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Math Anxiety: An eye-tracking study

ACT®

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 = -.27 to -.34) across middle and high school.
- Starting in 5th grade, MA steadily increases each year before hitting a peak in 9th-10th 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 5^{th}-12^{th} graders.

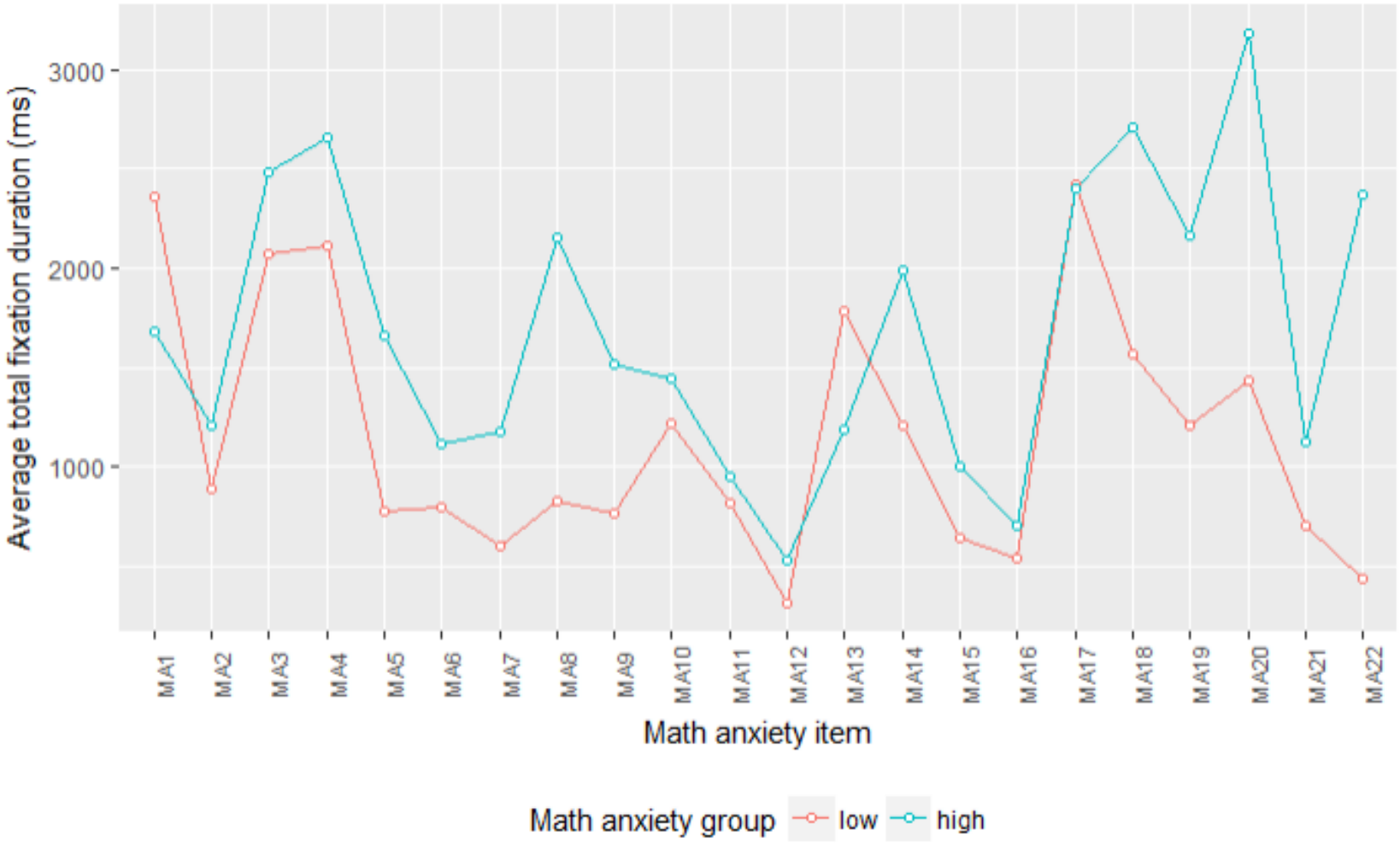
- Validation of the measures using eye-tracking data: fixation duration, saccadic amplitude, pupil size.

