



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

Denes Szucs

University of Cambridge, UK

Department of Psychology

Centre for Neuroscience in Education

<https://www.cne.psychol.cam.ac.uk/people/ds377@cam.ac.uk>

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)

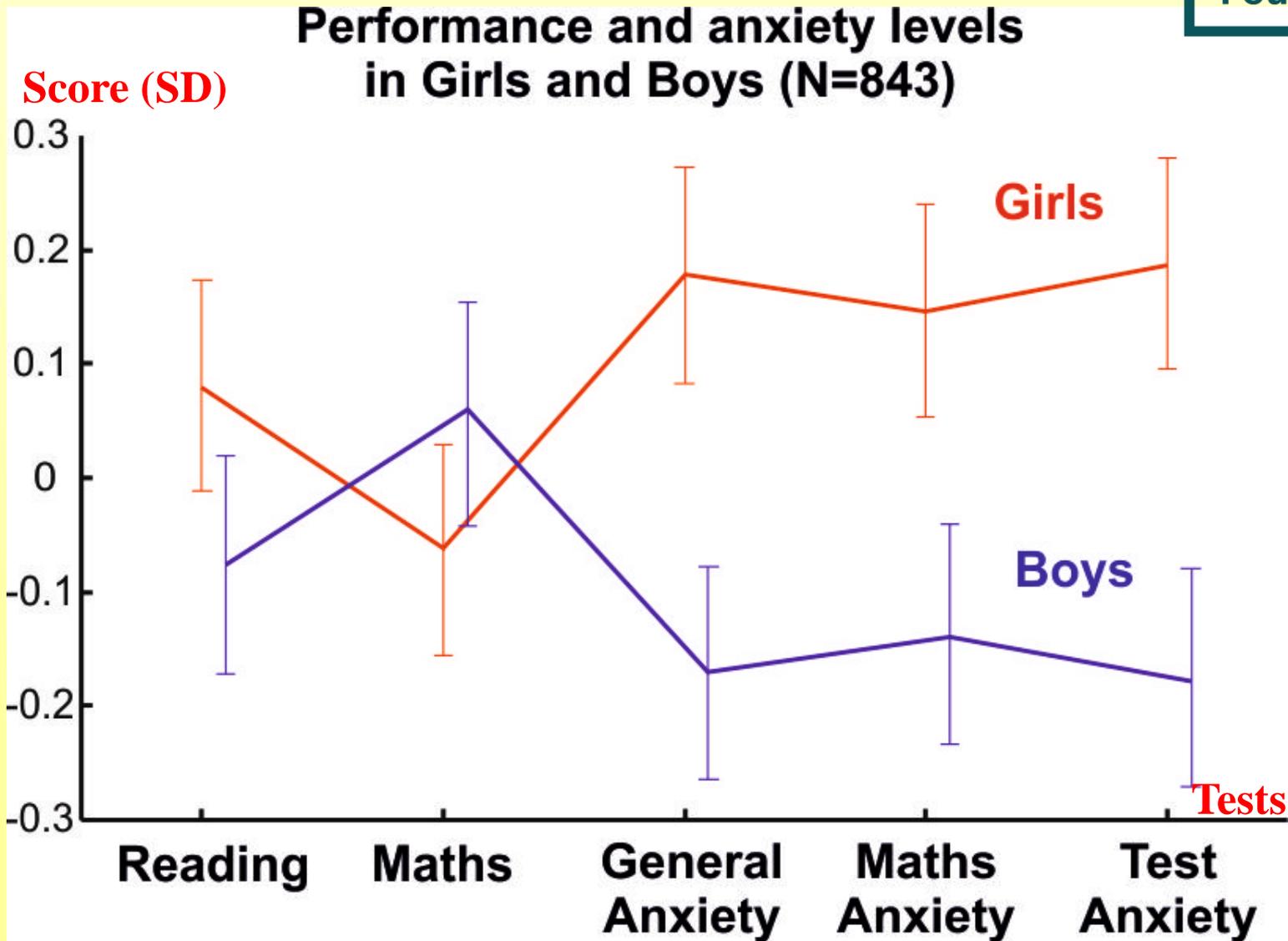
Quantitative part (questionnaires and statistical evaluation)

