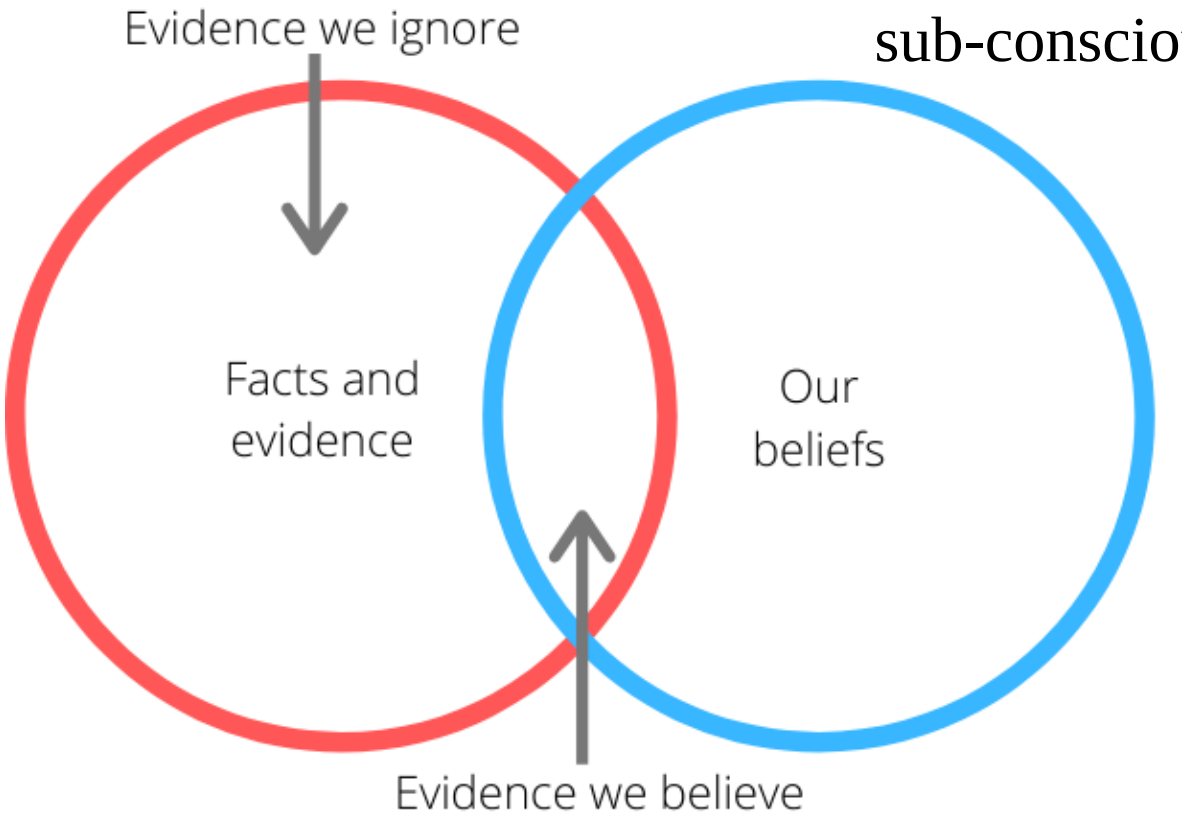
Confirmation Bias





Confirmation Bias

previously learned
sub-conscious



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.

The Confirmation Bias

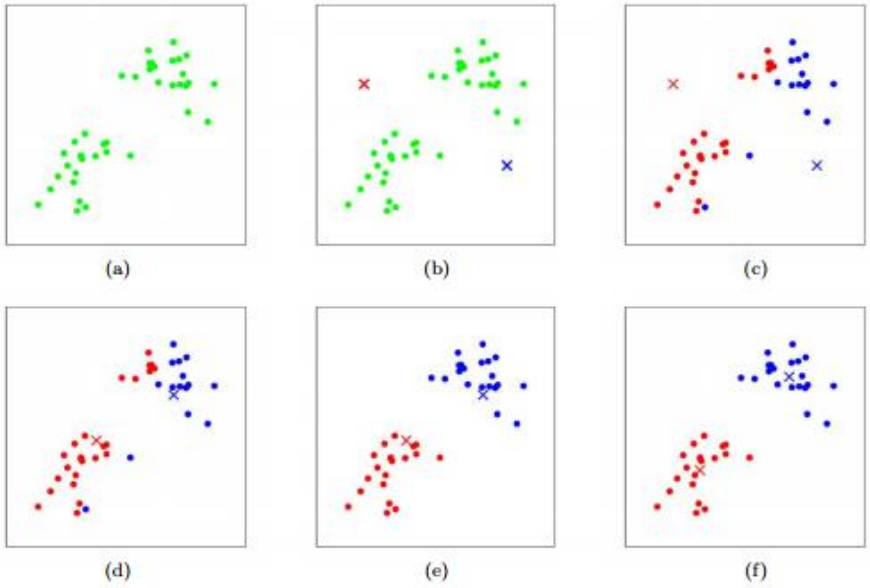
Favor information that confirms previously held beliefs

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

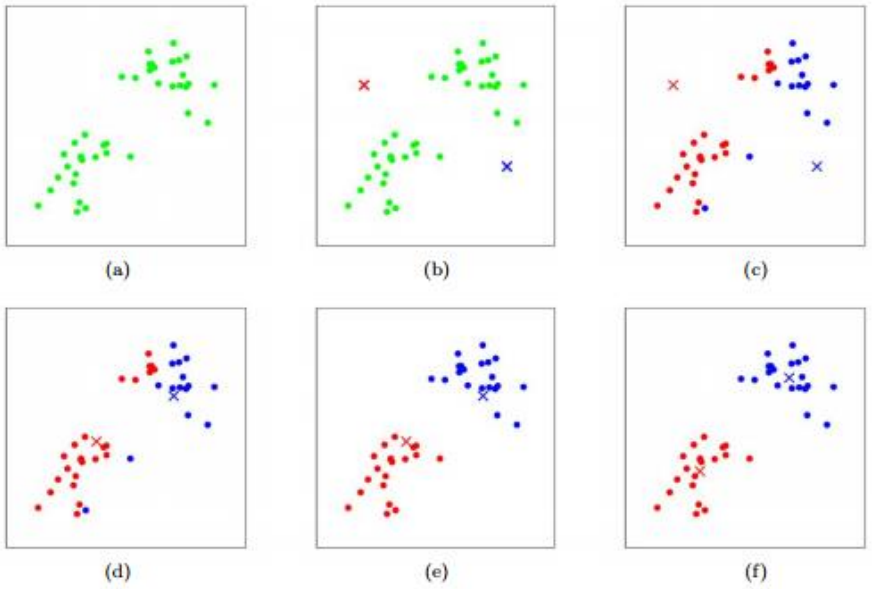
The Hindsight Bias

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)?