Results

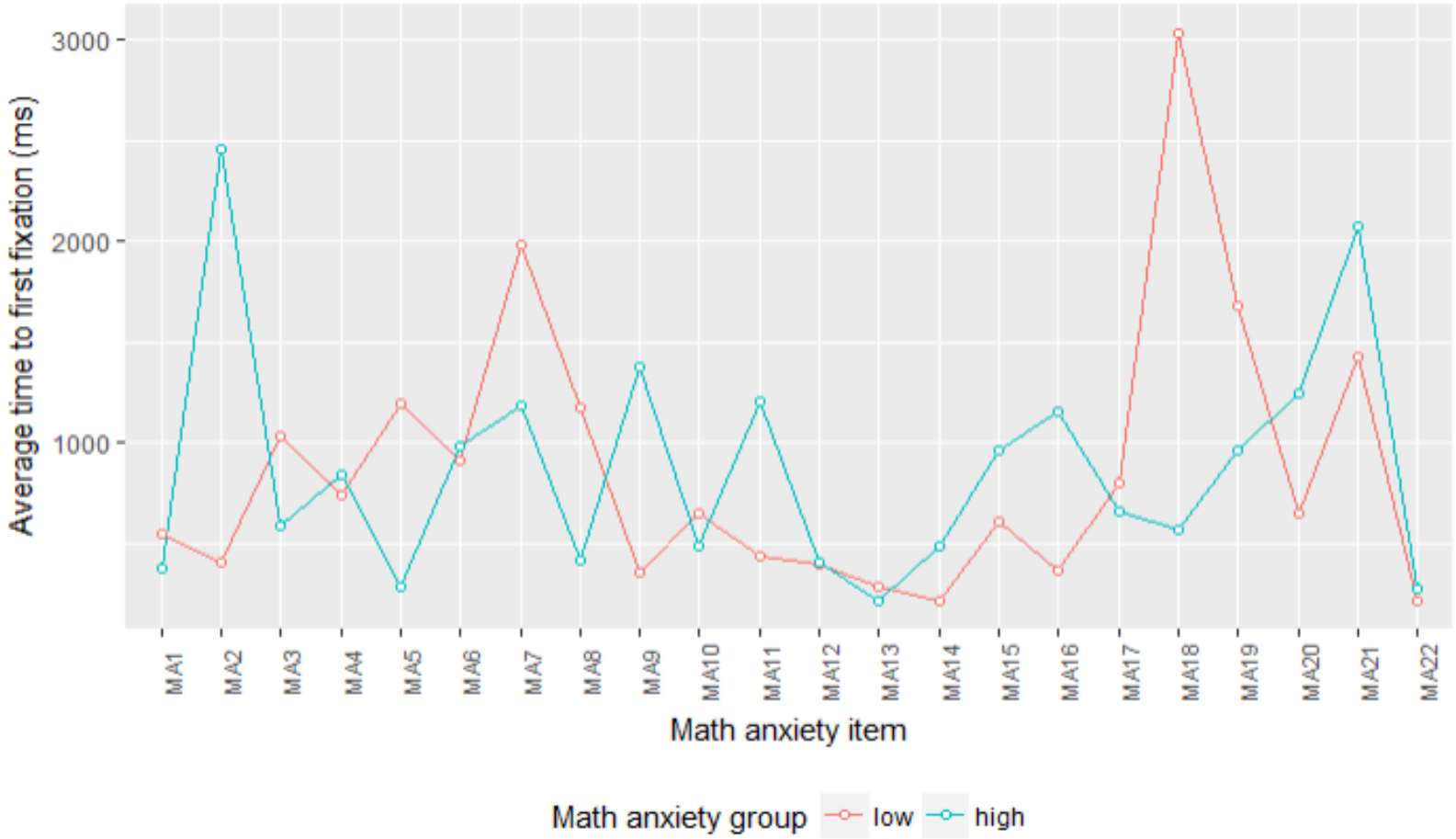
- Negative relationships between math anxiety and math performance (r = -.46*)
- Positive relationships between **math anxiety** and eye-movement data:
  - Fixation duration (r = .39, B = .47*)
  - Time to first fixation (r = .77*)
  - Saccadic amplitude (r = -.02)
  - Pupil Left size (r = -.52*)
  - Pupil Right size (r = -.33)
- Positive relationships between **math scores** and eye-movement data:
  - Fixation duration (r = .49*)
  - Time to first fixation (r = .11)
  - Saccade amplitude (r = .23)
  - Pupil left size (r = .50*)
  - Pupil right size (r = .38)

