Numerical & Mathematical Cognition I # 12

Mathematical Cognition and Learning Lab

JAGIELLONIAN UNIVERSITY IN KRAKÓW

Do Mathematicians Process Numbers Uniquely?
A Multilab Preregistered Study on Automatic Number Processing in Experts and Controls

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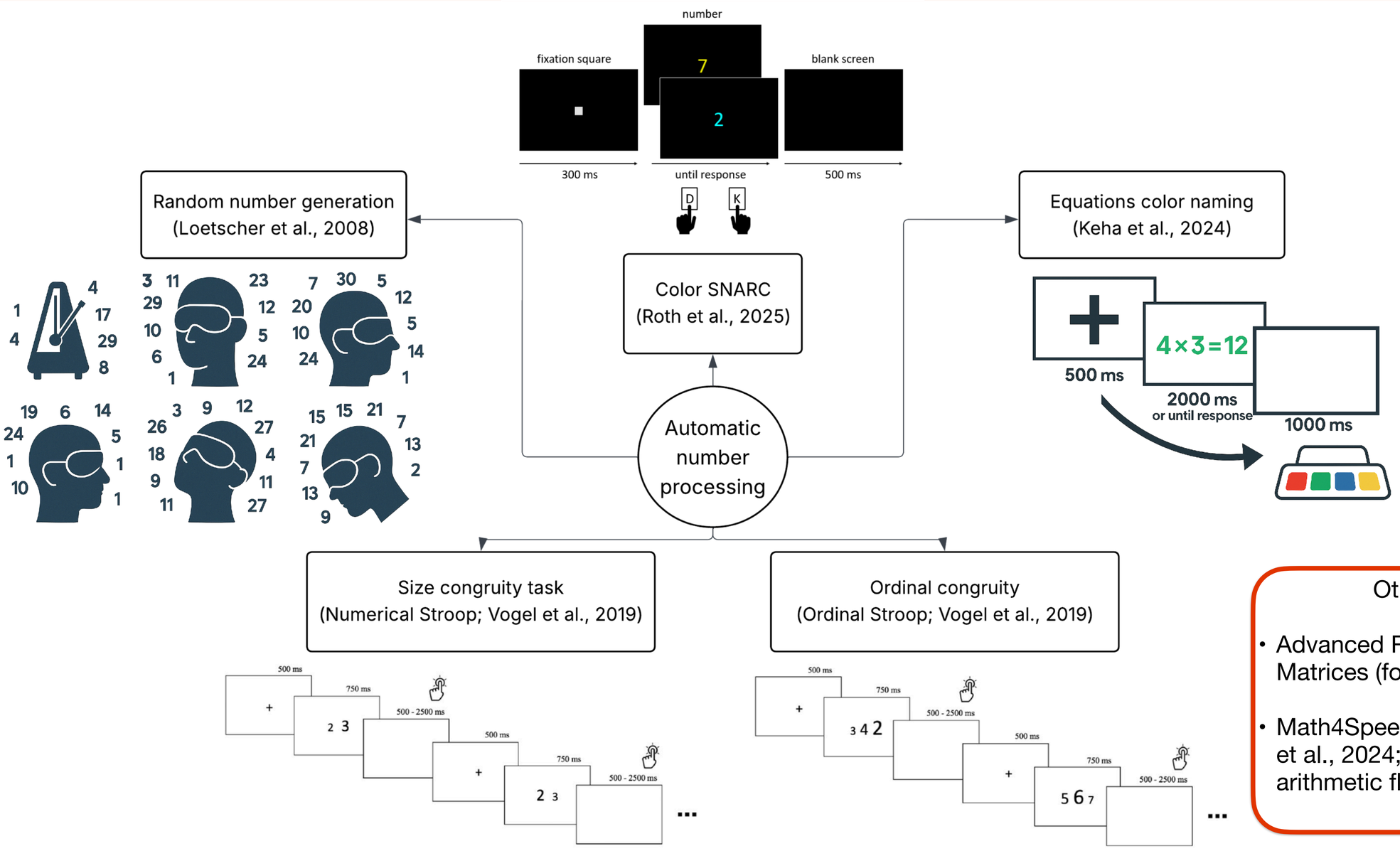
BACKGROUND

- Earlier studies (Hohol et al., 2020, *Sci.Rep.*; Meier et al., 2021, *J.Expert*) found no substantial differences in elementary number processing between experts and controls, except for the SNARC effect in the parity judgment task (Cipora et al., 2016, *Psych.Res*).
- Research focused mainly on tasks tapping into the semantic processing of numbers.
- Humans automatically process numbers even when it task irrelevant, e.g., when judging the color or size (Henik & Tzelgov, 1982, *Mem.Cogn*; Roth et al., 2025, *JEP:LMC*.
- Automatic number processing in mathematicians is understudied and may underpin numerical expertise.

Preregistered scenarios

- Consistent with prior work, mathematicians may not differ in elementary number processing.
- Mathematicians may show stronger automatic number processing, reflecting training or preexisting individual differences.
- Mathematicians may show weaker automatic number processing, reflecting greater cognitive flexibility and task adaptation.

TASKS



Other tasks

- Advanced Raven's Progressive Matrices (for group matching)
- Math4Speed (Loenneker et al., 2024; for quantifying arithmetic fluency)

PARTICIPANTS

- Parralel recruitement in Poland 🇵🇱, Austria 🇦🇹, and Italy 🇮🇹
- Target sample: > 50 matchematicians, 50 controls
- Mathematicians — inclusion criteria:
  - Masters degree in mathematics and holding PhD / PhD students of mathematics.
  - Individuals matched in terms of education (at least holding Masters degree or above in disciplines other than mathematics and physics) IQ, gender and age.
- Matching procedure: the same gender proportions and BF_{10} associated with group comparison regarding age and IQ will be < 3 (i.e., either indicating evidence for no difference between groups if BF10 < 0.33 or inconclusive evidence if with $0.33 < BF_{10} < 3$).

ANALYSIS

- Testing for the presence of the effect overall and in each group separately by means of one-sample t-test and Bayesian equivalent.
- Comparing the dependent measure of each task between mathematicians and controls by independent samples frequentist and Bayesian t-tests.
- Testing for individual prevalence of the effects by means of H0 bootstrapping using 90% CIs (Roth et al., 2025; Cipora et al., 2019) and comparing proportions of participants with Fisher exact test.
- Variables of interest:
  - Unstandardized SNARC slopes
  - The interference scores of the Numerical and Ordinal Stroop and the Equations task
  - Differences in the ratio of small numbers between conditions in RNG.

STUDY IN THE CONTEXT

- The study is the first step within the project *Mind, Number, Space: Spatial-Numerical Cognition in Professional Mathematicians*, which aims to investigate large-scale cognitive scaffolding for mathematical expertise.
- The project's logic is to test the same individuals across several sessions to collect multiple behavioral and neuroscientific datasets, in order to disambiguate the extent to which mathematical expertise emerges from domain-specific cognition.

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