Variability in Causal Reasoning

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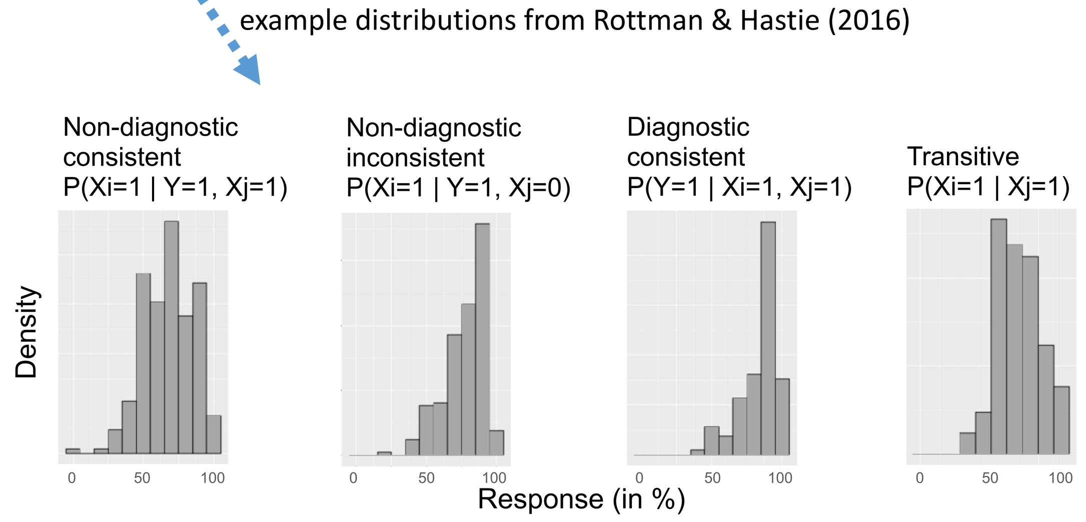
Background

We investigate the source of the considerable variability of causal judgments.

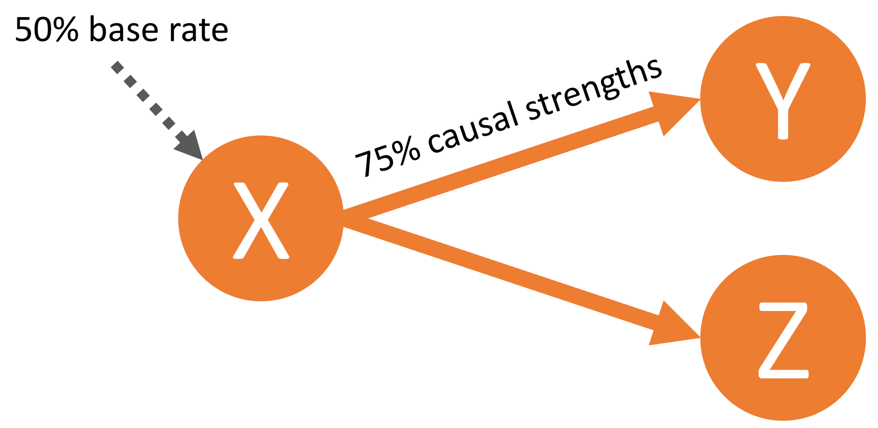


We do so by analyzing full response distributions of participant judgments, instead of just mean responses.

Questions

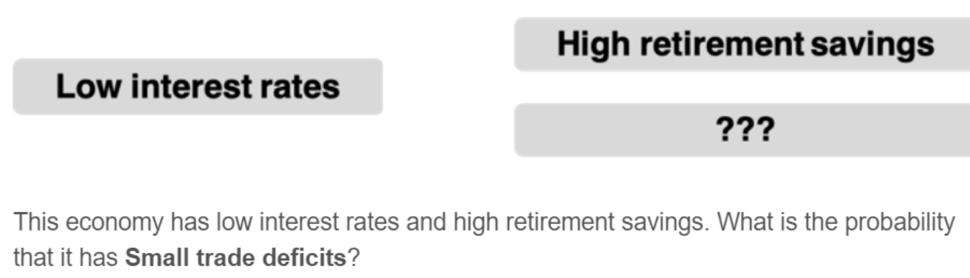
- Is there meaningful within-participant variability?
- Does variability differ across inference types?
  - Predictive vs diagnostic reasoning
  - Effect of conditional information
- Is individual level variability related to violations of Markov independence?
- Can existing models explain within-participant variability?

