THE UNIVERSITY of EDINBURGH

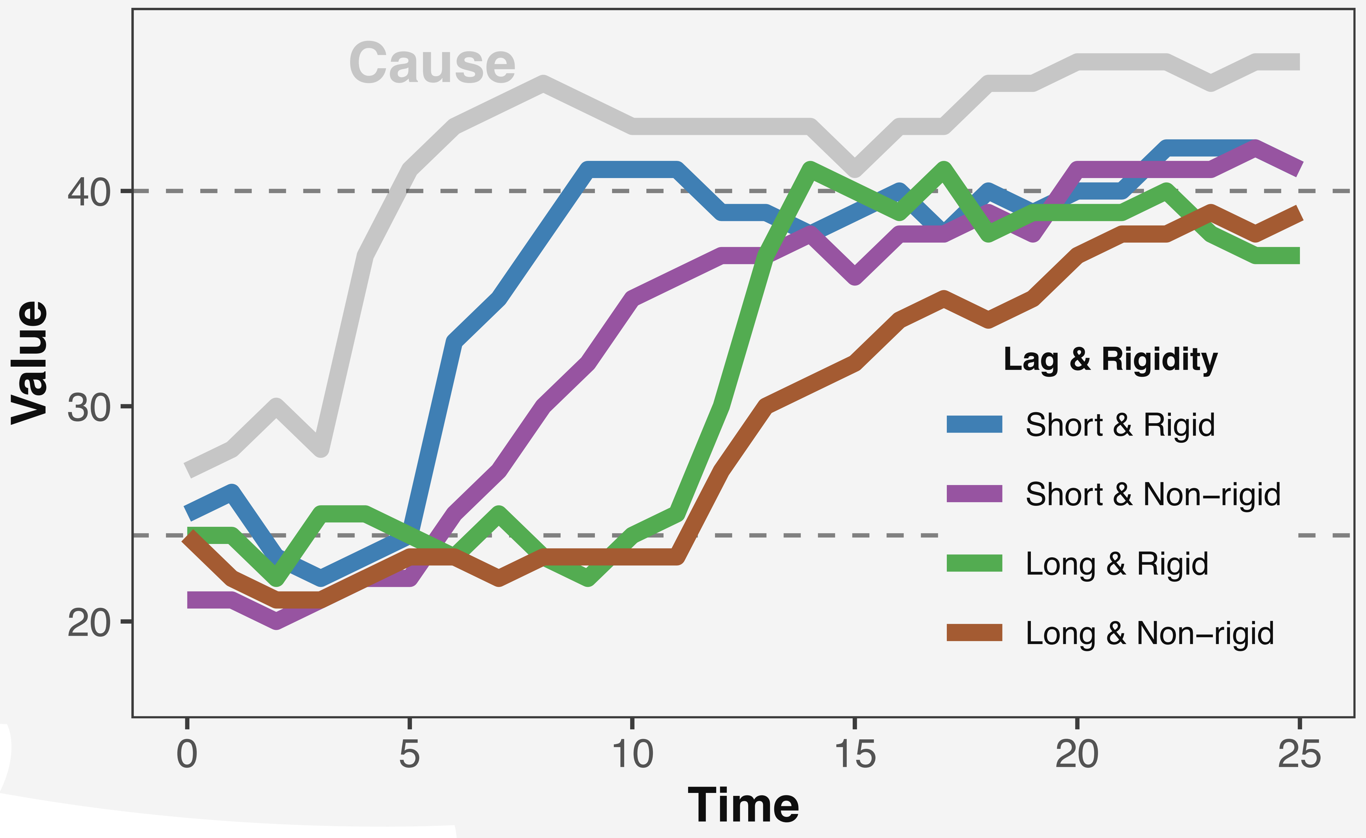
Tia Gong (tia.gong@ed.ac.uk, @Tianwei_Gong) & Neil R. Bramley

Rigidity

Delay Boundary

Change Direction

We found causal learning from dynamics is affected by MANY factors



- How people extract information from continuous inputs to make causal inferences?
- What factors influence time-series causal learning?