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 × 2 × 3 × 4 … × 8	512
8 × 7 × 6 × 5 … × 1	2,250

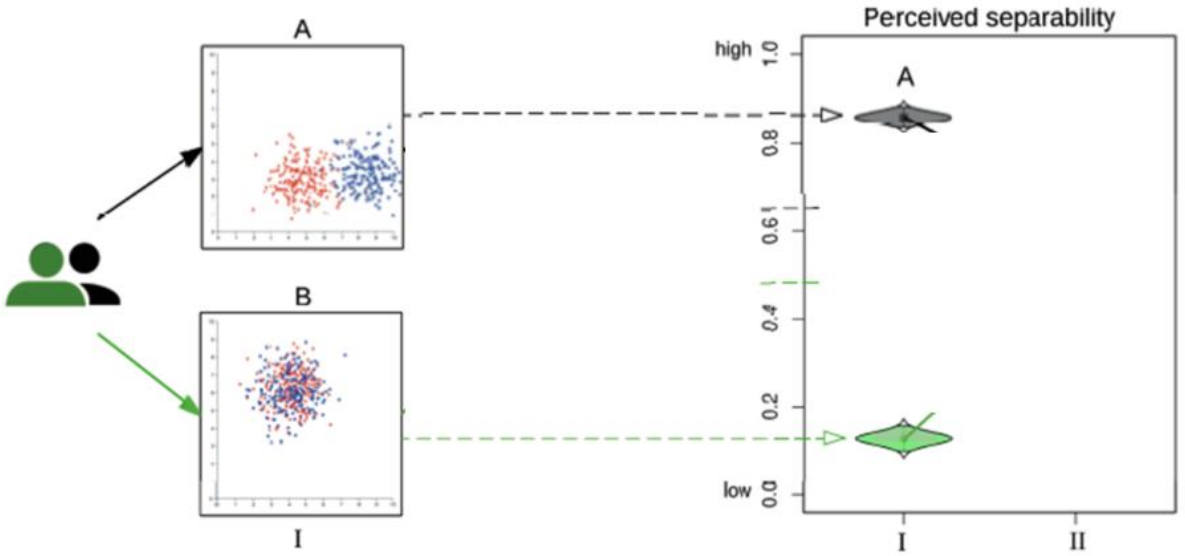
Answer: 40,320

Amos Tversky and Daniel Kahneman: "Judgment under uncertainty: heuristics and biases," *Science* (Sep. 27, 1974)

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.



Valdez et al. TVCG 2010

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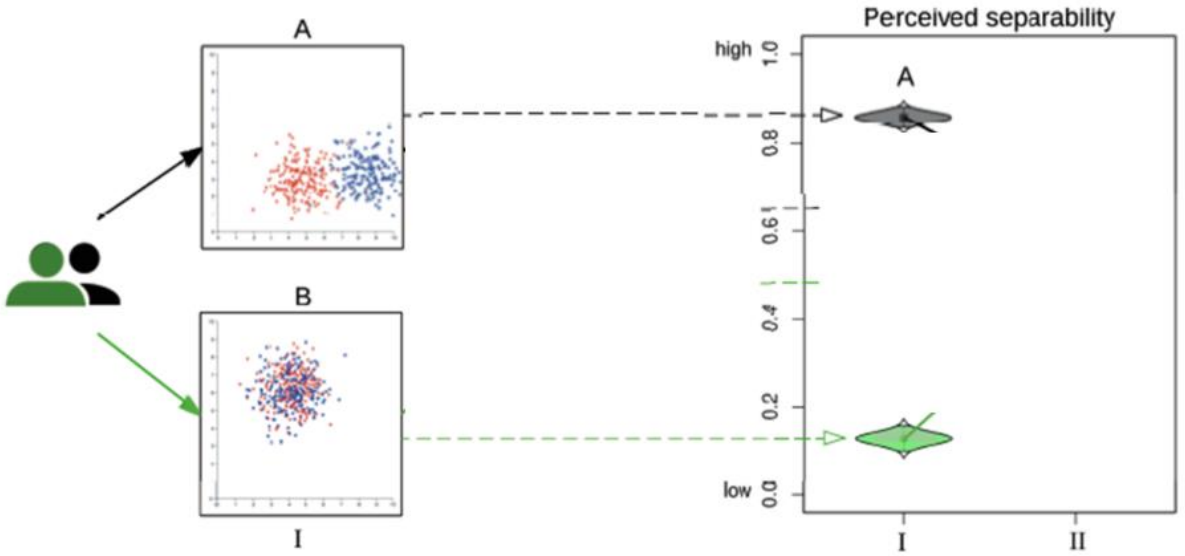

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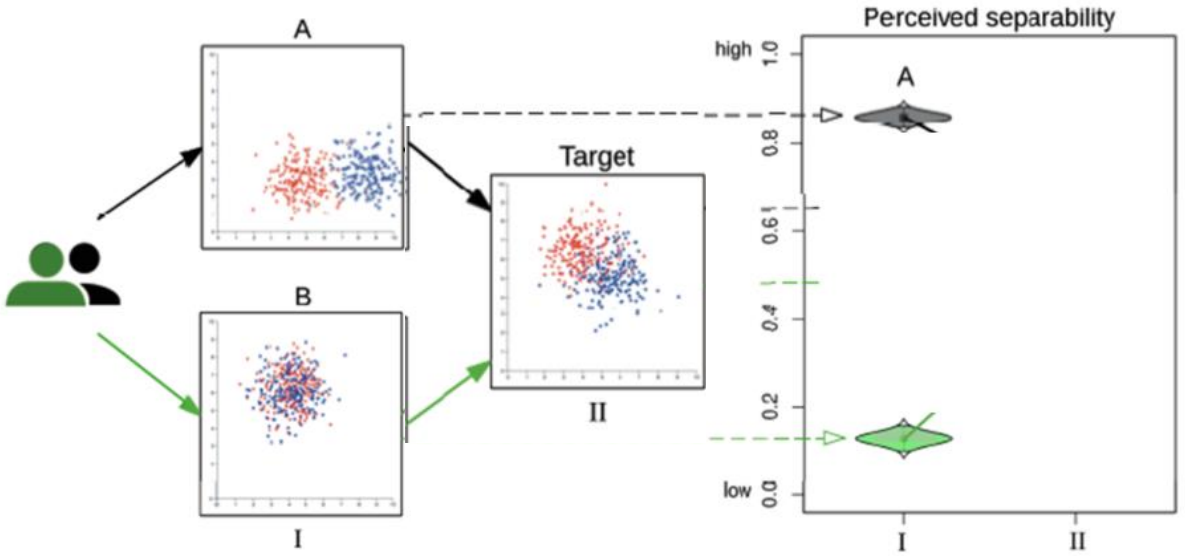

