# Confirmation Bias in Graphical Displays

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## Motivation

Prior beliefs influence how people read patterns in data. When people view tabular data, they make quick heuristic judgments congruent to their beliefs, rather than carefully thinking through the data[2], which makes them susceptible to confirmation bias[1].

Kahan et al. found people to be less accurate when solving a difficult problem in a political context, conforming their interpretation of the data to the result most consistent with their political beliefs[2].

What if we visualize the data instead of presenting numbers? Visualization designs afford different thinking patterns with data. Cognitive biases such as confirmation bias could be mitigated by data visualization, such as by using carefully designed charts[4]

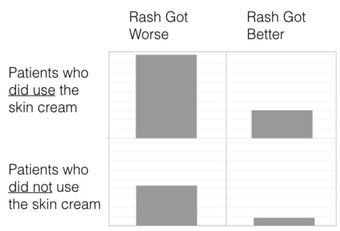
## Experiment 1

First, we primed participants to either think of the company as good, likely producing an effective skin cream, or bad, likely producing an ineffective skin cream.

**Tabular Data**

| | Rash Got Worse | Rash Got Better |
|---|---|---|
| Patients who did use the skin cream | 223 | 75 |
| Patients who did not use the skin cream | 107 | 21 |

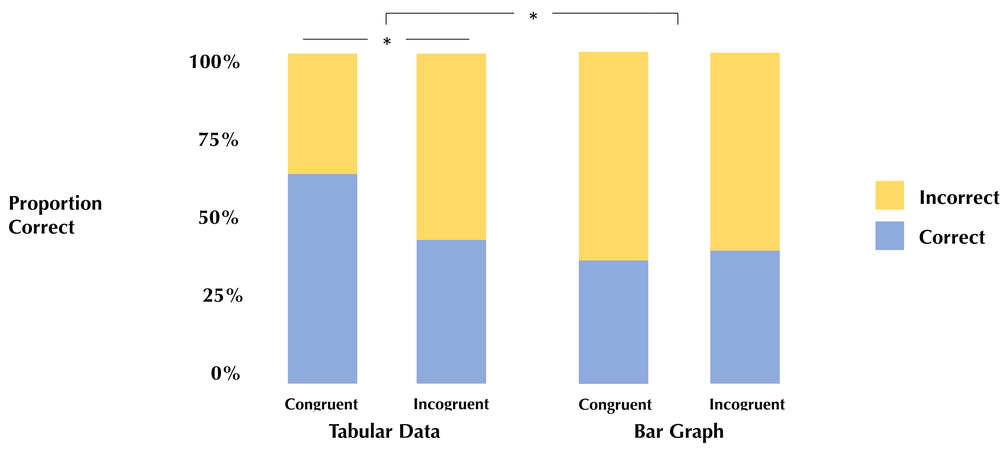
**Bar Graph**




*both showing rash more likely got better for patients who did use the skin cream.

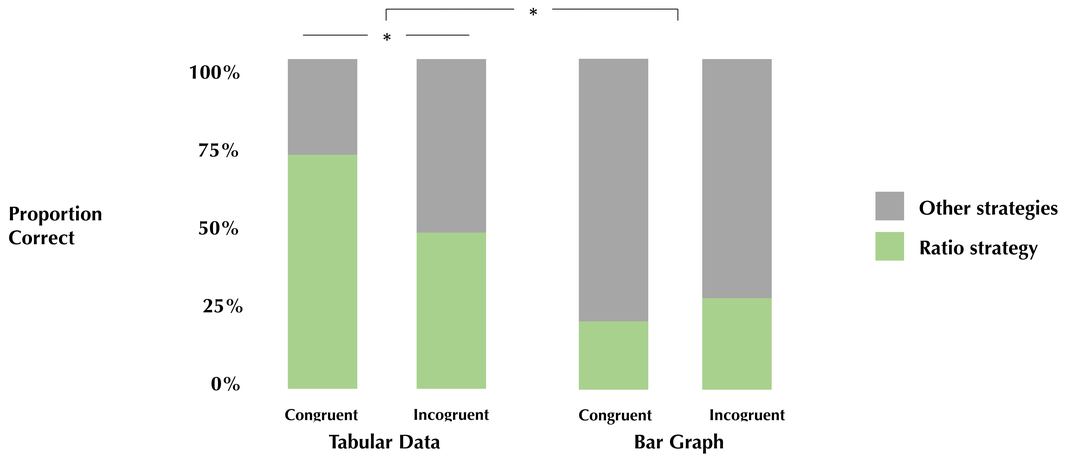
What result does the study support?

☐People who used the skin cream were more likely to get better than those who didn't.
☐People who used the skin cream were more likely to get worse than those who didn't.




There is confirmation bias when the problem is presented as **tabular data**. When the correct answer is congruent to people's belief, more people answered the question correctly.

There is no confirmation bias when the problem is presented as **a bar graph**. Accuracy is overall low regardless whether the correct answer is congruent to people's belief or not.




Participants overall used the correct ratio strategy more often to solve the problem when it was presented in a table. They were even more likely to do so when the correct answer was congruent to their belief.

Participants did not use the correct ratio strategy very often when the problem was presented as a bar graph. There was no difference whether the correct answer was congruent to their belief or not.

## Conclusion

We successfully replicated the findings in Kahan et al. and showed that confirmation bias can manifest in a neutral context with priming, when the data is presented as a table.

Confirmation bias vanished when the problem was presented as a bar graph. This likely happened because tabular data requires more effortful ratio comparisons of data than bar graphs.

The low accuracy in bar graphs could be due to people relying on salient visual features to compare data points visualized in bar charts, instead of critical thinking and calculating the ratios.