Download the full paper

Gong, T., & Bramley, N. R.(2020). Intuitions and perceptual constraints on causal learning from dynamics. In Proceedings of the 44th annual conference of the cognitive science society.

https://www.bramleylab.ppls.ed.ac.uk/pdfs/gong2022intuitions.pdf

Experiment

- 100 participants (aged 42±12) were recruited via Prolific Academic and were paid £1.20. The task took around 10 minutes.
- Participants were asked to imagine playing the role of a "forestry manager" who needs to identify the causal relationship between different pairs of Plant A and Plant B following observations

OU process

- Ornstein–Uhlenbeck process (Davis et al. 2020; Uhlenbeck & Ornstein, 1930) was used to generate how the value of Y would change given its current value and the previous value of X

$$P(\Delta v_y^t | v^t, \omega, k, \beta, \alpha, \sigma) = \omega[(\beta \cdot v_x^{t-k} + \alpha) - v_y^t] + N(0, \sigma)$$

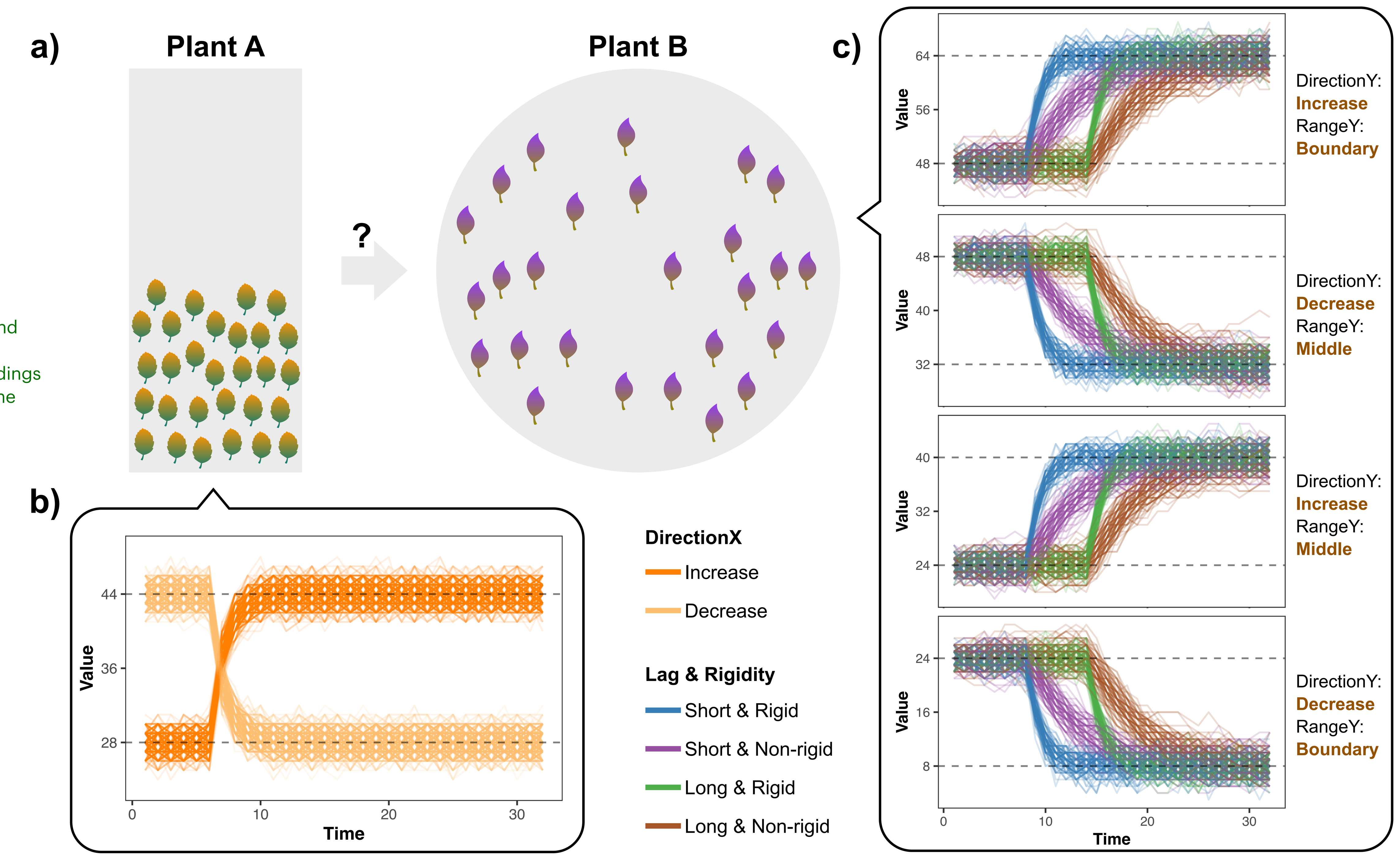
Condition	Level
Lag	short: $k = 2$ vs. long: $k = 8$
Rigidity	rigid: $\omega = 0.8$ vs. non-rigid: $\omega = 0.2$
Slope	positive: $\beta = 1$ vs. negative: $\beta = -1$
Range$_Y$	boundary vs. middle, controlled by α

