MORE GIST, BETTER MATH

FUZZY TRACE THEORY-BASED INVESTIGATION OF THE RELATIONSHIP BETWEEN LONG-TERM MEMORY AND MATHEMATICAL SKILLS

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$$6 \times 4 = ?$$

Long-term memory and mathematical skills

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ROLE OF LONG-TERM MEMORY

Long-term memory becomes more critical with age, gradually becoming better **predictor of mathematical performance** (Calderon-Tena & Caterino, 2016).

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SCARCITY OF RESEARCH

Associations between long-term memory and mathematical skills are relatively **understudied**.

Is precise memory always beneficial for math performance?

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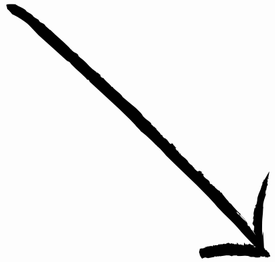
Reyna and Brainerd (1993) demonstrated that in some mathematical tasks **remembering** specific **problem facts doesn’t improve** performance or even impacts it **negatively**.

Fuzzy-trace theory

(Brainerd & Reyna, 1990, 2004; Reyna & Brust-Renck, 2020)

Verbatim trace
(exact representation)



Gist trace
(fuzzy, aproximate representation capturing the meaning)

Purpose of the current study

Studying **associations** between **verbatim** and **gist** long-term **memory** and various kinds of **mathematical skills**.

Applying fuzzy-trace theory in the field of mathematical cognition.

Method

123 PARTICIPANTS AGED 18-34

- 32 male
- 79 female
- 1 reported another gender
- 2 chose not to disclose their gender.

PROCEDURE

Arithmetic fluency → Math4Speed task (Loenneker et al., 2024)

Mathematical reasoning → set of school math problems (Szczygieł & Hohol, 2024)

Performance of approximate number system → dot comparison task (Gebuis & Reynvoet, 2011)

Math self-concept → self-description questionnaire (Marsh & O'Neill, 1984)

Memory stimuli

Target: On the coast, there are **6** banana trees and **14** coconut palms.

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New unrelated: On the coast, there are **20** banana trees and **13** coconut palms.