Setting



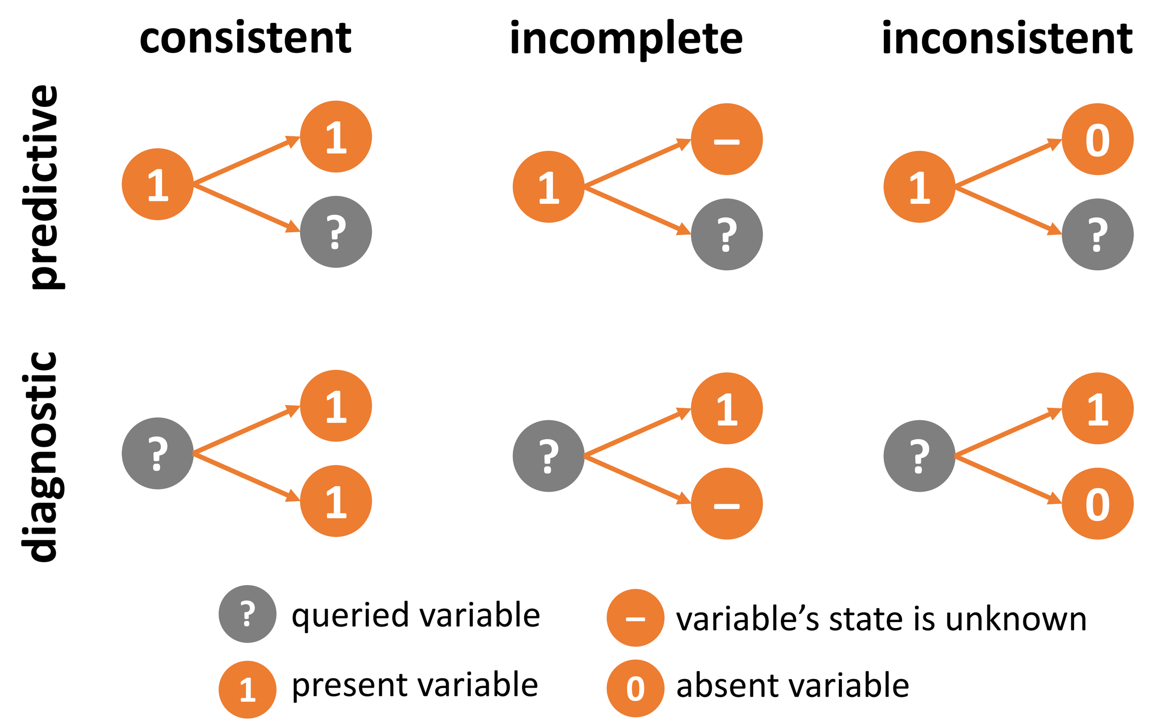
Inference task

- given state of 1 or 2 variables
- predict unknown variable's state (0 – 100)



