



Ministry of Science and Higher Education
Republic of Poland

This study was funded by the Polish state budget through the Ministry of Science and Higher Education of Poland under the program "Science for Society II", project ID: NdS-II/SN/0332/2024/01; the total value of the project 1 000 000 PLN.

LONG-TERM MEMORY AND MATHEMATICAL SKILLS


A FUZZY-TRACE
THEORY-DRIVEN STUDY

MICHAŁ OBIDZIŃSKI
NINA BAŻELA
MATEUSZ HOHOL



JAGIELLONIAN UNIVERSITY
IN KRAKÓW





Long-term memory and mathematical skills

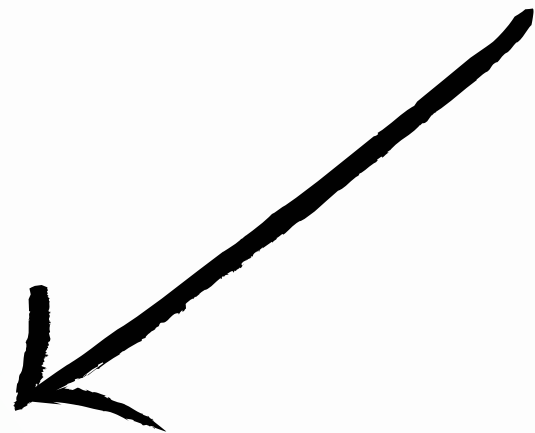
- As people age, long-term memory becomes **increasingly important** and a **stronger predictor** of math performance (Calderon-Tena & Caterino, 2016).
- Research on the associations between long-term memory and mathematical skills is relatively **scarce**.

Is precise memory always beneficial for math performance?

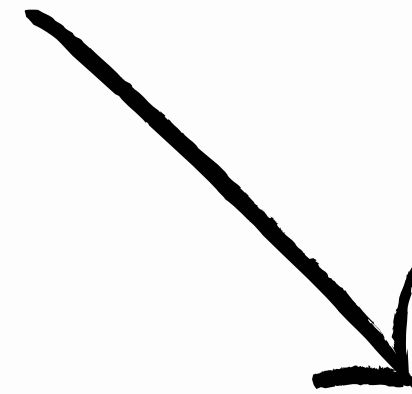
Reyna and Brainerd (1993) demonstrated that in some mathematical tasks **remembering** specific **problem facts** **doesn't improve** performance or even impacts it **negatively**.

Fuzzy-trace theory


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



Verbatim trace
(exact representation)



Gist trace
(fuzzy, approximate
representation capturing
the meaning)



Purpose of the current study

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

123 PARTICIPANTS AGED 18-34



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.

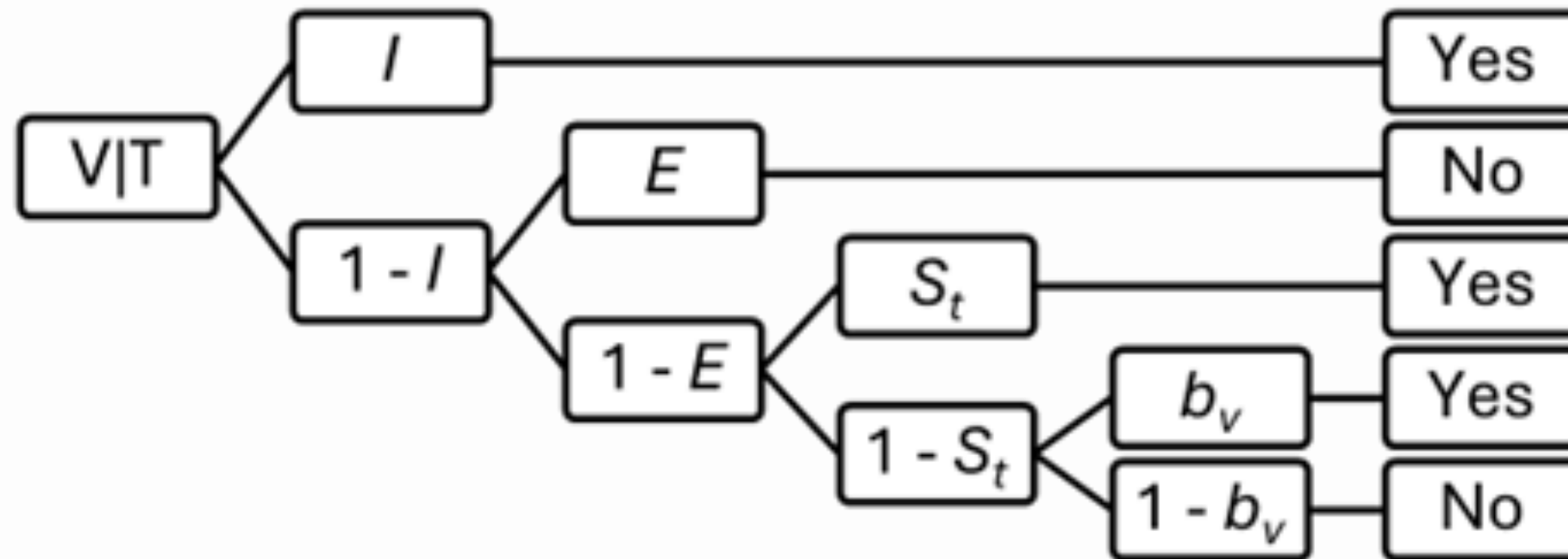
New related: On the coast, there are **7** banana trees and **17** coconut palms.

