The Link Between Relational Inference and Math: What Kinds of Relations Matter?

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Introduction

- Mathematics often requires making inferences about relationships from given information.
  - For example, if a > b, and b > c, we can infer a > c.
- This type of reasoning, transitive inference, has previously been linked to math achievement (Handley et al. 2004; Morsanyi et al. 2013, 2017, 2018).
- However, relational inferences can involve other types of relations other than transitive.
- We propose that relational inference should be assessed using a broad set of relations including but not limited to transitive relations.
- We predict that Relational Inference, measured in this way, will predict math ability better than transitive inference alone..

Methods

- College-aged participants (N=85) completed tasks assessing:
- Math reasoning: CRT-Long and Probabilistic Reasoning Scale (Primi et al. 2016, 2017).
- Predictors: Transitive Inference, and (Other) Relational Inference.
- Controls: Conditional Inference and Ordering Ability (Morsanyi et al. 2018).

Table 1
Type of Relations and Examples

	Example	
Type of Relation	Example Premises	Valid Conclusions
Transitive (Non-Reflexive)	In a group of three friends: Mike is **taller than** Jim, Jim is **taller than** Ben.	Mike is taller than Ben. Ben is NOT taller than Mike.
Equivalence	In a group of three friends: Joe is the **same age as** Nate, Nate is the **same age as** Evan.	Joe is the same age as Evan . Evan is the same age as Joe.
3-Cyclical	In a game of rock, paper, scissors: Amber's move **beats** Beryl's move, Beryl's move **beats** Crystal's move.	Crystal's move beats Amber's move. Amber's move does NOT beat Crystal's move.
Non-Transitive (Indeterminate)	In a romantic comedy: Stacy **loves** Robb, Robb **loves** Jackson.	No valid conclusion can be made.

Table 2
Descriptive Statistics for all Tasks

Task	M	SD
Transitive Inference	0.92	0.10
Relational Inference	0.79	0.12
CRT-Long	0.40	0.28
Probabilistic Reasoning	0.77	0.09
Conditional Inference	0.65	0.14
Ordering Ability *	0.00	0.79

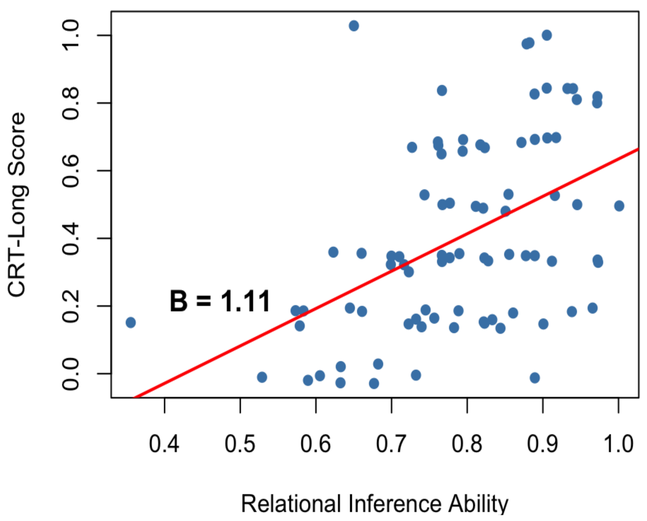
* scored using combined z-scores.

Two linear regressions were conducted with CRT-Long and PRS as the dependent variables.

Model 1 Predictors : Transitive and Conditional Inference, and Ordering Ability

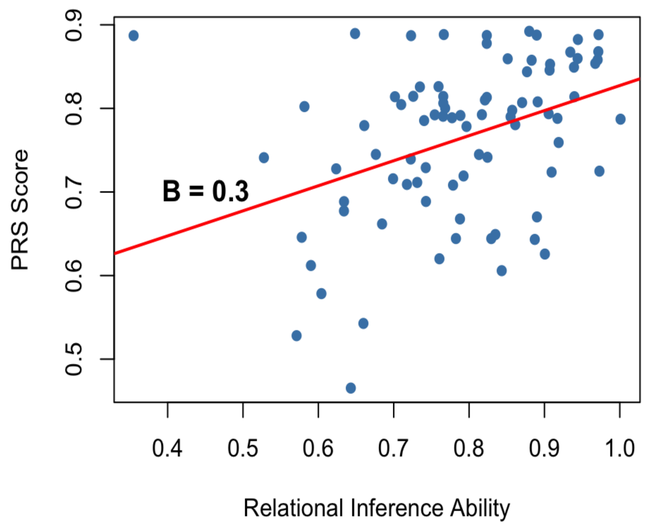
Model 2 Predictors: All of those in Model 1 plus Relational Inference

Relational Inference Ability and CRT-Long Scores



Adding Relational Inference explained an additional 10.6% of variance, $F(1, 78) = 11.98$, $p < .001$.

Relational Inference Ability and PRS Scores



Adding Relational Inference explained an additional 4.2% of variance, $F(1, 78) = 5.13$, $p < 0.005$.

Discussion

- Logical reasoning is critical in math but goes beyond reasoning about transitive relations.
- Incorporating more relations into tasks designed to assess logical reasoning significantly improves our ability to predict mathematical reasoning skills.
- Future studies could explore the potential pathways linking relational inference to math achievement, developmental trajectories for relational inference ability, and interventions to improve relational inference ability.

References

Morsanyi, K., McCormack, T., & O'Mahony, E. (2018). The link between deductive reasoning and mathematics. *Thinking & Reasoning*, *24*(2), 234–257. https://doi.org/10.1080/13546783.2017.1384760

Primi, C., Morsanyi, K., Chiesi, F., Donati, M. A., & Hamilton, J. (2016). The development and testing of a new version of the cognitive reflection test applying item response theory (IRT). *Journal of Behavioral Decision Making*, *29*(5), 453–469. https://doi.org/10.1002/bdm.1883

Primi, C., Morsanyi, K., Donati, M. A., Galli, S., & Chiesi, F. (2017). Measuring probabilistic reasoning: The construction of a new scale applying item response theory. *Journal of Behavioral Decision Making*, *30*(4), 933–950. https://doi.org/10.1002/bdm.2011

Wong, T. T.-Y., & Morsanyi, K. (2023). The link between transitive reasoning and mathematics achievement in preadolescence: The role of relational processing and deductive reasoning. *Thinking & Reasoning*, *29*(4), 531–558. https://doi.org/10.1080/13546783.2022.2095031