Experiment

6 inference types



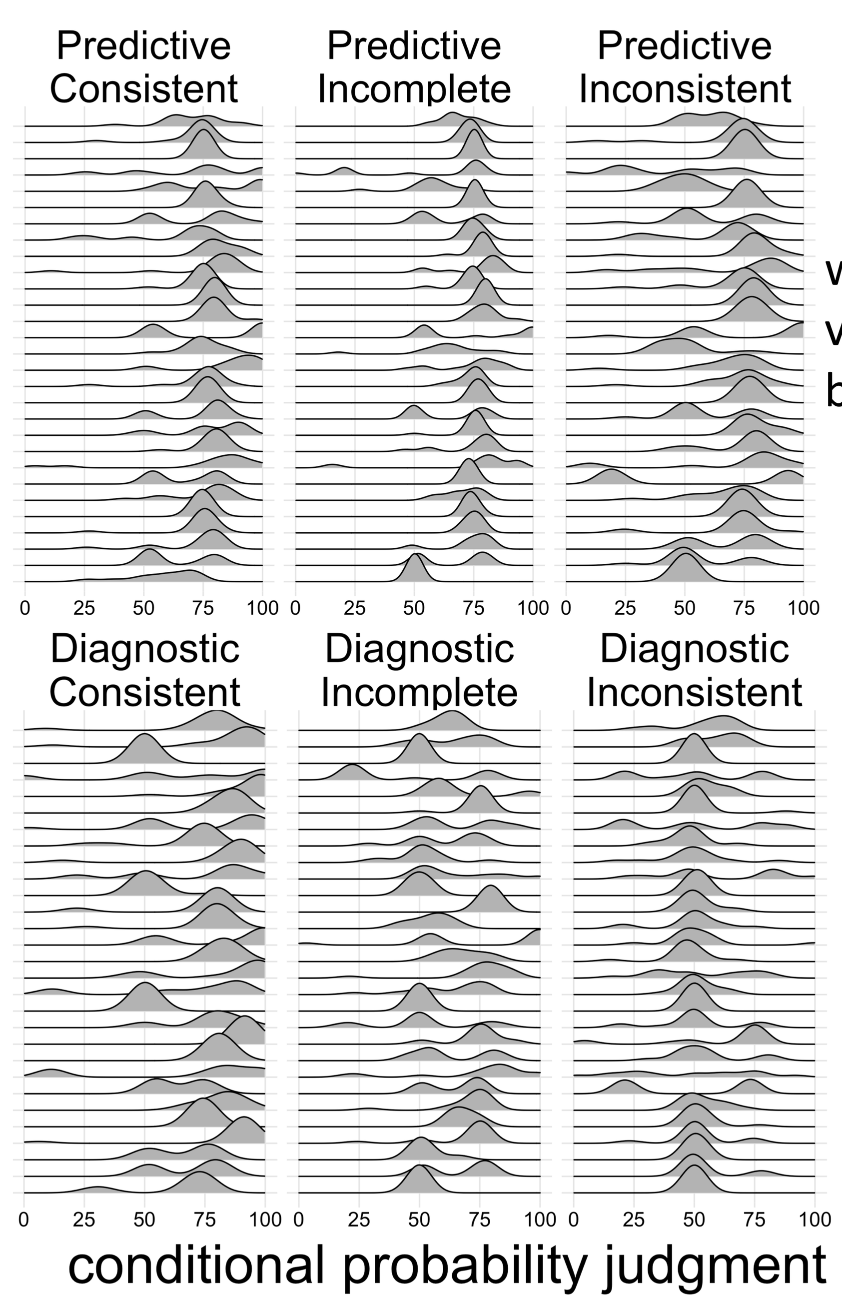
Repeated independent measurements

To get multiple measurements of a single inference type we collapsed over:

- 5 different domains
- Flipping the two effects
- Absence and presence P(Y=1) = 1- P(Y=0)