- 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:



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

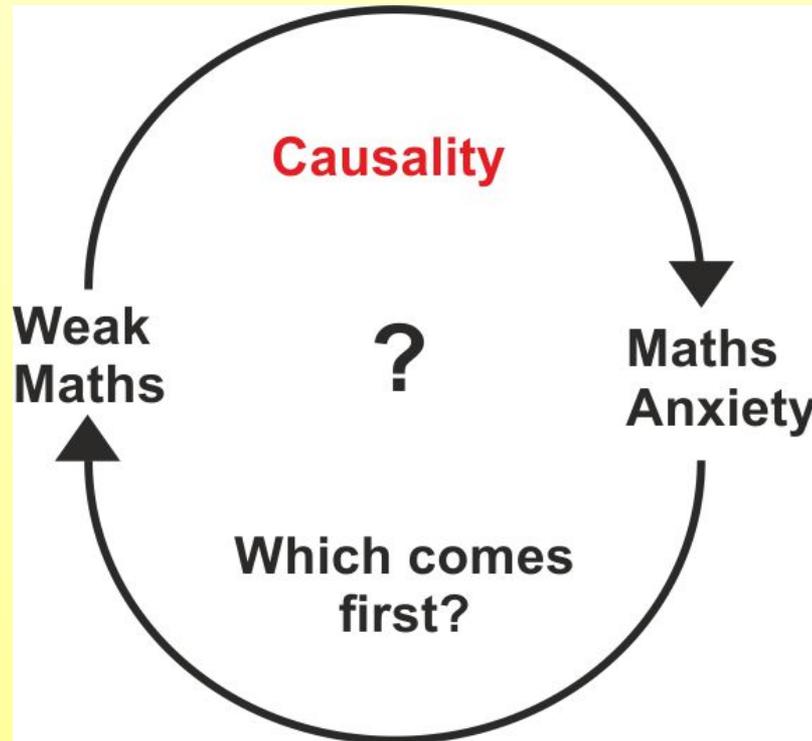
- **Secondary** school girls and boys:

