Understanding the origins and experience of mathematics anxiety in primary and secondary school pupils

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Emotional factors in maths: Mathematics anxiety

We need to understand and prevent/remediate MA because

1) Many students and adults experience MA, a general **dread of maths**
   → We can positively affect ***mental health and quality of life***

2) MA decreases math ***performance***
   → We can increase maths ***performance*** by decreasing MA

3) Persistent maths anxiety leads to **avoidance** of maths ***learning*** and maths related **careers**.
   → We can increase the number of students ***taking up maths*** and **STEM** subjects
The project (2013-2016)

We studied
~1750 British children (Cambridgeshire, Essex)
~1000 Italian children (Northern Italy)
~300 Colombian children (Bogota)

Quantitative part (questionnaires and statistical evaluation)
- Develop of measurement tool for MA in children ➔ Questionnaire
- Gender differences in MA
- The specific nature of MA (is MA a unique form of anxiety?)
- Developmental time course of MA
- The relationship of low maths achievement / specific math learning difficulties and MA

Qualitative part (interviews)
- The origins and experience of MA
Girls report consistently higher anxiety levels
UK Primary school sample; 9-10 years of age:

**Performance and anxiety levels in Girls and Boys (N=843)**

- **Score (SD)**
  - Reading
  - Maths
  - General Anxiety
  - Maths Anxiety
  - Test Anxiety

95% bootstrap confidence intervals
Specificity and development of MA

- **Primary** school girls and boys:
  MA, general (everyday) anxiety and test anxiety strongly correlate. There are children who show low or high anxiety on all of these anxiety forms.

- **Secondary** school girls and boys:
  Academic anxieties become more separated from other forms of anxiety. Some students show low general (everyday) anxiety BUT high academic anxiety (MA and test anxiety). These students perform the worst.
Math anxiety and weak math (Cognitive deficit as a cause?)

For review see: Carey, Hill, Devine & Szucs, *Frontiers in Psychology*, 2015
- 80% of children with high MA are normal to high achievers
- Being math anxious is **not** a consequence of Weak math in general
Not experiences but rather, their interpretation differs between students with high and low MA

Often mentioned triggers:

- Half of students with high MA were afraid of being asked maths questions in front of a class
- **comparing** work unfavourably with more able peers and siblings
- Triggered by loss of confidence when encountering more **challenging** work than before (e.g. moving a child into higher achievement group!)

‘... in year 7 I was in the middle group, by I was top of the class... when she moved me up... my confidence just went straight down... because I realized how clever everyone else was in the top set, and how much more they learnt than me’

- Confused when taught by **different methods** by different teachers and parents

- In **primary** school dislike of teachers was **rarely** mentioned as anxiety inducing.  
- Many more **secondary** school students had mentioned **bad** interpersonal relations with teachers as cause of their MA.

- **Secondary school** students (aged 12-13) with high MA often referred to the increased hardness of math relative to their primary school experience as well as to increased homework load and higher stakes.
Interview data

Students with low MA often interpreted their negative experiences from a positive angle. ‘sometimes my mind gets a bit confused … I felt really frustrated … but after two days … everything went into my head and I knew everything.’ - Interview excerpt from a 9-10 year-old female student
Brief recommendations

**Student** level interventions
- Step by step increase student self-confidence and self-efficacy
- Increase metacognitive skills: distinguish between performance requirements (quick solutions; public demonstration of solutions) vs. math discovery (fun)
- Fight gender stereotypes about math being a male domain (for females)
- Discussion of worries about maths and their potential resolution

**Teacher** level interventions
- Discussion of worries about maths and their potential resolution (trainee teachers have high MA!)
- Subject matter training to decrease MA (increased confidence in maths)
- Subject communication training to decrease MA
- Coordination of teaching methods in order to avoid confusing students with diverse solution methods
- Interpersonal communication training
- Evaluate communication clarity especially with secondary school students
- Clarify own gender ability beliefs and stereotypes about maths

**Parent** level interventions
- Value attached to maths
- Gender stereotypes about maths
Priorities for further research

1. What triggers of MA are the most important at what age?

2. What interventions work best at what age for what group? EVIDENCE
   - Type:
     - Prevention
     - Remediation
   - For what group?
     - Low math achievement students
     - Normal to high achievers
     - Girls
   - Intervention level
     - Student
     - Teacher
     - Parent
   - When?
     - Before school (family)
     - During school: primary / secondary
Thank you!
Maths is undoubtedly a difficult subject. Symbolic thinking needs a lot of training.

But: Not all mathematics difficulties result from cognitive difficulties.

Several children and adults have mathematics anxiety (MA) which severely disrupts their performance. Math vs. MA correlation: $r \approx -0.3$

MA is a debilitating negative emotional reaction to mathematics; a general dread of maths.
Defined as “a feeling of tension and anxiety that interferes with the manipulation of numbers and the solving of mathematical problems in … ordinary life and academic situations”.

MA ranges from the feeling of mild tension to experiencing strong fear of mathematics. MA is not restricted to test or classroom settings but generalizes to everyday situations.

MA appears in primary school, and seems to grow stronger by secondary age.

Devine, … Szucs et al. 2012. *Behavioural and Brain Functions*
Carey, Hill, Devine & Szucs (2017); Frontiers in Psychology: The Modified Abbreviated Math Anxiety Scale: A Valid and Reliable Instrument for Use with Children

mAMAS
modified
Abbreviated
Maths Anxiety
Questionnaire

~1750
8-13 year-old
British Children

<table>
<thead>
<tr>
<th></th>
<th>Low anxiety</th>
<th>Some anxiety</th>
<th>Moderate anxiety</th>
<th>Quite a bit of anxiety</th>
<th>High anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Having to complete a worksheet by yourself.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. Thinking about a maths test the day before you take it.</td>
<td>1</td>
<td>2</td>
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<td>5</td>
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<tr>
<td>3. Watching the teacher work out a maths problem on the board.</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<td>5</td>
</tr>
<tr>
<td>4. Taking a maths test.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. Being given maths homework with lots of difficult questions that you have to hand in the next day.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. Listening to the teacher talk for a long time in maths.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. Listening to another child in your class explain a maths problem.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. Finding out you are going to have a surprise maths quiz when you start your maths lesson.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. Starting a new topic in maths.</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<td>5</td>
</tr>
</tbody>
</table>
No change in the gender gap since the 1980s/90s

Figure 1. Average mathematics anxiety levels for Grades K–12 and undergraduate.

Hembree, 1990