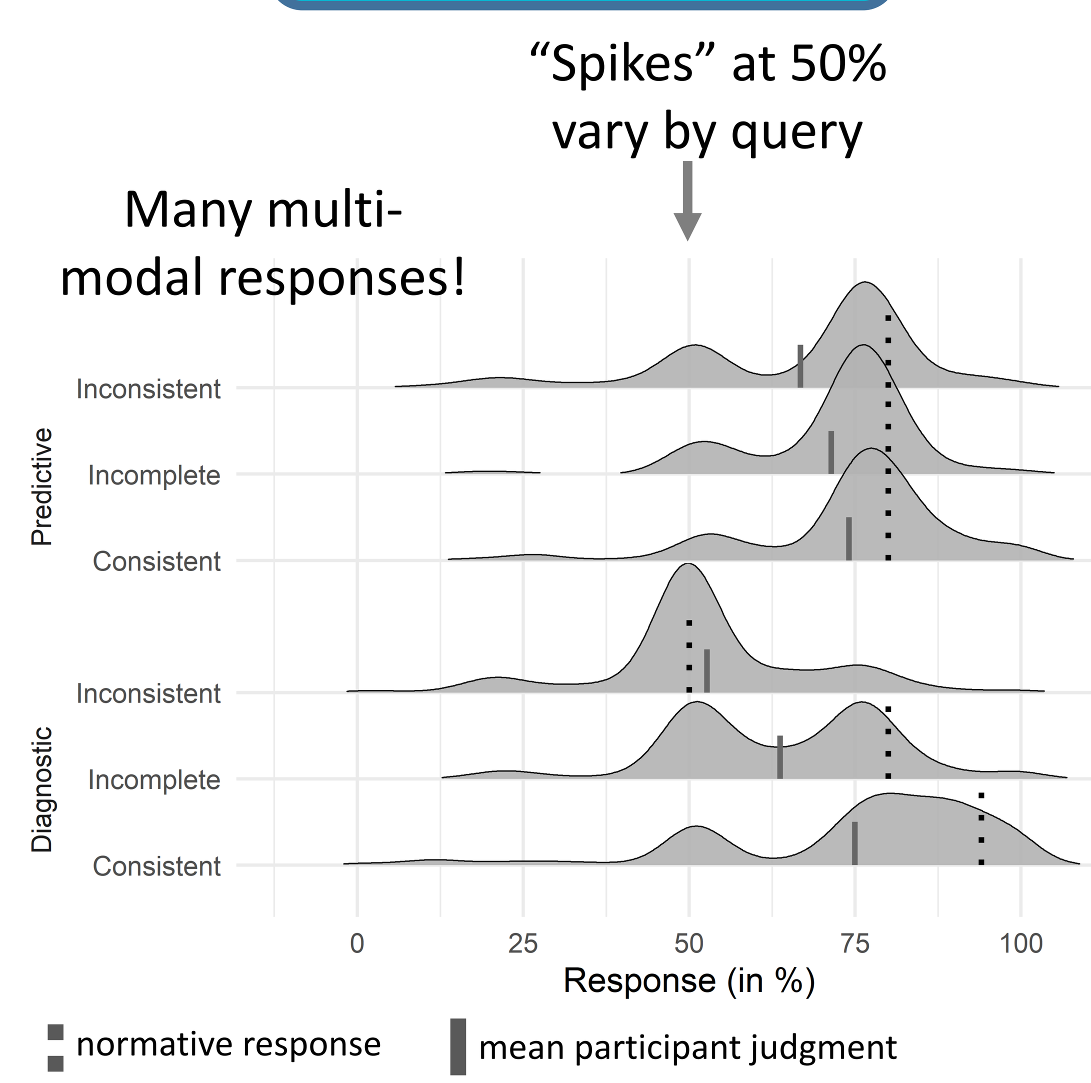
Resulting in 20 measurements of each inference type, and 120 queries per participant.

