

Are causal judgments graded?

Background

Thinking of causation as graded helps to explain why, when a forest is burned down after a match is lit, the match is seen as more causal than the presence of oxygen or the lack of rain—even though all are causally necessary. Although this idea may hold intuitively, it remains to be tested empirically.

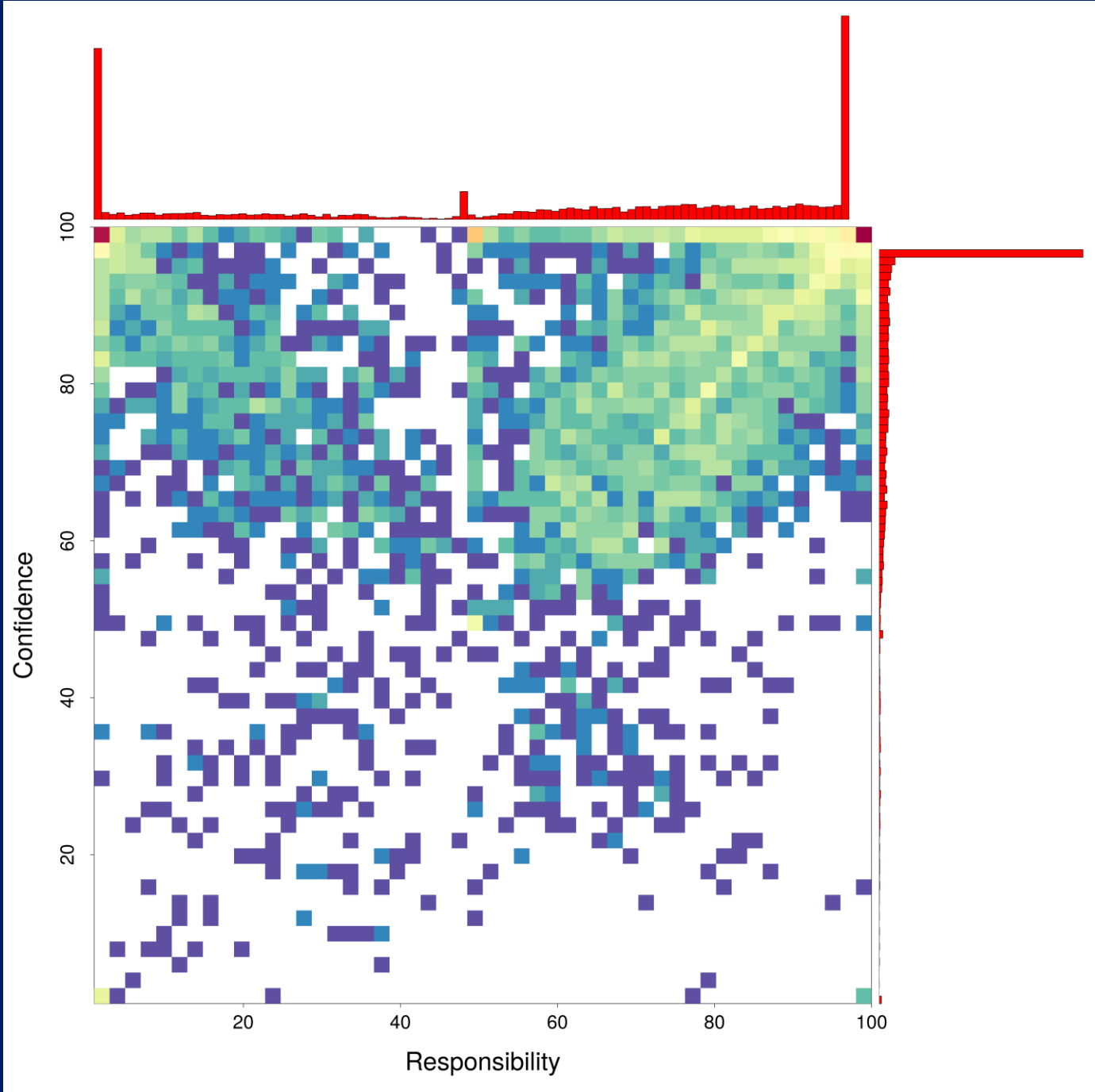
Questions:

- 1.) How are causal ratings distributed?
- 2.) How can we interpret intermediate ratings?
- 3.) How are causal judgments updated?