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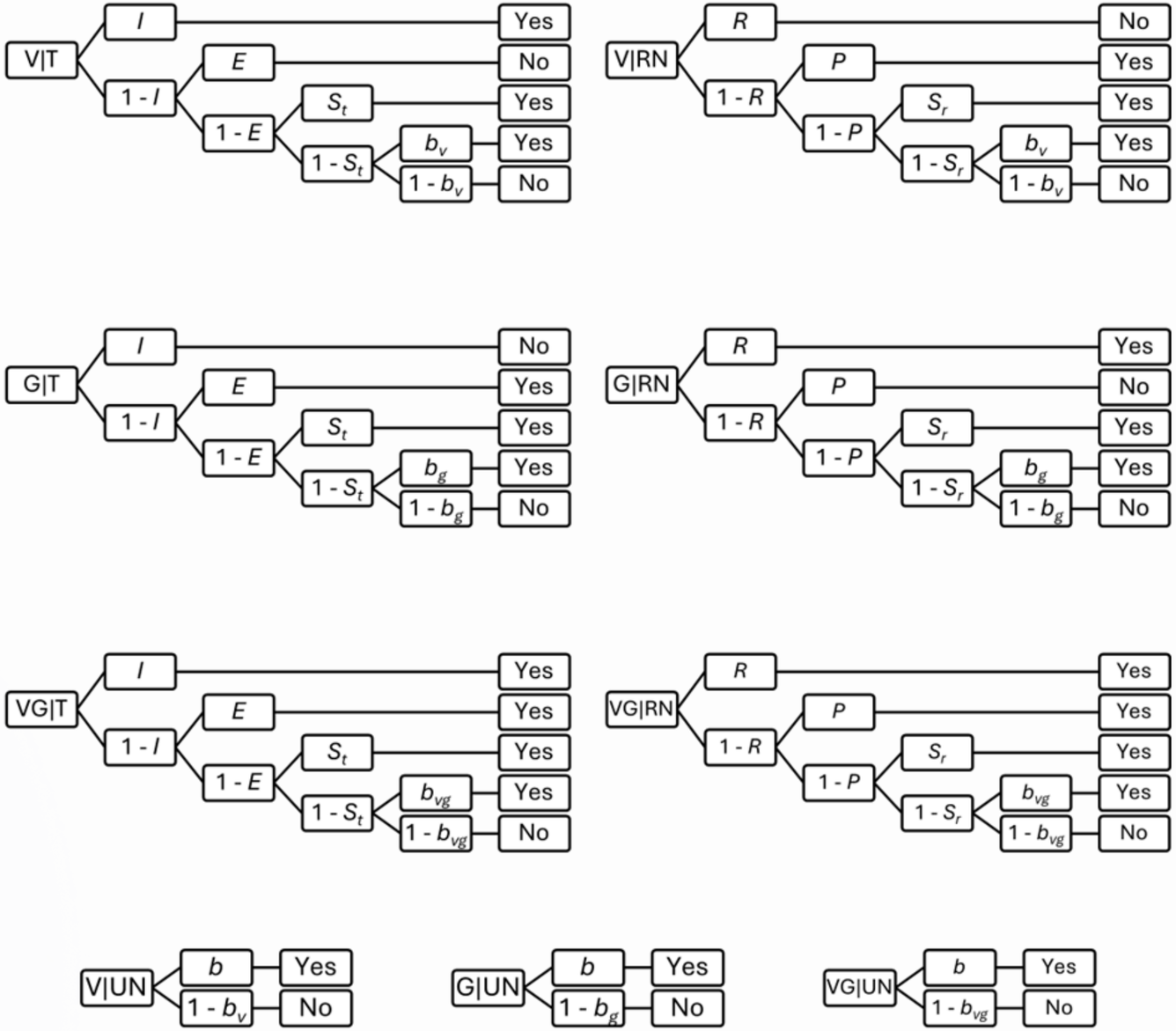
Question probes:

- Is the stimulus the same as target?
- Is the stimulus only similar to the target?
- Is the stimulus either the same as or similar to the target?

Conjoint recognition model



Results

Associations with general memory score

- Long-term memory **correlated positively** with **multiplication**, **division**, **math reasoning** and **math self-concept**.
- **We didn't find correlation** with general score in **arithmetic fluency** and **approximate number system** performance.

	LTM	ANS	M4S Addition	M4S Subtraction	M4S Multiplication	M4S Division	M4S All	Math reasoning	Math self-concept
LTM	-	0.10	0.11	0.07	0.18†	0.17†	0.15	0.28**	0.18†

Note: *$p < .05$, two-tailed. **$p < .01$, two-tailed. ***$p < .001$, two-tailed. †$p < .05$, one-tailed

Associations with specific memory processes

	ANS	M4S Addition	M4S Subtraction	M4S Multiplication	M4S Division	M4S All	Math reasoning	Math self-concept
b_g	0.08	0.08	0.04	0.06	0.06	0.07	0.22*	0.07
b_y	-0.08	-0.07	-0.07	-0.15	-0.16	-0.13	-0.20*	-0.12
b_{yg}	< -0.01	-0.06	-0.11	-0.07	-0.15	-0.11	< -0.01	-0.11
E	0.16	0.15	0.19	0.16	0.19	0.18	0.33**	0.28*
S_r	0.11	0.11	0.10	0.21	0.14	0.16	0.32**	0.18
S_t	0.14	0.07	< -0.01	0.13	0.05	0.08	0.27*	0.13
P	-0.11	-0.05	-0.02	-0.10	-0.14	-0.11	-0.22*	-0.17
R	0.14	0.07	0.04	0.13	0.14	0.11	0.26*	0.19
I	-0.02	0.07	0.04	0.09	0.15	0.09	0.14	0.06

- **Math reasoning** correlated with different memory processes, but there were **more correlations** with **gist-based** than with **verbatim-based** processes.
- **Math self-concept** correlated only with one **verbatim-based** process.