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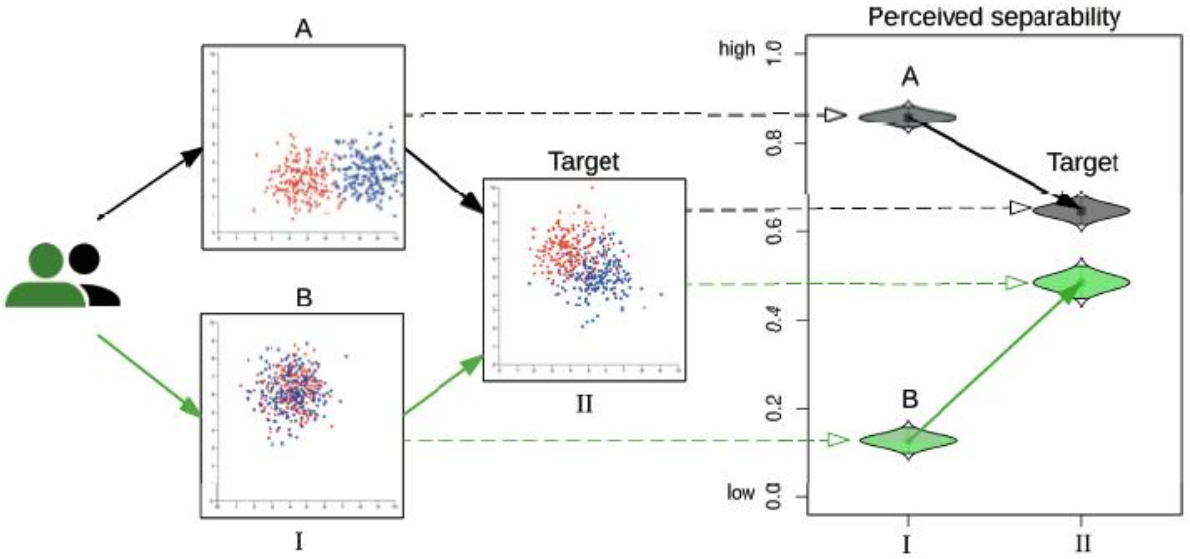


Valdez et al. TVCG 2018

The Availability Heuristic

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

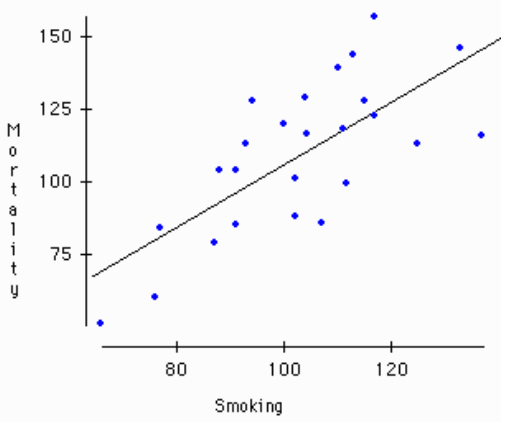
- this can lead to misconceptions and prejudices

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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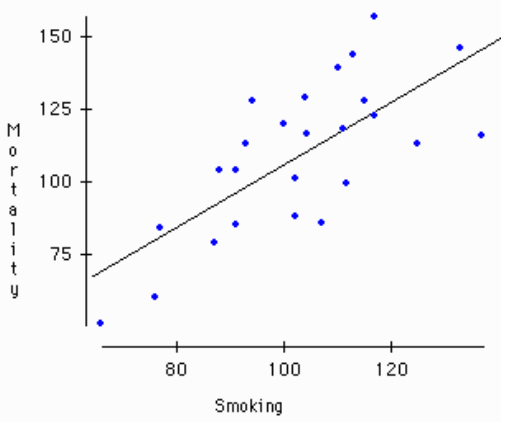
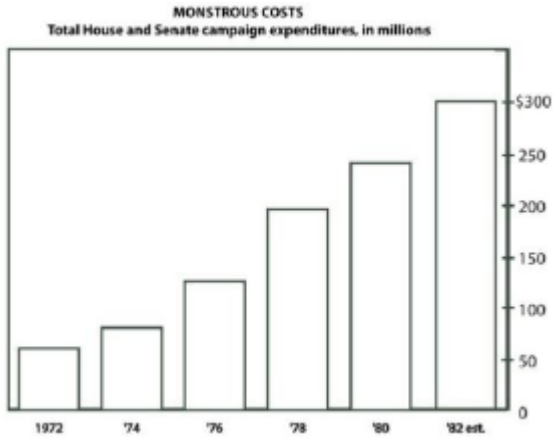
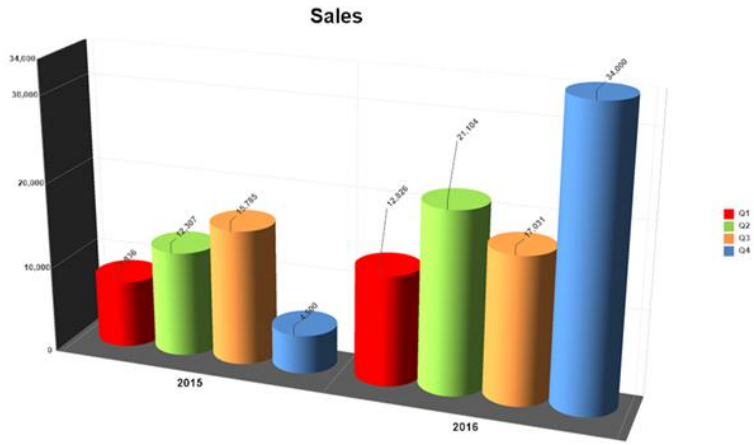