* P < .05

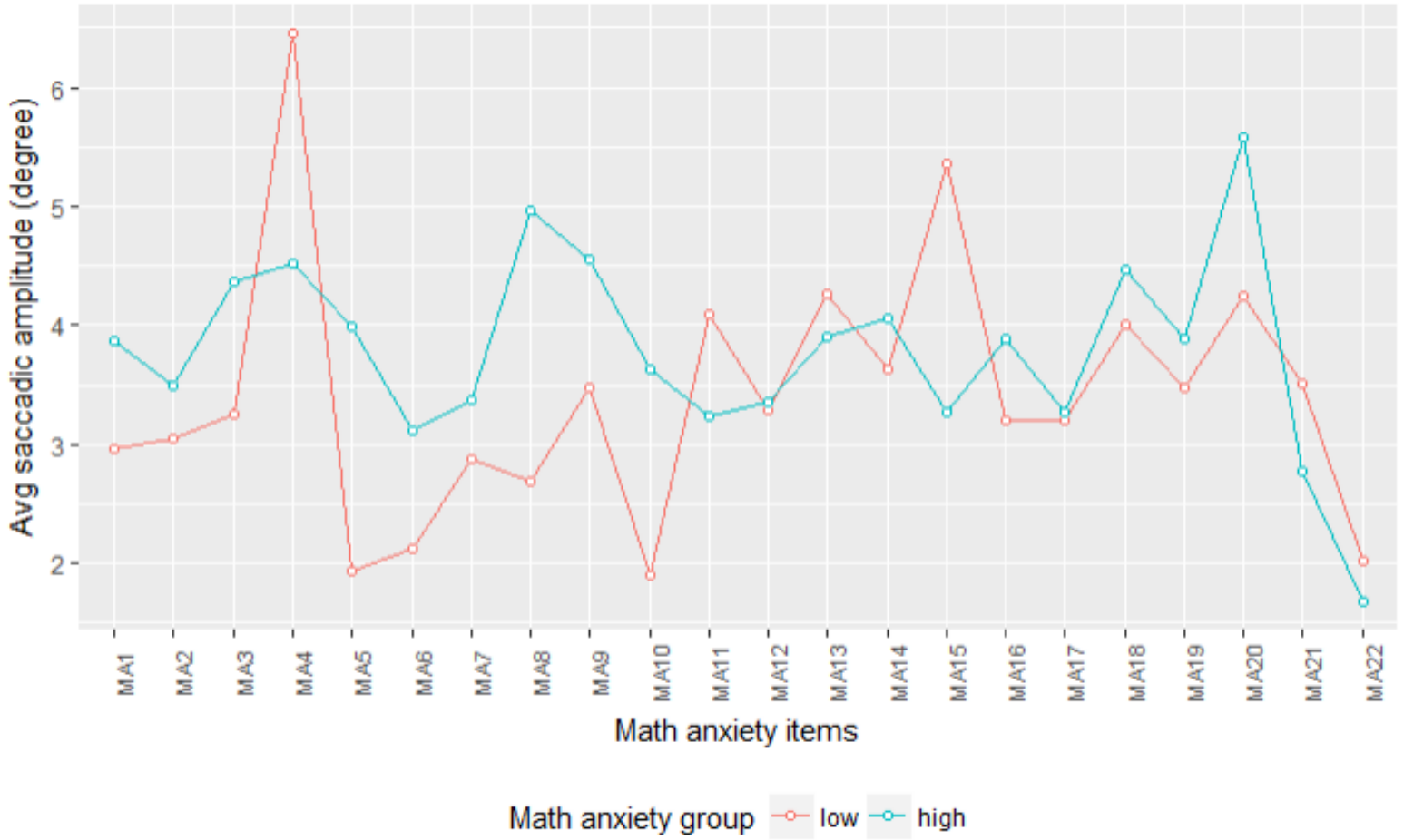
Results


Average total fixation duration (ms)
3000
2000
1000
MA1
MA2
MA3
MA4
MA5
MA6
MA7
MA8
MA9
MA10
MA11
MA12
MA13
MA14
MA15
MA16
MA17
MA18
MA19
MA20
MA21
MA22
Math anxiety item
Math anxiety group
low
high

