



Math Anxiety and Working Memory in Symbolic and Nonsymbolic Fraction Performance Across Grades 7–9



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Introduction

- Fractions are difficult to learn, and math anxiety (MA) affects fraction performance in adults and elementary school children (Xue et al., 2024)
- Working memory (WM) has been identified as a mediator between MA and fraction performance among college students (Sidney et al., 2018)
- MA may affect performance on symbolic but not nonsymbolic fraction tasks in elementary school children and adults (Mielicki et al., 2023; Starling-Alves, 2022)
- These relationships are underexplored in middle school context

Research Questions

RQ1. Does working memory mediate the relationship between math anxiety and 1) symbolic fraction, 2) nonsymbolic fraction performance, and 3) general arithmetic fluency?

RQ2. How does the relationship between math anxiety and fraction comparison performance vary across grades and formats?

Methods

Participants:

- 250 Grade 7–9 students** ($M_{\text{age}} = 13.8$, $SD = 0.92$; Grade 7: $n = 93$, Grade 8: $n = 88$, Grade 9: $n = 69$)

- Design:** 3-session online study

Measures:

- General Arithmetic Fluency:** Math fluency task
- Symbolic Fraction Tasks:** Fraction comparison, fraction number line estimation (NLE), fraction arithmetic, and fraction schemes
- Nonsymbolic Fraction Task:** Fraction comparison
- Math Anxiety (MA):** Math anxiety questionnaire
- Working Memory (WM):** Backward digit span task

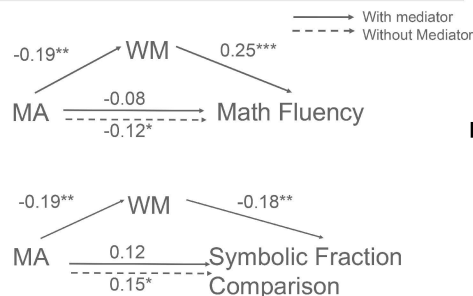
Results (RQ1)

Math fluency & symbolic fraction comparison: WM statistically accounted for the association between MA and performance.

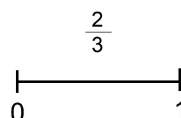
$$1 + 2 =$$

$$6 \times 3 =$$

$$\frac{3}{7} \quad \frac{5}{6}$$



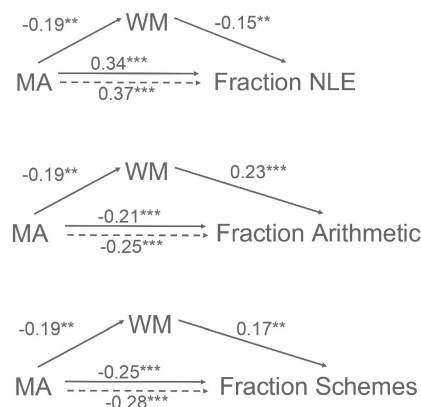
Fraction NLE, arithmetic, and schemes: WM partially mediates the relationship between MA and performance.



$$\frac{3}{5} + \frac{12}{25} =$$

$$\frac{5}{16} + \frac{4}{11} =$$

The stick shown below is $\frac{3}{4}$ as long as a whole candy bar. Draw the whole candy bar.



Nonsymbolic fraction comparison: No — WM does not mediate the relationship between MA and performance.



Results (RQ2)

- Nonsymbolic fraction comparison:** No significant differences between high- and low-MA groups.
- Symbolic fraction comparison:** MA effects strongest in Grade 8, disappears by Grade 9.

Fraction comparison performance across grades by MA group

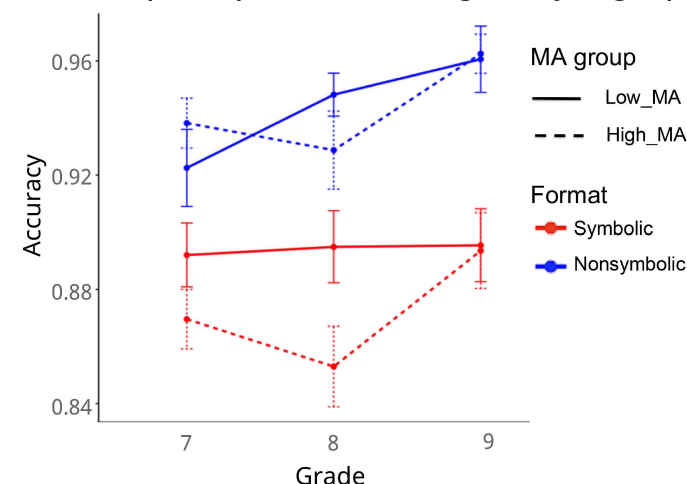


Figure 2. Fraction comparison accuracy across grades by Math Anxiety level (median split within each grade)

Discussion

- MA affects symbolic, but not nonsymbolic, fraction knowledge, suggesting format-specific effects.
- MA effects on symbolic performance attenuate across grades, indicating developmental change.
- Task demands may differentially engage MA and WM.

Acknowledgement

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FRACTIONS & ALGEBRA PROJECT

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