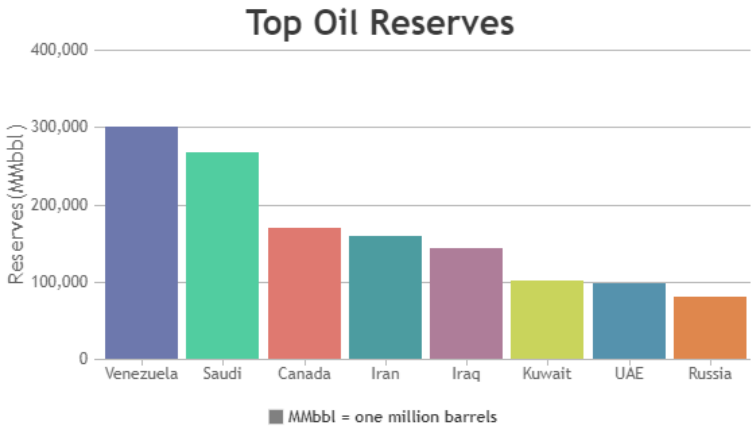
The Halo Effect

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

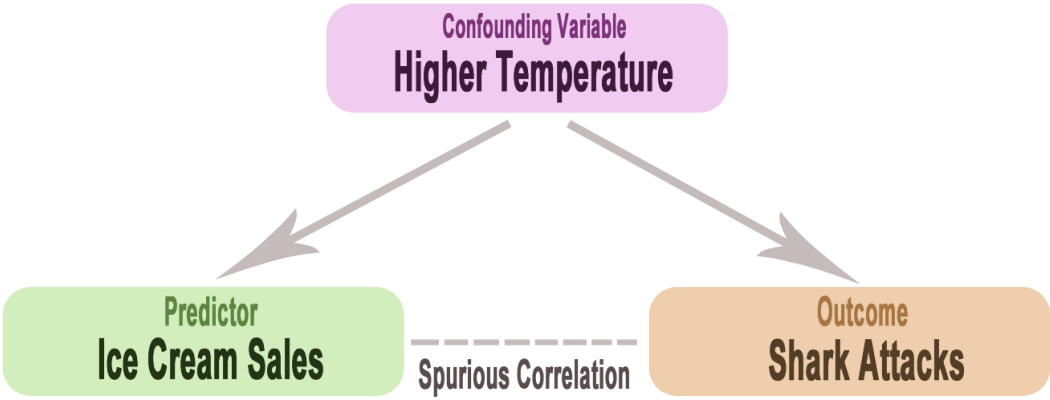
Occurs when the data sample is not an accurate representation of the population

- 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)
- susceptibility bias – for example, when one disease predisposes for a second disease, and the treatment for the first disease erroneously appears to predispose to the second disease

Confounding

Rate of ice cream consumption

Number of sunburns



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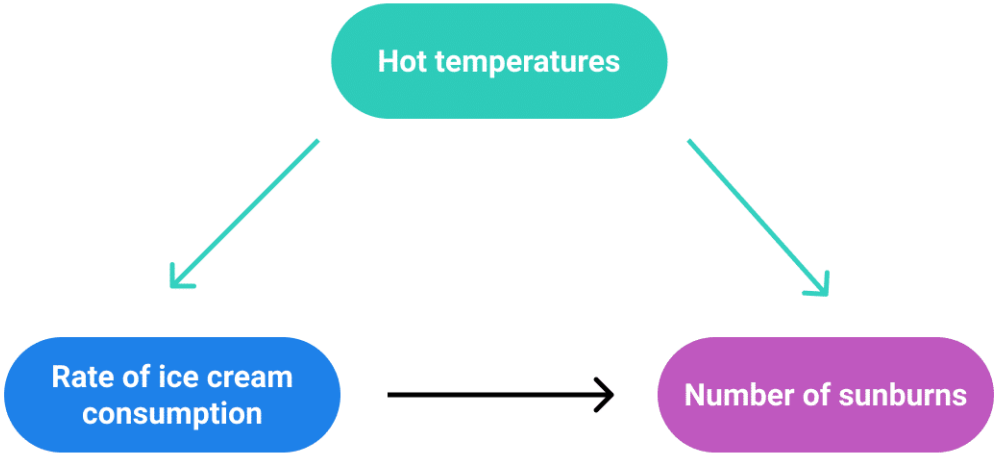
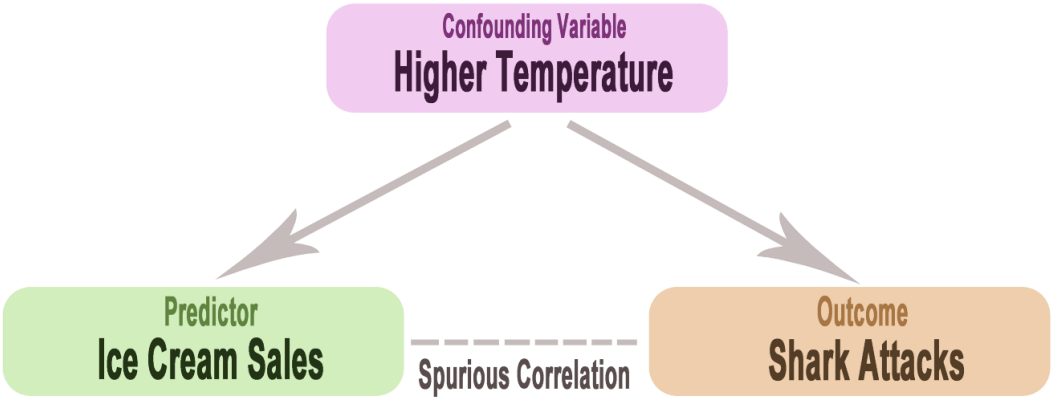
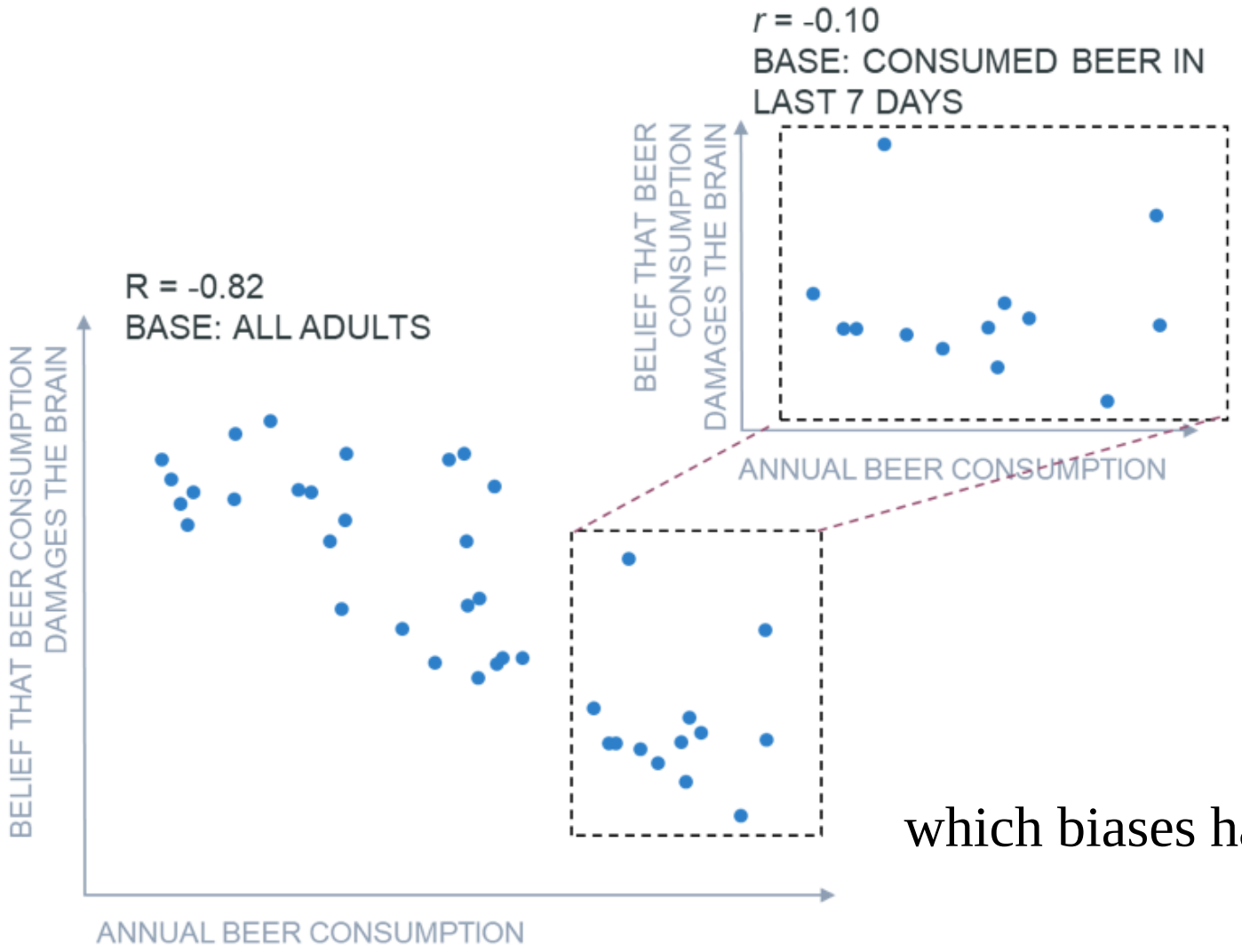