Raw results

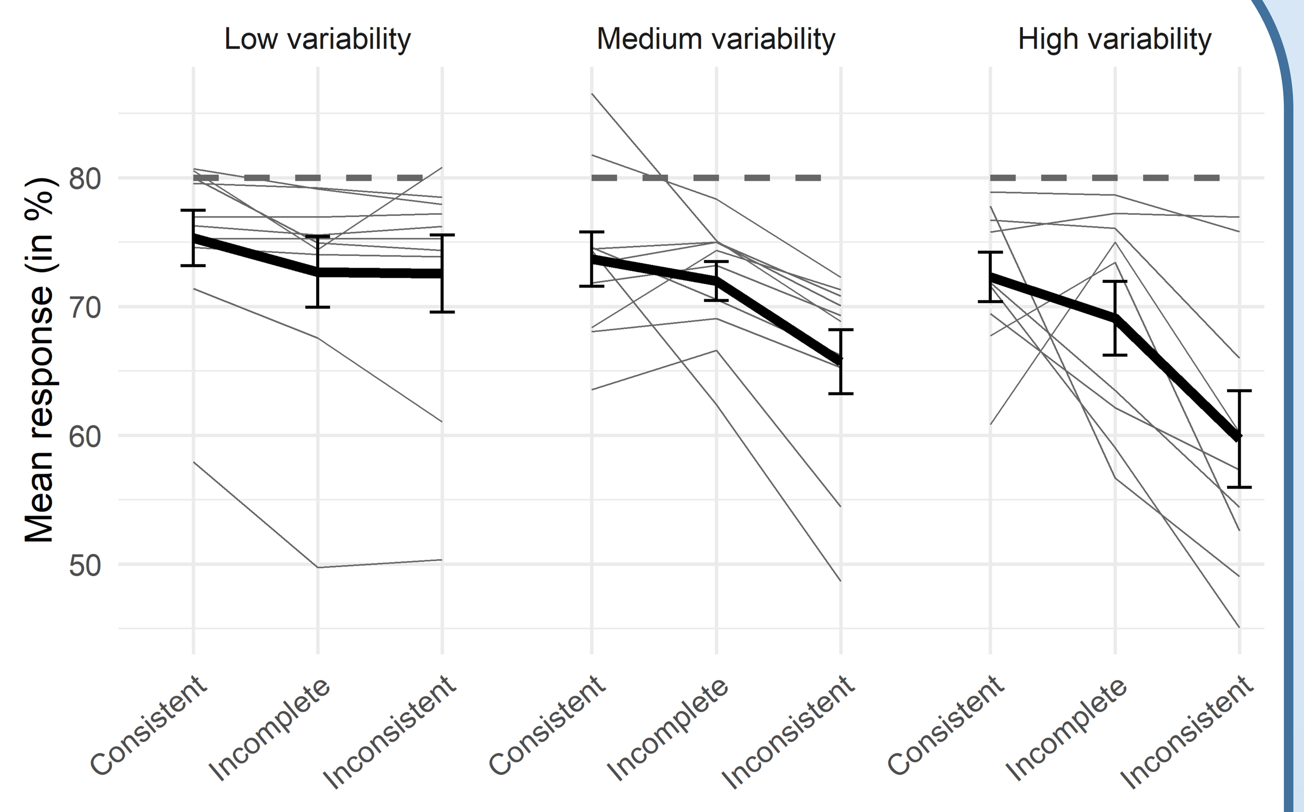


within-participant variability differs by inference type!