Academic anxieties become more separated from other forms of anxiety

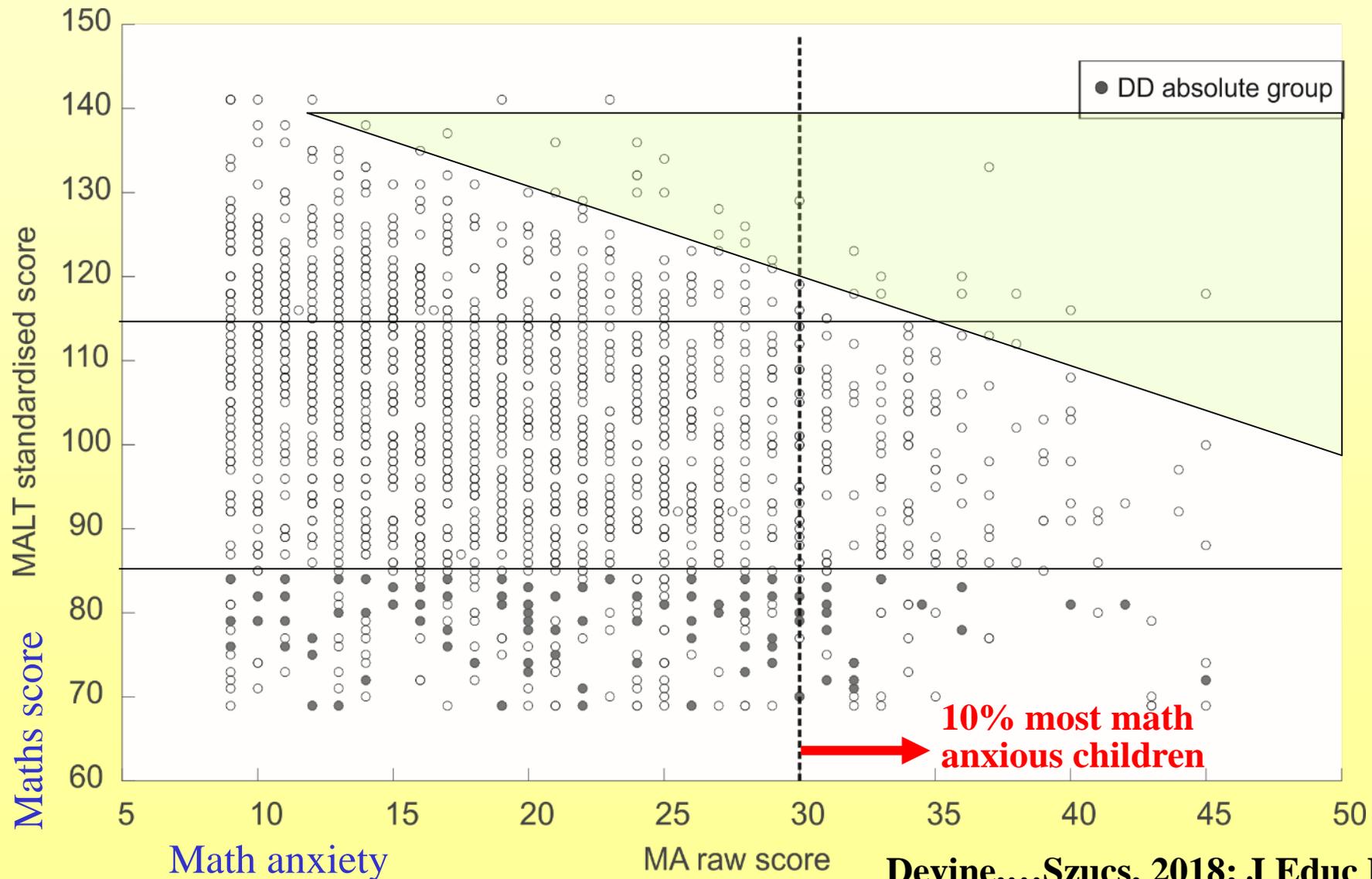
Some students show **low general** (everyday) anxiety BUT **high academic** anxiety (MA and test anxiety)

These students **perform the worst**

Math anxiety and weak math (Cognitive deficit as a cause?)



- **80%** of children with **high MA** are **normal to high achievers**
- Being math anxious is **not** a consequence of Weak math in general



Interview data



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!

Emotional/motivational factors in maths: Mathematics anxiety

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.

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

	😊				☹️
	Low anxiety	Some anxiety	Moderate anxiety	Quite a bit of anxiety	High anxiety
1. Having to complete a worksheet by yourself.	1	2	3	4	5
2. Thinking about a maths test the day before you take it.	1	2	3	4	5
3. Watching the teacher work out a maths problem on the board.	1	2	3	4	5
4. Taking a maths test.	1	2	3	4	5
5. Being given maths homework with lots of difficult questions that you have to hand in the next day.	1	2	3	4	5
6. Listening to the teacher talk for a long time in maths.	1	2	3	4	5
7. Listening to another child in your class explain a maths problem.	1	2	3	4	5
8. Finding out you are going to have a surprise maths quiz when you start your maths lesson.	1	2	3	4	5
9. Starting a new topic in maths.	1	2	3	4	5