Selection Bias – Example 1



which biases have occurred?

Selection Bias – Example 2

video link

One more

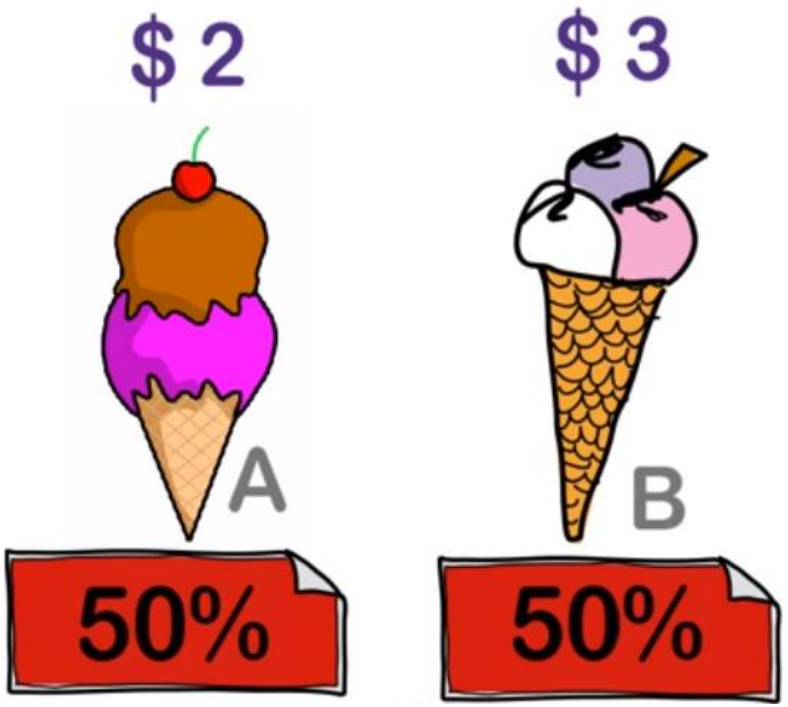
The attraction bias

- 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 lover price
- depending on how you feel you will pick either one of them