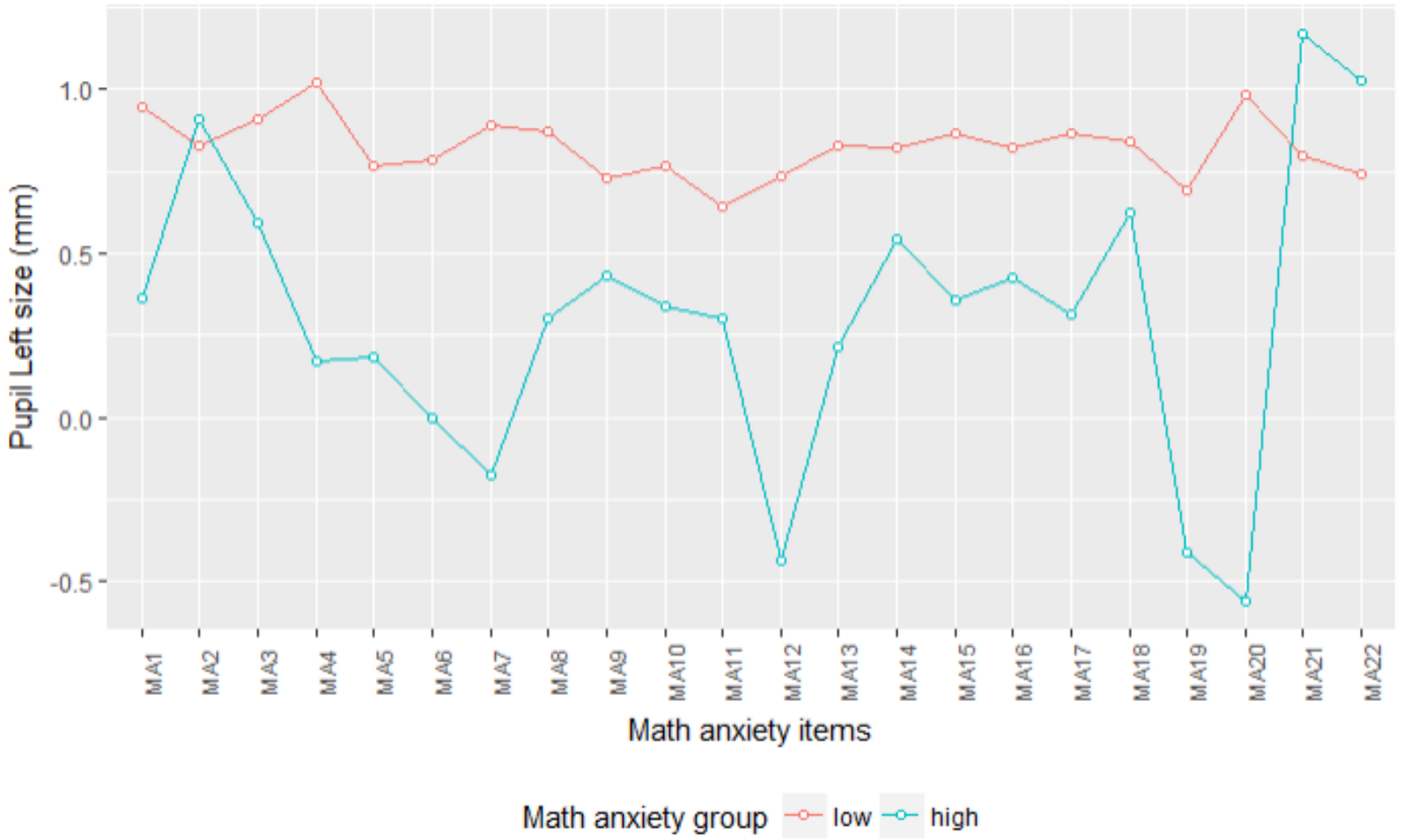
Results


Average time to first fixation (ms)
3000
2000
1000
MA1
MA2
MA3
MA4
MA5
MA6
MA7
MA8
MA9
MA10
MA11
MA12
MA13
MA14
MA15
MA16
MA17
MA18
MA19
MA20
MA21
MA22
Math anxiety item
Math anxiety group
low
high