Our future research directions

- Applying fuzzy-trace theory framework to studying working memory and arithmetic fact retrieval.
- Measuring other mathematical skills, especially symbolic number comparison.
- Studying differences in gist and verbatim numerical memory in individuals with dyscalculia.

Thank you for your attention!

Find our preprint at:

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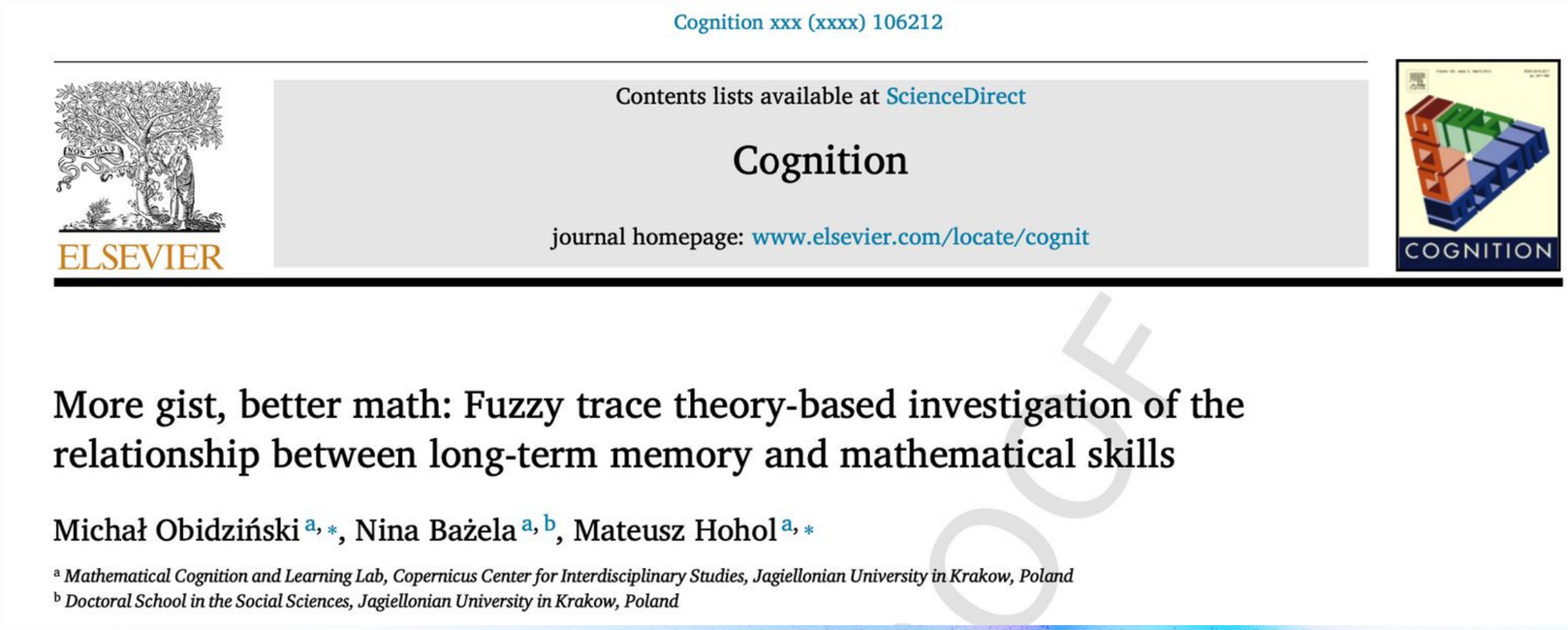
Soon to be published in Cognition



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