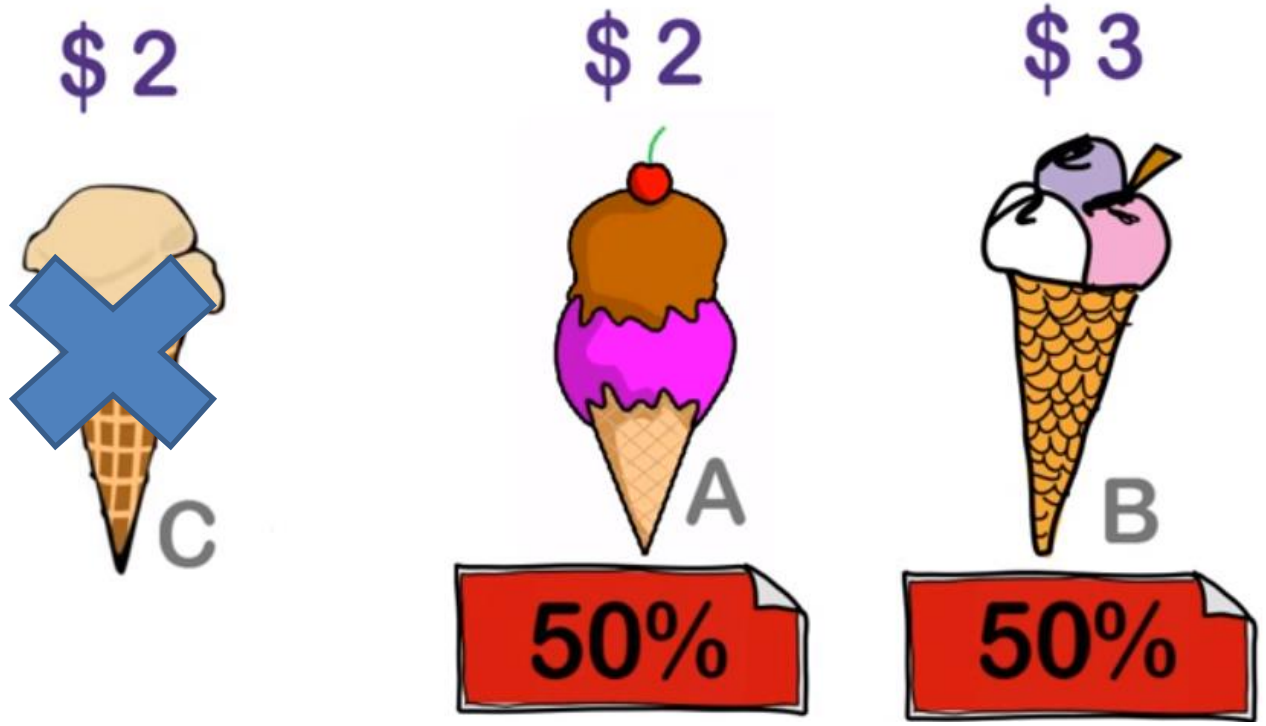


ice cream cone
A and B have the
same market share

youtube video

The Attraction Effect (2)

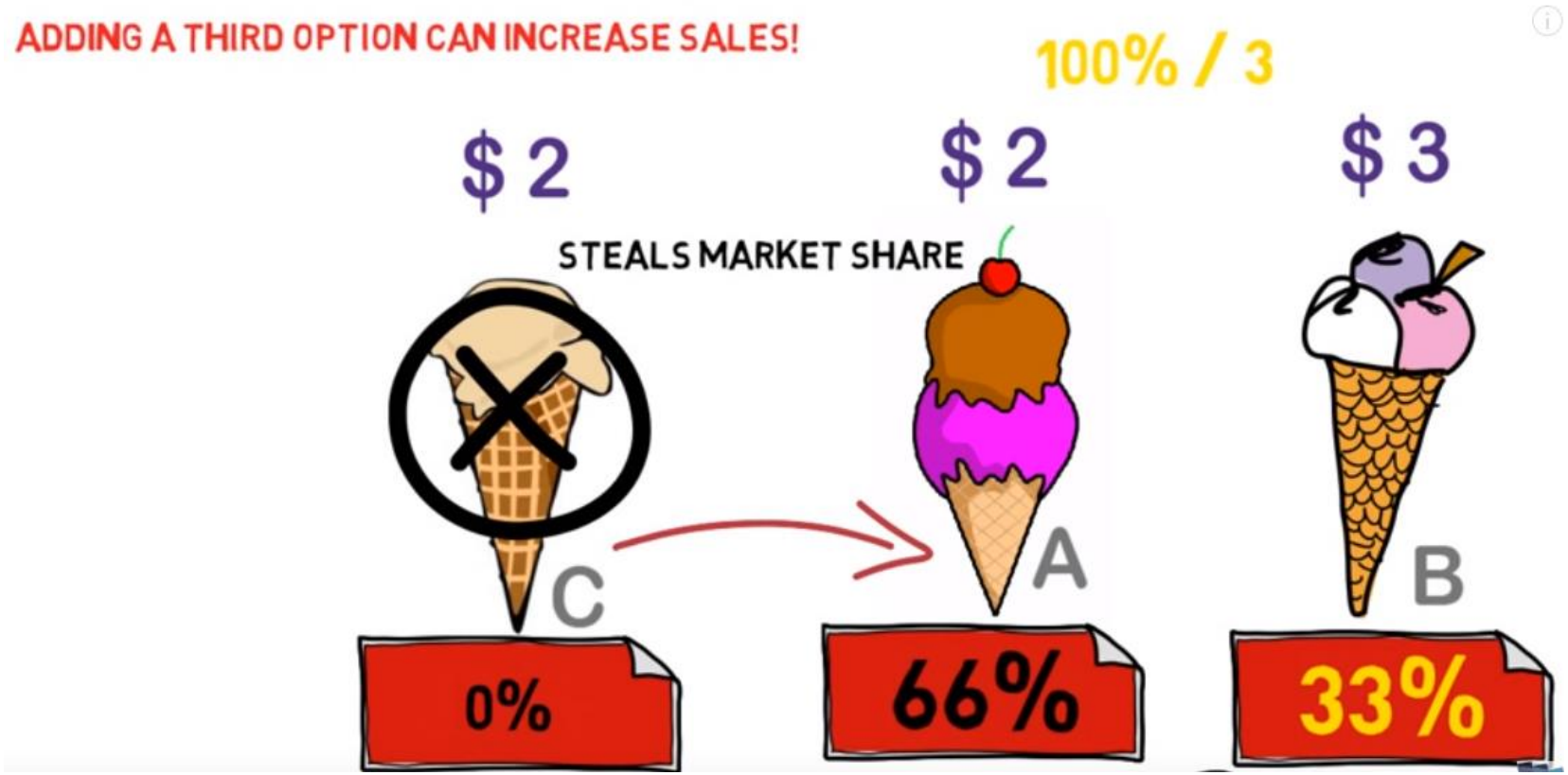
Now suppose there was a third ice cream cone available