Descriptive Analysis

We completed a meta-analysis of causality ratings from four studies on causal judgment. To quantify the discreteness of causal ratings, we used Hartigen's dip test. Additionally, we predicted ratings from discretized ratings made by rounding to a ternary ordinal variable.

	Gerstenberg et al 2015	Icard et al 2017	Henne et al 2019	Morris et al 2019
Stimulus	Video Clips	Vignettes	Vignettes	Vignettes
Response Scale	Visual Analog Scale	7-point Likert	7-point Likert	9-point Likert
Causal Structure	Complex	Conjunctive/Disjunctive	Conjunctive/Disjunctive	Conjunctive/Disjunctive
Omissive	No	No	Yes	No
Dip Test	D = 0.104, p < 2.2e-16	D = 0.111, p < 2.2e-16	D = 0.091, p < 2.2e-16	D = 0.077, p < 2.2e-16
Discreteness	R^2 = 0.95, p < 2.2e-16	R^2 = 0.93, p < 2.2e-16	R^2 = 0.94, p < 2.2e-16	R^2 = 0.92, p < 2.2e-16



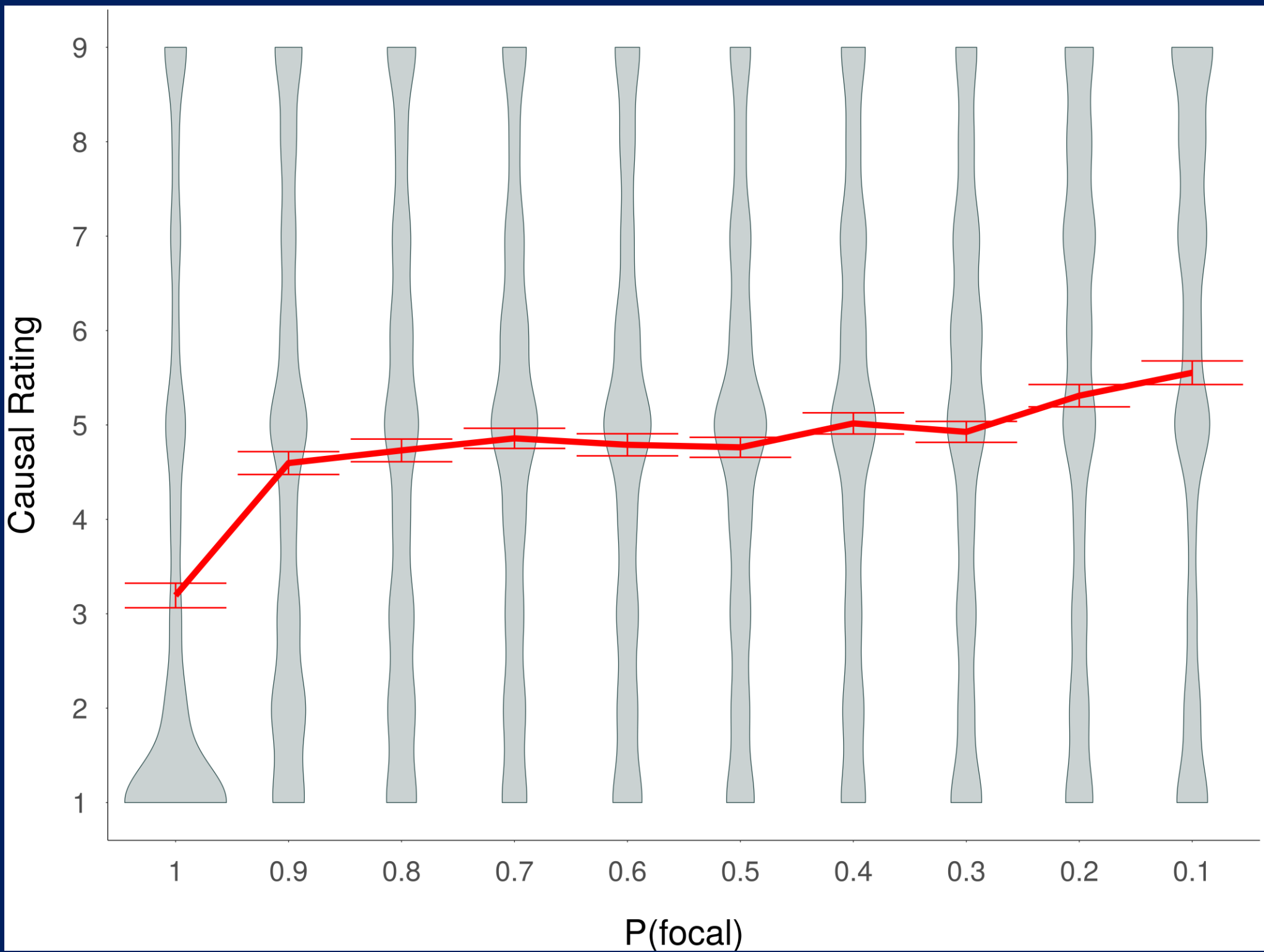
In a replication of Gerstenberg et al (2015), we found a linear relationship between confidence and rating extremity, but also intermediate ratings of high confidence.

