Math Anxiety: An eye-tracking study

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What is Math Anxiety?

• Feelings of tension or worry that interfere with mathematical performance in daily life and school settings (Richardson & Suinn, 1972).

• Distinct from both general and test anxiety.

• Not related to general intelligence.

• A cause of math performance deficits (Ashcraft et al., 2007; Hembree, 1990).

• Mathematically anxious students enjoy mathematics less, have lower perceptions of their mathematic abilities, and do not see value of mathematics in everyday life.
What has existing research found about math anxiety?

- Inverse relationship between MA and mathematical performance \( (r = -0.27 \text{ to } -0.34) \) across middle and high school.
- Starting in 5\textsuperscript{th} grade, MA steadily increases each year before hitting a peak in 9\textsuperscript{th}-10\textsuperscript{th} grade, then remains steady in high school and college.
- MA has been conceptualized in two ways:
  - Learning and evaluation subscale (MARS; Richardson & Suinn, 1972)
  - General anxiety and negative reactions (MAQ; Wigfield & Meece, 1988)
- Several MA measures are excessively age restricted.
Our study

• Develop a MA self-report instrument appropriate for 5th-12th graders.

• Validation of the measures using eye-tracking data: fixation duration, saccadic amplitude, pupil size.
Results

• Negative relationships between math anxiety and math performance \((r = -0.46^*)\)

• Positive relationships between math anxiety and eye-movement data:
  • Fixation duration \((r = 0.39, B = 0.47^*)\)
  • Time to first fixation \((r = 0.77^*)\)
  • Saccadic amplitude \((r = -0.02)\)
  • Pupil Left size \((r = -0.52^*)\)
  • Pupil Right size \((r = -0.33)\)

• Positive relationships between math scores and eye-movement data:
  • Fixation duration \((r = 0.49^*)\)
  • Time to first fixation \((r = 0.11)\)
  • Saccade amplitude \((r = 0.23)\)
  • Pupil left size \((r = 0.50^*)\)
  • Pupil right size \((r = 0.38)\)

\* \(P < .05\)
Results

[Graph showing average total fixation duration (ms) against Math anxiety item for low and high math anxiety groups.]
Results

![Graph showing the average time to first fixation (ms) for Math anxiety items.](chart.png)

Math anxiety group:
- Low
- High
Results

The graph shows the average saccadic amplitude (degree) for low and high math anxiety groups across different math anxiety items. The x-axis represents the math anxiety items, while the y-axis represents the average saccadic amplitude. The graph indicates differences in saccadic amplitude between the two groups, with higher values for the high math anxiety group compared to the low math anxiety group.
Results

The graph shows the pupil left size (in mm) for each math anxiety item, comparing low and high math anxiety groups.
Results
Results
Recommendations for Teaching

Students with high MA interact visually with items differently (e.g., they spend more time on items)

- Increase length of testing session
- Decrease length of test
- Test more frequently but with shorter assessments

Math anxiety affects working memory, and students with less working memory tend to perform worse

- Allow students to use tools to reduce load on working memory
- Demonstrate various strategies for recording work/steps
- Reduce requirements to perform mental math