- nobody would pick it

youtube video

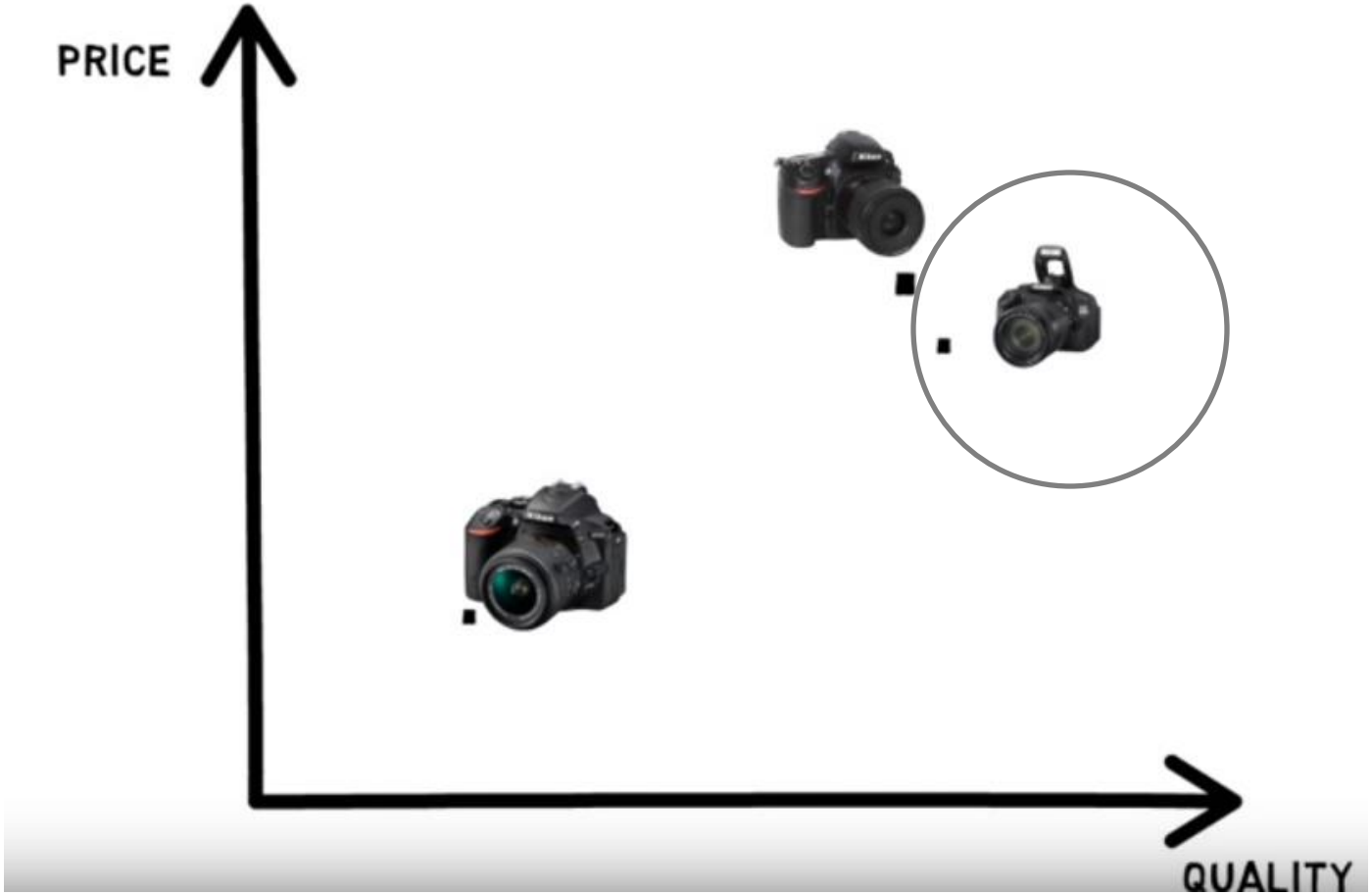
The Attraction Effect (3)



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

youtube video

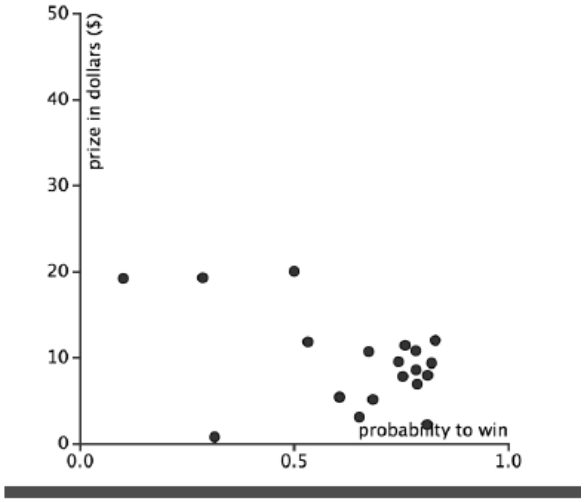
One More Example



Application to Visualization

Decision making with conflicting goals

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



Dimara et al. TVCG 2019

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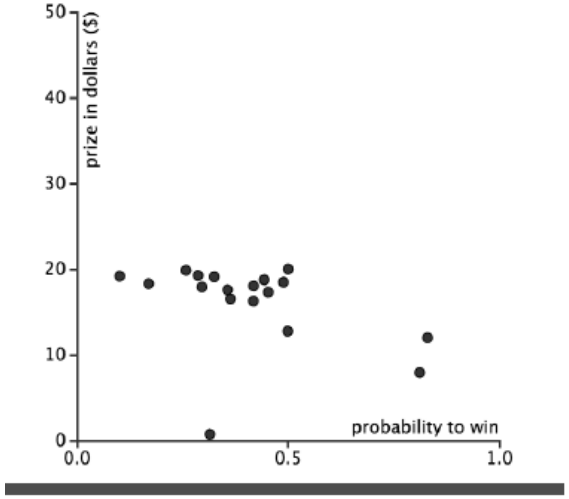