Revisiting Effects on Causal Judgment

Regressions are typically used to examine effects of normality on causal judgment, suggesting that people update causal judgments gradually. However, we found multi-modal distributions across all probabilities of focal and alternate causes.

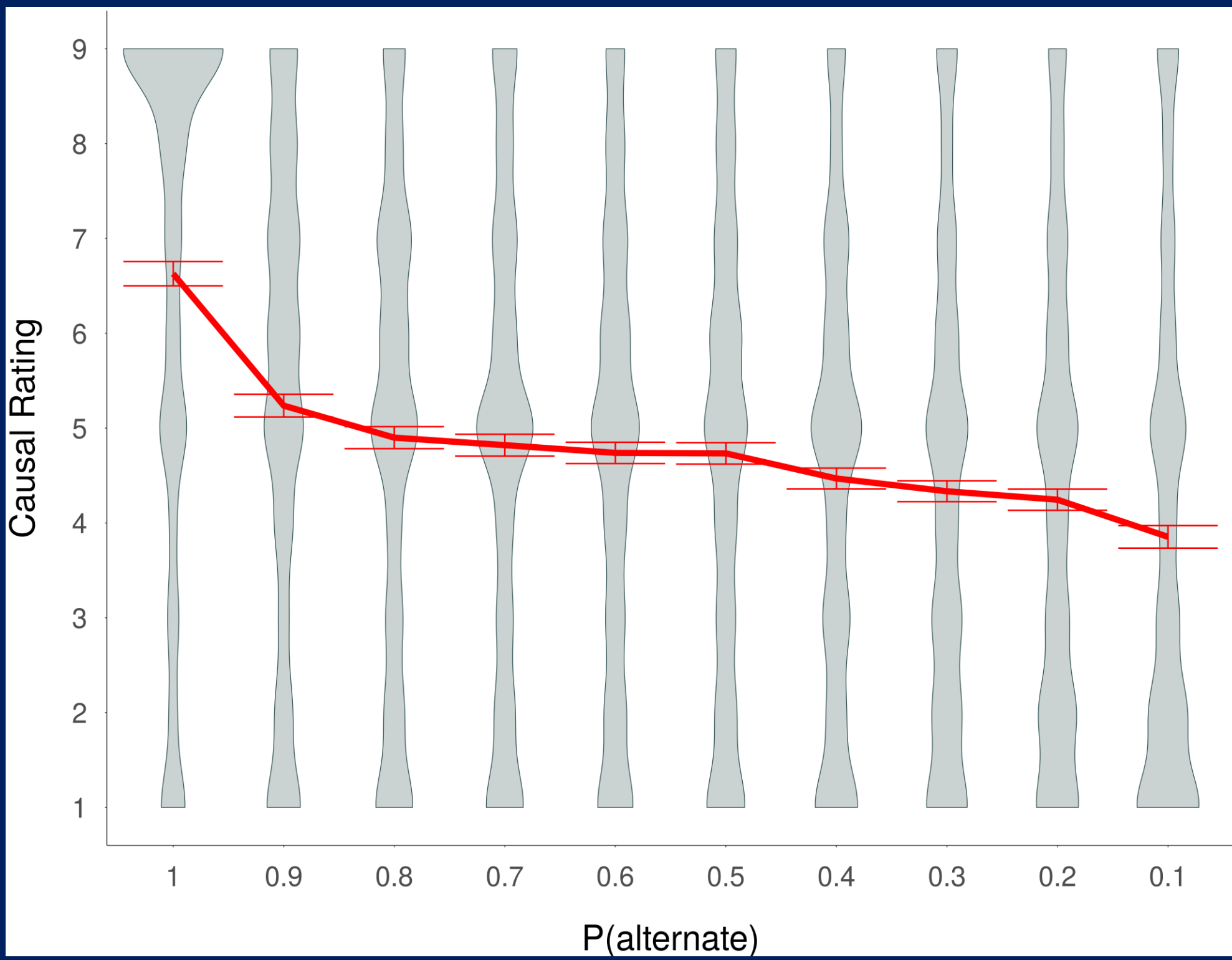
Abnormal Inflation

When a forest fire ensues after a match is lit, the match is often perceived as more causal than the presence of oxygen. One reason is that lit matches are relatively rare, and oxygen is relatively common. This concept is known as abnormal inflation: **as a cause gets rarer, its perceived strength increases.**



Causal Supersession

If the fire ensues after a match is instead lit inside a vacuum chamber, in which there is supposed to be no oxygen, people are less likely to blame the match. This is known as causal supersession: **as an alternate cause becomes rarer, the perceived strength of the focal cause decreases.**



Conclusions

- 1.) Causal ratings are distributed tri-modally, consisting of causal, non-causal, and intermediate ratings.
- 2.) Intermediate ratings may reflect either underlying uncertainty about causal attribution or true partial causality. Confidence can separate these possibilities.
- 3.) People update causal ratings discretely. Graded effects reflect population-level, not individual, trends.

Treating causal judgment as a discrete variable can help us

- avoid misleading interpretations of data
- provide an explanatory benchmark for probabilistic models
- consider more discrete theories (e.g. causal mental model theory, Khemlani et al 2014)

References

Gerstenberg, T., Goodman, N.D., Lagnado, D.A., & Tenenbaum, J.B. (2015). How, whether, why: Causal judgments as counterfactual contrasts. *CogSci*.
Henne, P., Niemi, L., Pinillos, A., De Brigard, F., Knobe, J.. (2019). A Counterfactual Explanation for the Action Effect.
Icard, T. F., Kominsky, J. F., & Knobe, J. (2017). Normality and actual causal strength. *Cognition*, 161, 80-93.
Khemlani, S. S., Barbey, A. K., & Johnson-Laird, P. N. (2014). Causal reasoning with mental models. *Frontiers in human neuroscience*, 8, 849.
Morris, A., Phillips, J. S., Gerstenberg, T., & Cushman, F. A. (2019). Quantitative causal selection patterns in token causation.