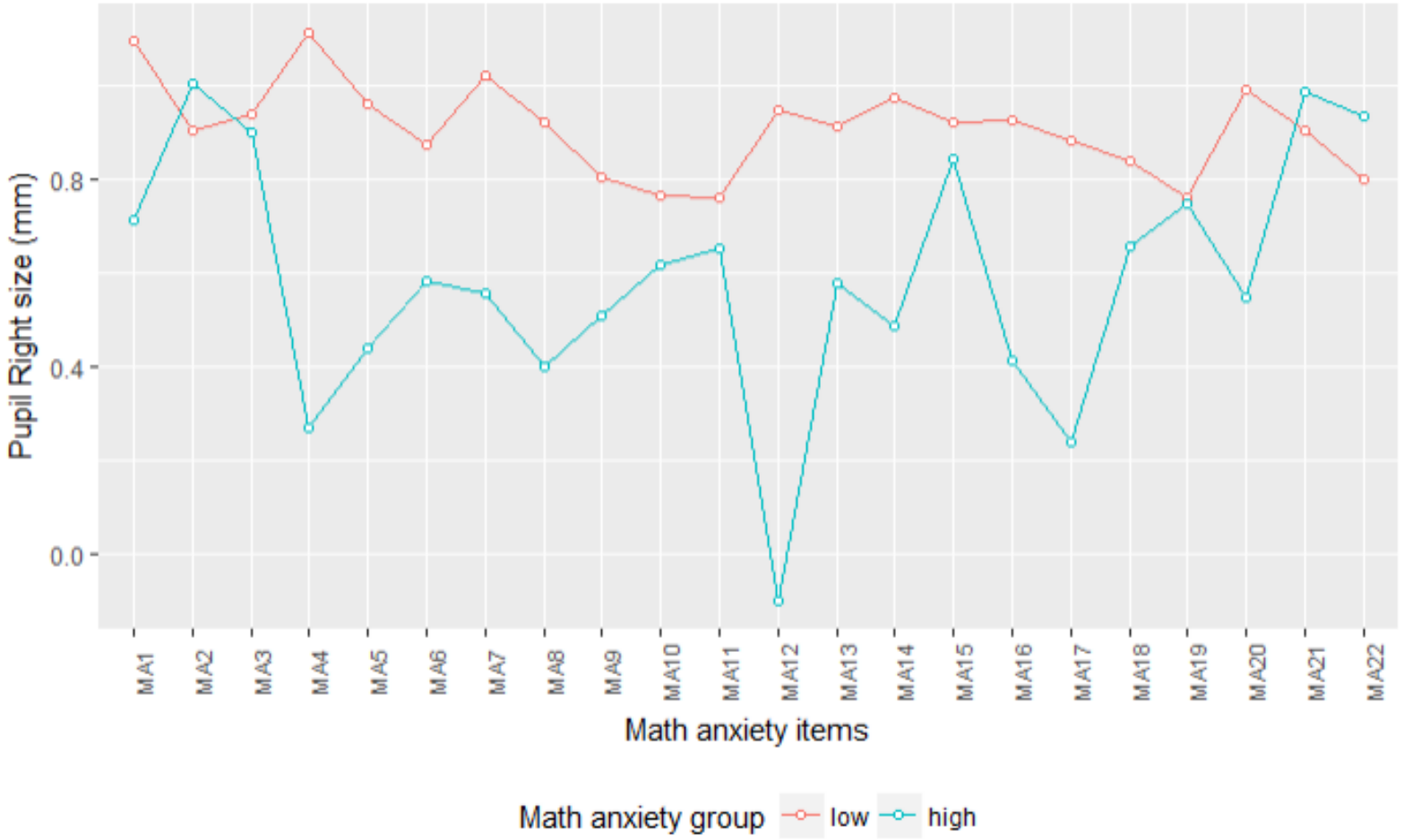
Results


Avg saccadic amplitude (degree)
6
5
4
3
2
MA1
MA2
MA3
MA4
MA5
MA6
MA7
MA8
MA9
MA10
MA11
MA12
MA13
MA14
MA15
MA16
MA17
MA18
MA19
MA20
MA21
MA22
Math anxiety items
Math anxiety group
low
high