Results

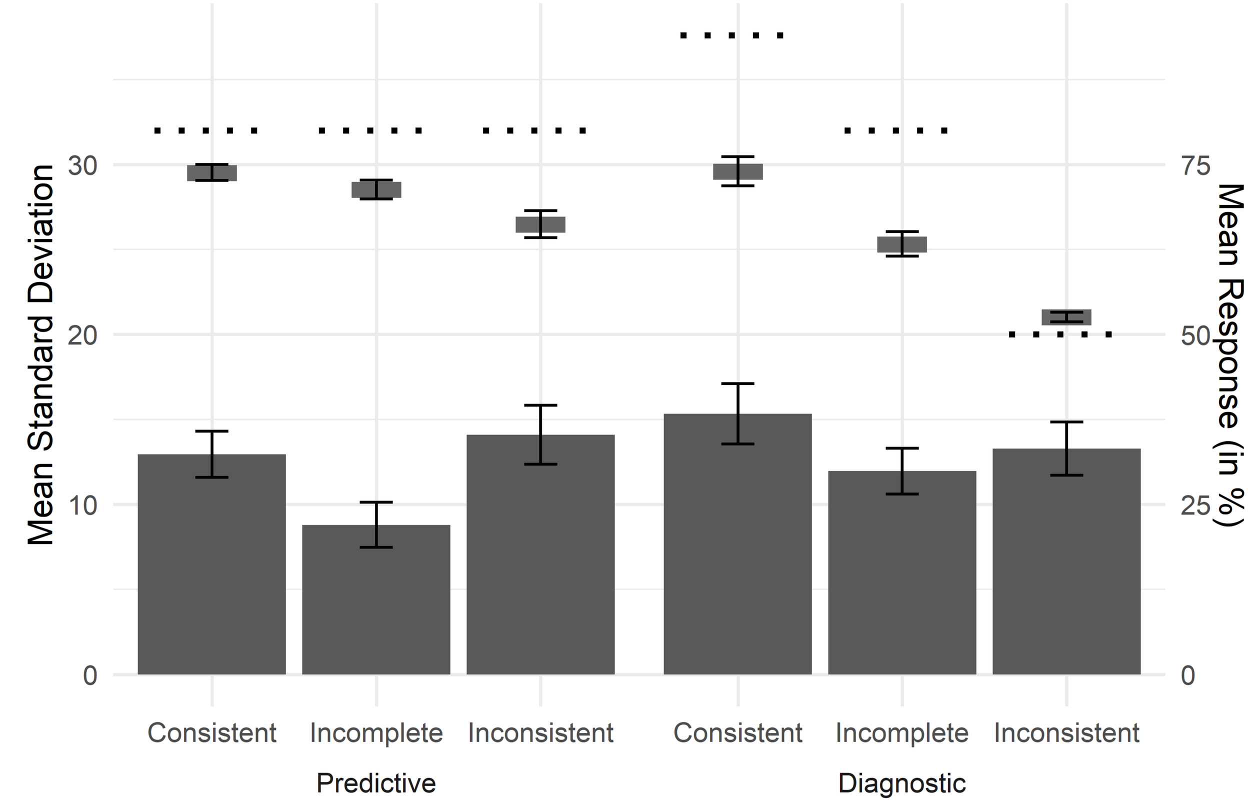


Markov violations



More variable participants committed larger Markov violations. A common process might drive both Markov violations and a part of the observed variability

Variability per inference type



Within-participant variability (bars) does not follow mean response (floating boxes) and varies systematically per inference type:

- Variability is lower for inferences with incomplete information.
- Variability is higher for diagnostic inferences.

These findings indicate that the observed within-participant variability reflects (at least partly) a decision-making process, and not just noise.

Sources of variability

- Motor or general task noise cannot explain the variability, as it varies systematically and is multi-modal.
- Distributions are not centered on the normative response, counter to predictions of e.g. the Beta inference model (R&H, 2016)
- Uncertainty about the parameters of the causal network is unlikely as a source. It could explain increased variability for diagnostic inferences, but cannot explain other findings.
- Default responding might explain spikes at 50%. A possible explanation of changes in spikes might be that guessing is more likely with more ambiguous information.
- The Mutation Sampler (D&R, 2020) can explain the changing spikes and predicts within-participant variability.

Conclusions

- Within-participant variability in causal reasoning can be probed experimentally and is related to the type of inference
- Variability can't be explained by simple additions to normative CGM model
- Computational models need to account for (systematic variation in) variability

References:
D&R: Davis & Rehder (2020) A Process Model of Causal Reasoning. Cog. Sci.
Rehder (2014) Independence and Dependence in Human Causal Reasoning. Cog. Psy.
Rehder (2018) Beyond Markov: Accounting for independence violations in causal reasoning. Cog. Psy.
R&H: Rottman & Hastie (2016) Do People Reason Rationally about Causally Related Events? Cog. Psy.