No change in the gender gap since the 1980s/90s

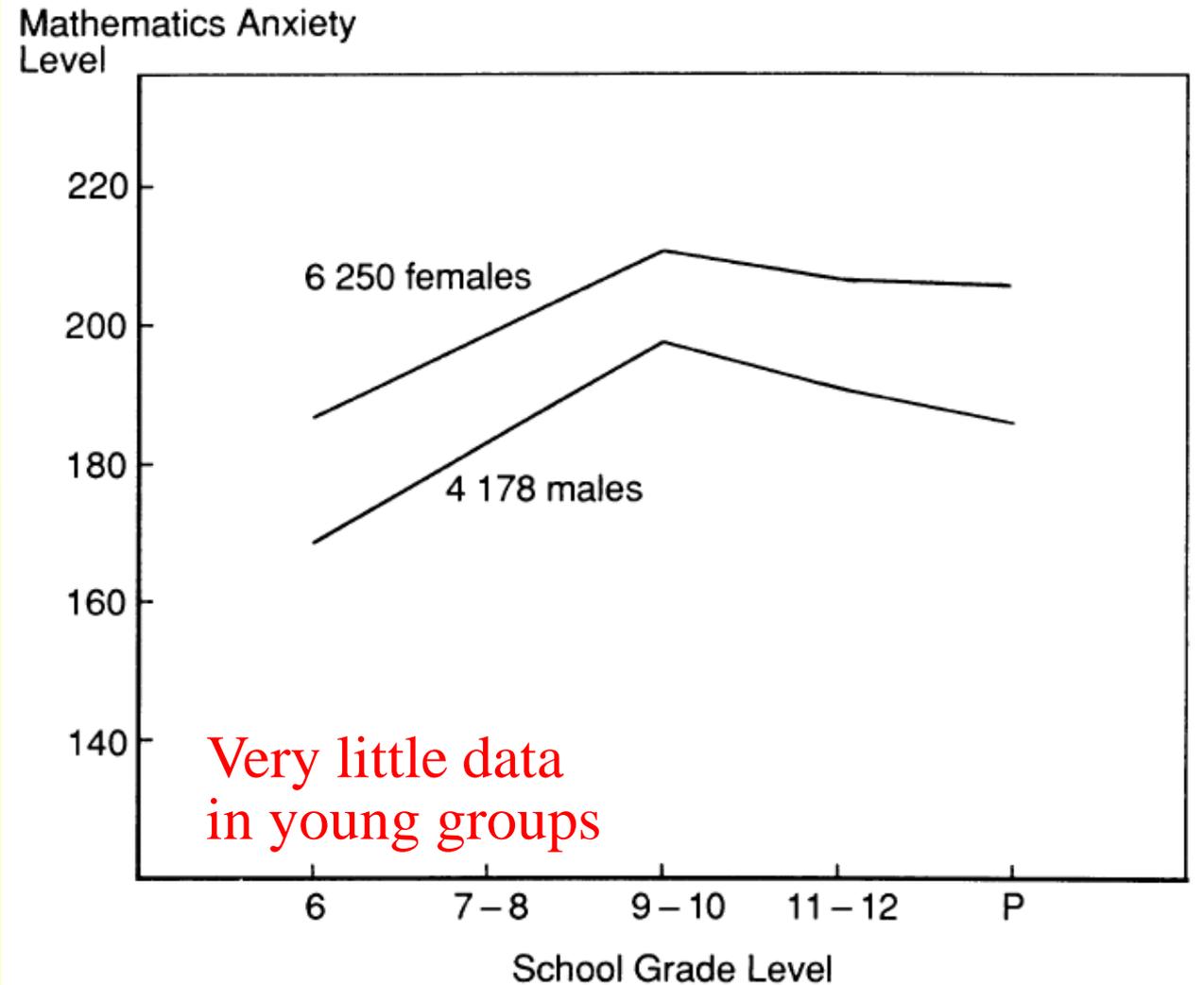


Figure 1. Average mathematics anxiety levels for Grades K-12 and undergraduate.