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

Question probes:

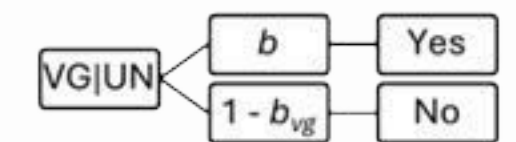
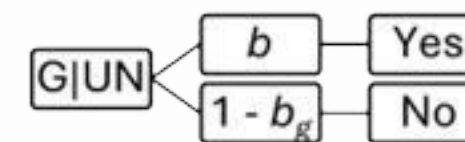
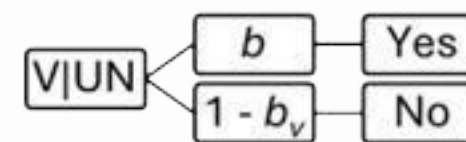
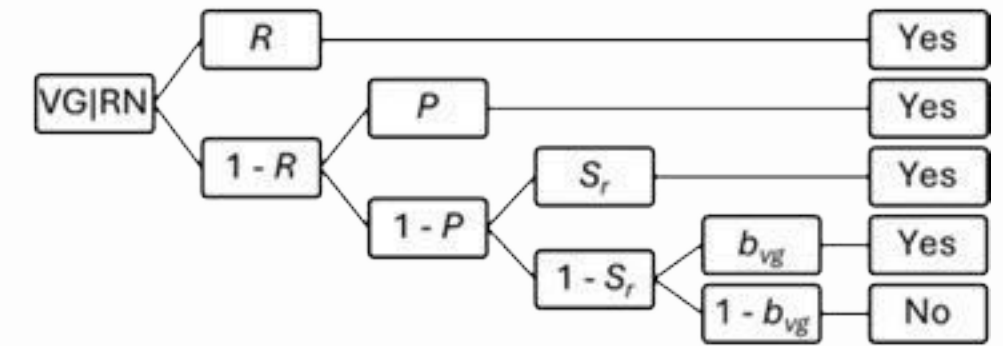
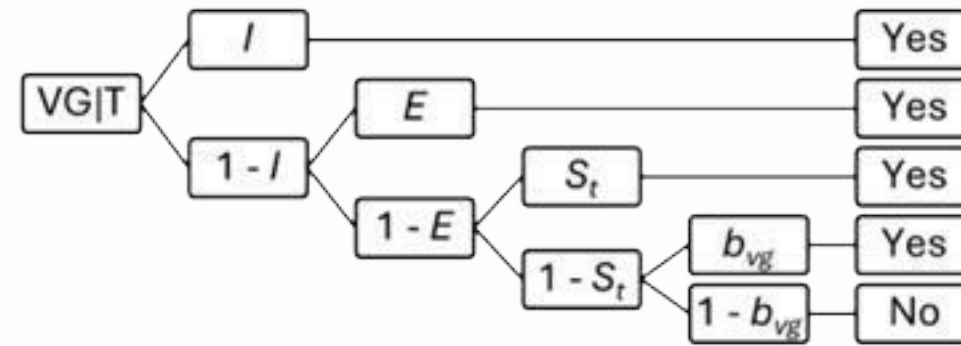
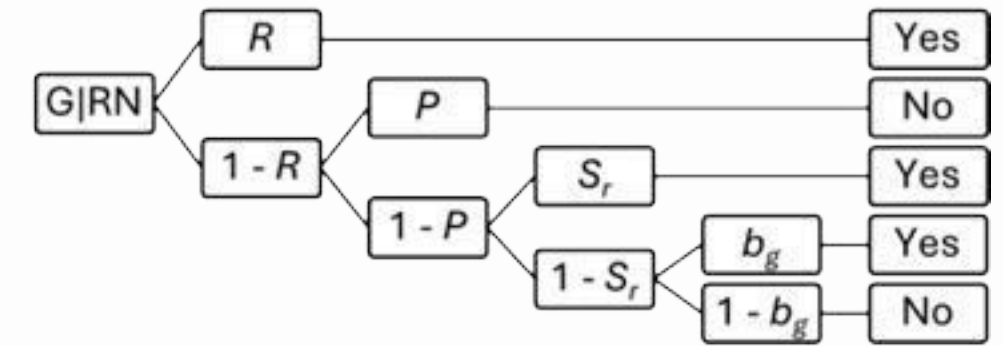
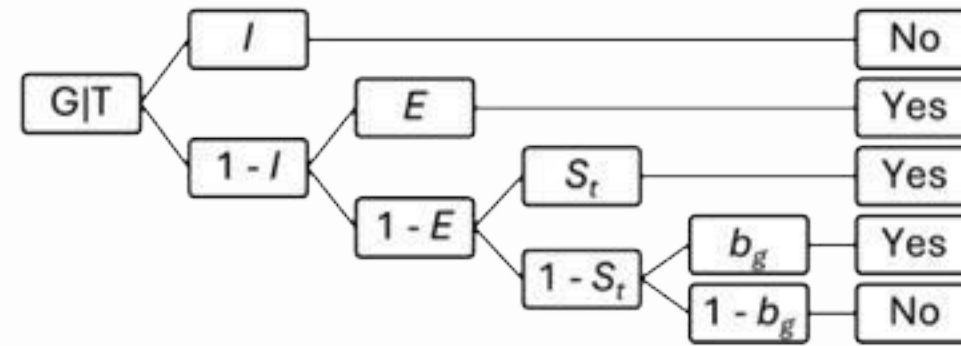
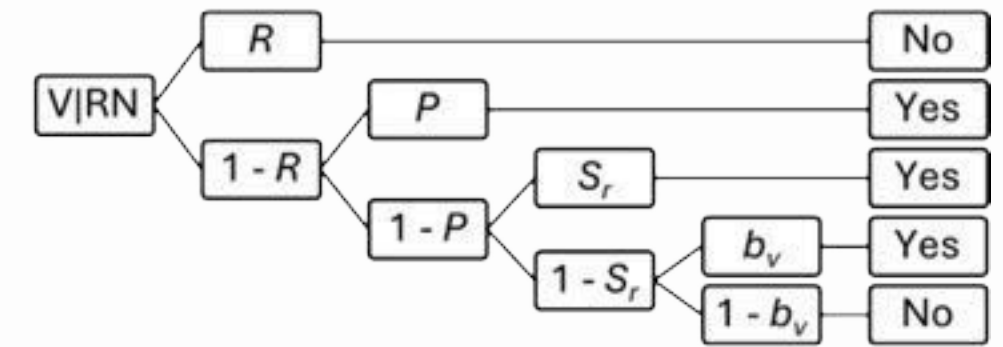
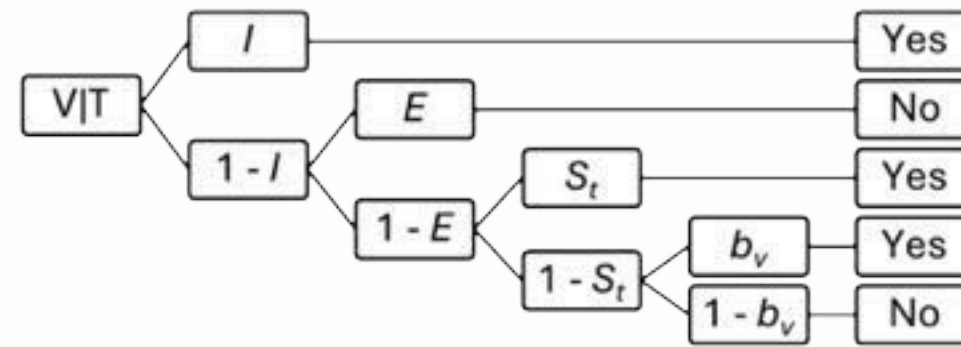
- Is the stimulus the same as target?
- Is the stimulus only similar to the target?
- Is the stimulus either the same as or similar to the target?