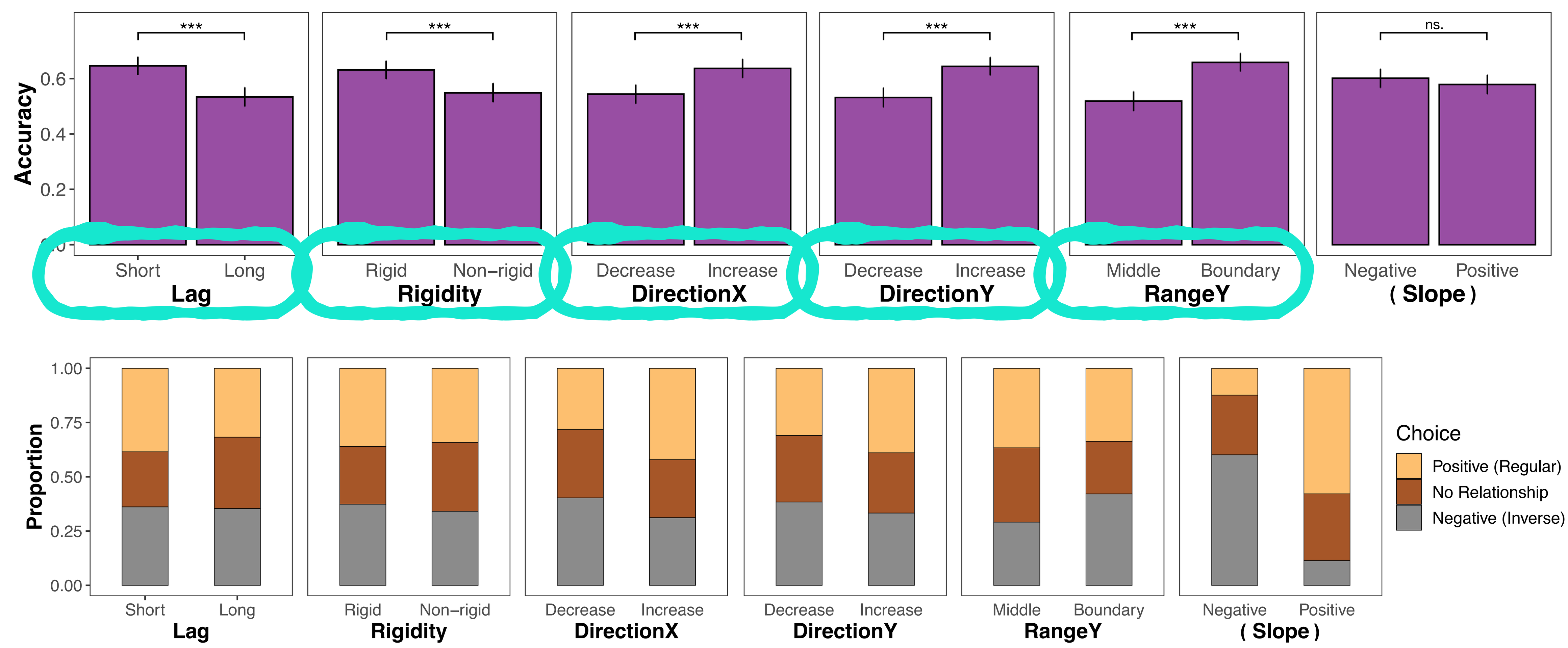
Method

- Each participant went through 16 trials representing all combinations of Lag, Rigidity, RangeY, and DirectionY. The DirectionX and hence Slope was randomly selected for each trial.
- Participants answered "What is the relationship between Plant A and B" by choosing one of the three radio buttons labeled: "Positive (regular)", "Negative (inverse)", and "No relationship"

Results

- As has been found with discrete variables (Buehner & McGregor, 2006), people more reliably identified a relationship when its causal lag was short than long (inductive bases).
- Accuracy were higher when the effect changed rigidly, and when the change was closer to the bound (perceivability).
- Accuracy were higher when the cause increased or the effect increased (inductive bases).
- Further work is needed to reverse engineer how human inductive biases and perceptual constraints combine in shaping causal representation, which could deviate from standard statistical models (Granger, 1969).





References

Buehner, M. J., & McGregor, S. (2006). Temporal delays can facilitate causal attribution. *Thinking & Reasoning*, *12*(4), 353–378.
Davis, Z., Bramley, N. R., & Rehder, B. (2020). Causal structure learning in continuous systems. *Frontiers in Psychology*, *11*, 244.
Granger, C. W. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica*, 424–438.
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