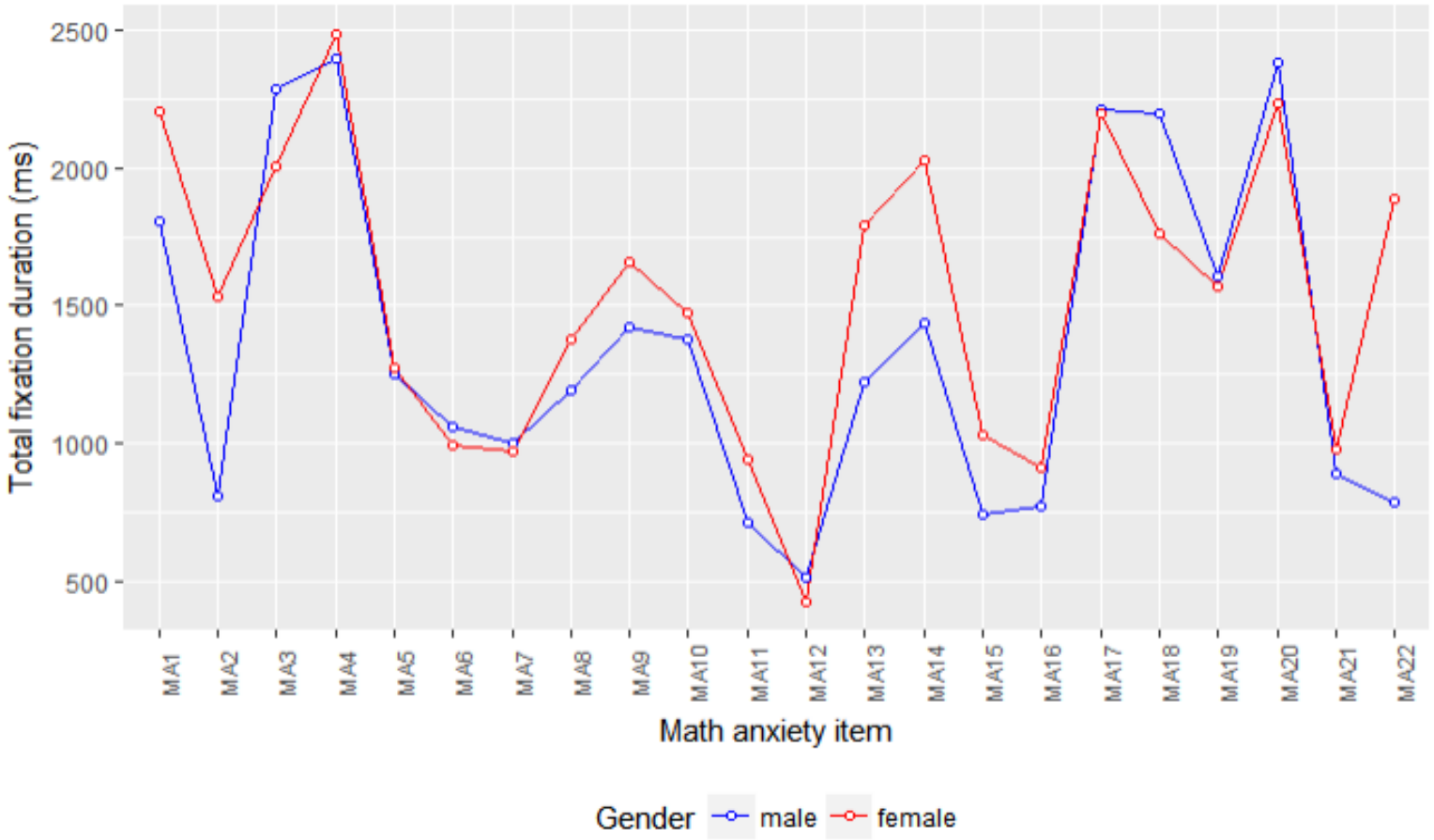
Results


Pupil Left size (mm)
1.0
0.5
0.0
-0.5
MA1
MA2
MA3
MA4
MA5
MA6
MA7
MA8
MA9
MA10
MA11
MA12
MA13
MA14
MA15
MA16
MA17
MA18
MA19
MA20
MA21
MA22
Math anxiety items
Math anxiety group
low
high

Results


Pupil Right size (mm)
0.8
0.4
0.0
MA1
MA2
MA3
MA4
MA5
MA6
MA7
MA8
MA9
MA10
MA11
MA12
MA13
MA14
MA15
MA16
MA17
MA18
MA19
MA20
MA21
MA22
Math anxiety items
Math anxiety group
low
high

Results


Total fixation duration (ms)
2500
2000
1500
1000
500
MA1
MA2
MA3
MA4
MA5
MA6
MA7
MA8
MA9
MA10
MA11
MA12
MA13
MA14
MA15
MA16
MA17
MA18
MA19
MA20
MA21
MA22
Math anxiety item
Gender
male
female

Recommendations for Teaching