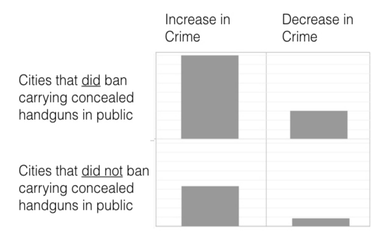
## Experiment 2

We measured participant's prior belief on how much they agreed with the statement "greater gun restriction laws are necessary to reduce violence."

**Tabular Data**

| | Increase in Crime | Decrease in Crime |
|---|---|---|
| Cities that did ban carrying concealed handguns in public | 223 | 75 |
| Cities that did not ban carrying concealed handguns in public | 107 | 21 |

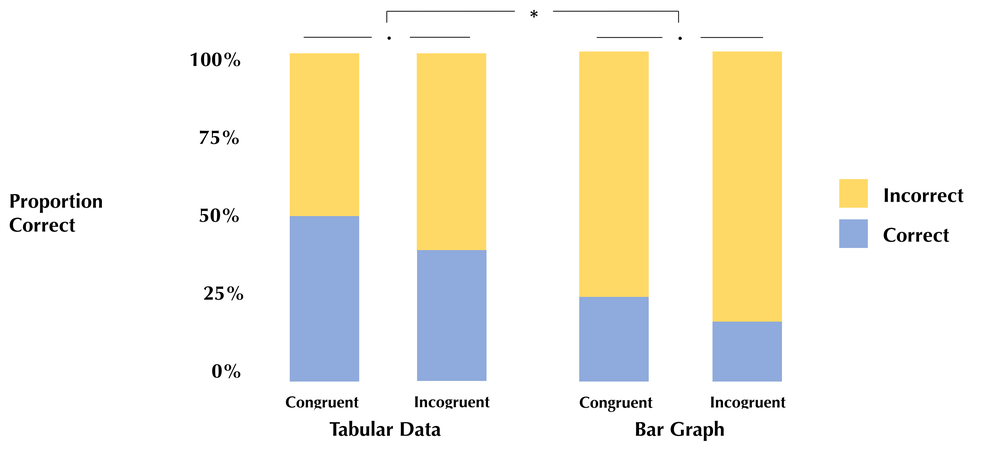
**Bar Graph**




*both showing crime more likely decreased for cities that did ban carrying concealed handguns in public.

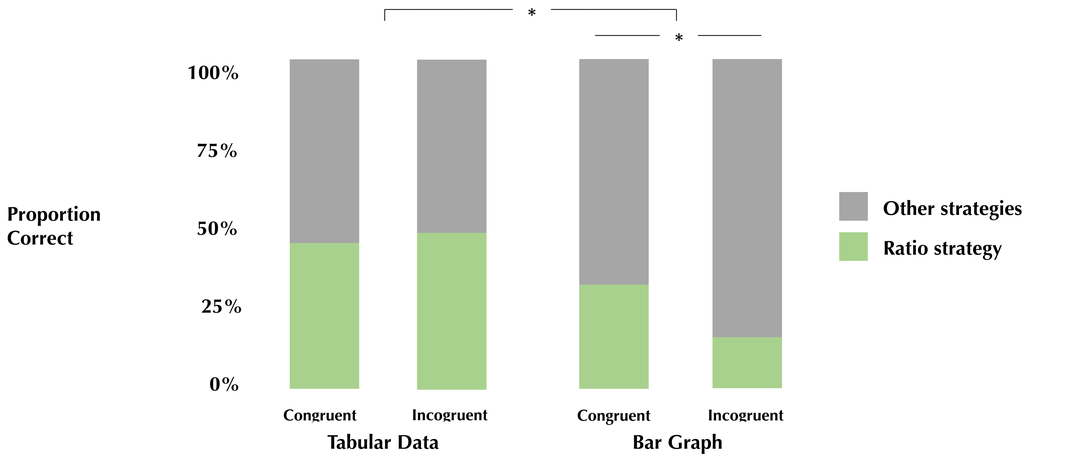
What result does the study show?

☐Cities that did ban carrying concealed handguns were more likely to have a **decrease** in crime than cities without bans.
☐Cities that did ban carrying concealed handguns were more likely to have an **increase** in crime than cities without bans.




We found trending confirmation bias when the problem is presented as **tabular data**, although the effect size was smaller.

There is trending confirmation bias when the problem is presented as **a bar graph**. Accuracy again is overall lower compared to the tabular data condition.




Participants overall used the correct ratio strategy more often to solve the problem when it was presented in a table. There was no difference whether the correct answer was congruent to their belief or not.

Participants did not use the correct ratio strategy very often when the problem was presented as a bar graph. They were even more likely to do so when the correct answer was congruent to their belief.

## Reference

[1] Chaiken, S. (1980). Heuristic versus systematic information processing and the use of source versus message cues in persuasion. *Journal of personality and social psychology*, *39*(5), 752.
[2] Kahan, D. M., Peters, E., Dawson, E. C., & Slovic, P. (2017). Motivated numeracy and enlightened self-government. Behavioural Public Policy, 1(1), 54-86.
[3] Michal, A. L., Uttal, D., Shah, P., & Franconeri, S. L. (2016). Visual routines for extracting magnitude relations. Psychonomic bulletin & review, 23(6), 1802-1809.
[4] Sukumar, P. T., & Metoyer, R. (2018). A Visualization Approach to Addressing Reviewer Bias in Holistic College Admissions. In *Cognitive Biases in Visualizations* (pp. 161-175). Springer, Cham.
[5] Zacks, J., & Tversky, B. (1999). Bars and lines: A study of graphic communication. *Memory & Cognition*, *27*(6), 1073-1079.

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