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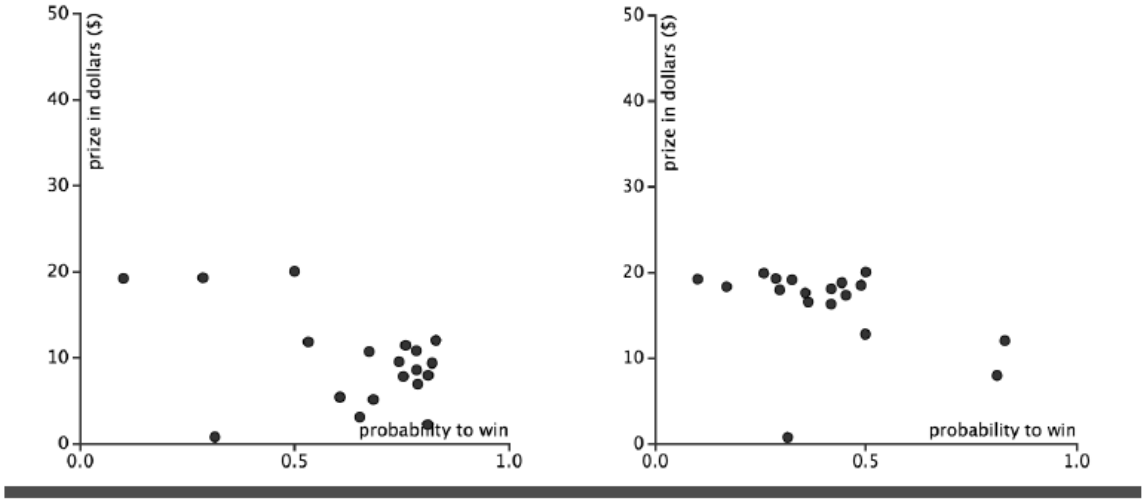

Placement of decoys will always make A or C most attractive in selection and attention tasks

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

Dimara et al. TVCG 2019

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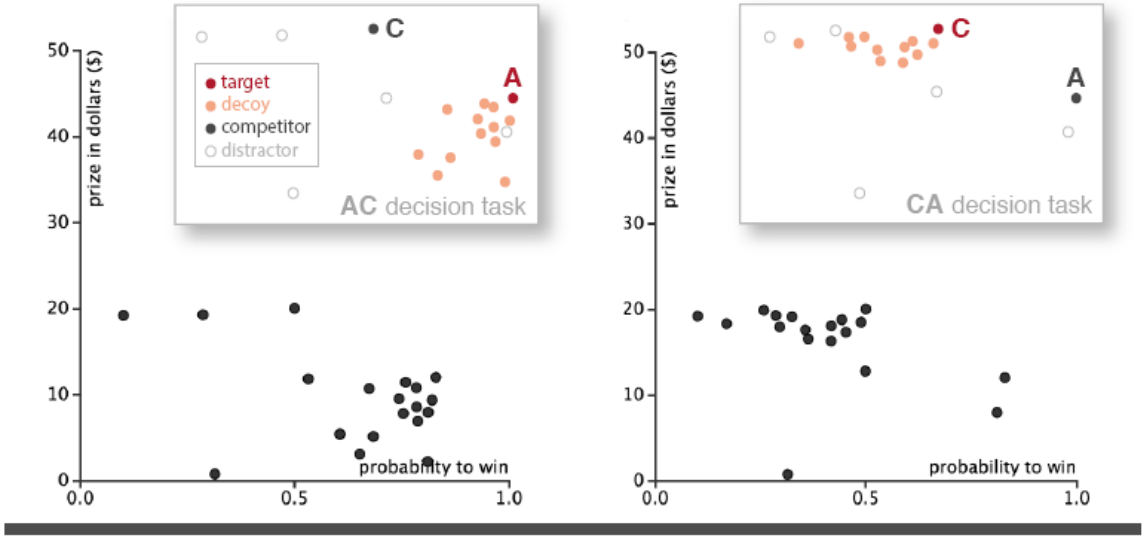

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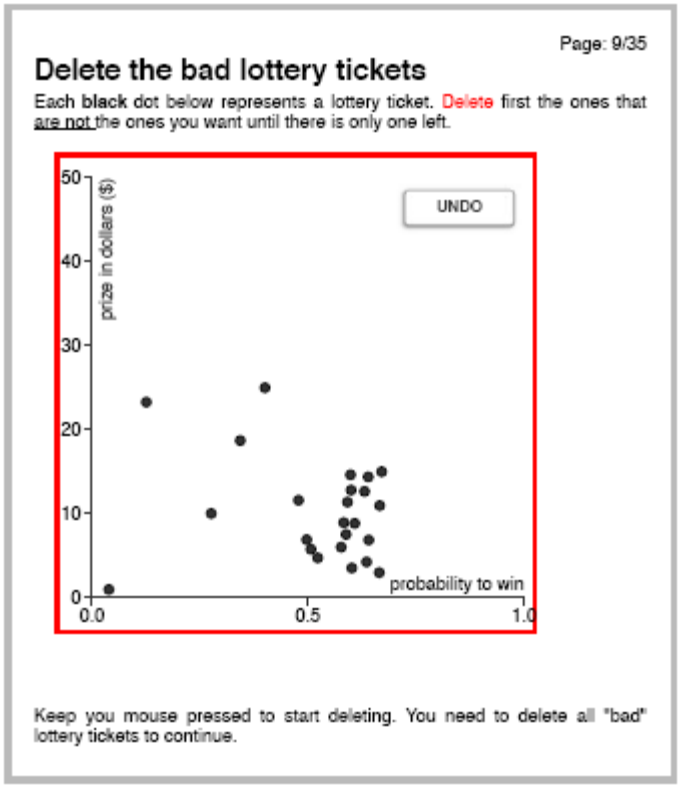
A Mitigation technique

Allow user to delete data points



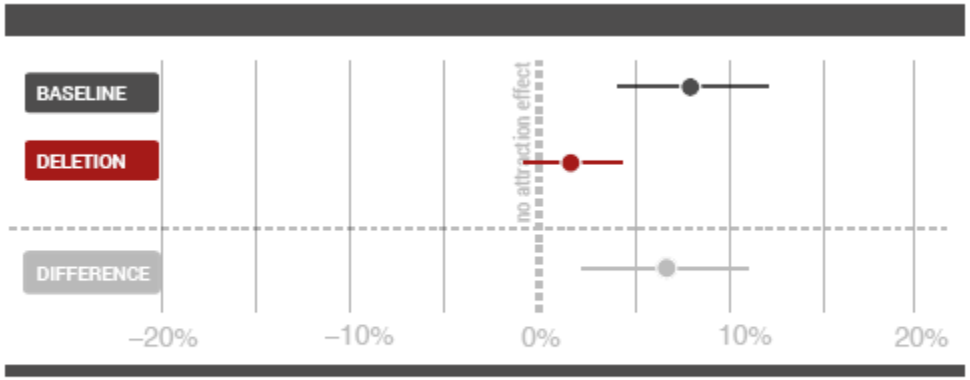


Fig. 8. Point estimates and 95% confidence intervals for the attraction effects in *baseline* and *deletion* conditions.

indeed allowed users to overcome the bias

Dimara et al. TVCG 2019

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