Possible routes leading to “yes” or “no”,
 when presented with a **target** and asked “**Is it a target?**”

Conjoint recognition model



Associations with memory score

- **Positive correlations** 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
h_g	0.08	0.08	0.04	0.06	0.06	0.07	0.22*	0.07
h_v	-0.08	-0.07	-0.07	-0.15	-0.16	-0.13	-0.20*	-0.12
h_{vg}	< -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

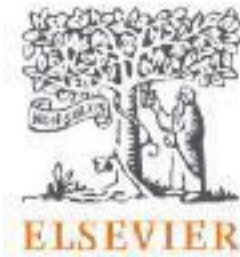
- Applying fuzzy-trace theory framework to studying **working memory** and **arithmetic fact retrieval**.
- Measuring other mathematical skills, especially symbolic number comparison.
- Studying differences in gist and verbatim numerical memory in individuals with **dyscalculia**.



Michał Obidziński

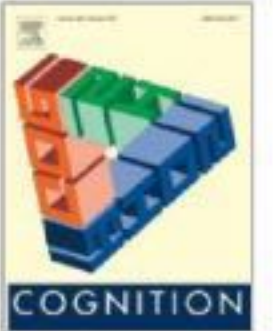


Mateusz Hohol



Cognition

Volume 263, October 2025, 106212



Full Length Article

More gist, better math: Fuzzy-trace theory-based investigation of the relationship between long-term memory and mathematical skills

Michał Obidziński^a  , Nina Bażela^{a,b}, Mateusz Hohol^a  