Understanding dyscalculia

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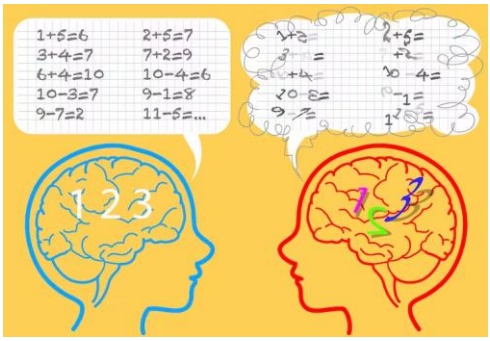
@KMorsanyi



Loughborough University

Centre for Early Mathematics Learning

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Outline

- a bit of context
- what is dyscalculia and how is it diagnosed?
- is dyscalculia only about maths?
- everyday problems associated with dyscalculia
- dyscalculia and other developmental conditions
- how can we support people with dyscalculia?

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The broader context

- government statistics suggest that 17 million adults in England (49% of the working age population) have the numeracy level of a primary school pupil, and only 22% of adults are functionally numerate (Smith, 2017)
- by the end of secondary school, the gap between the highest and lowest achieving students in mathematics in England equals around eight years of schooling, which is larger than in most other countries (OECD, 2015)
- low numeracy is linked not only to poor academic achievement and limited career opportunities, but also to an increased risk of unemployment, mental and physical illness, and higher rates of arrest and incarceration (e.g., Hudson et al., 2009) even in the presence of adequate literacy (Parsons & Bynner, 2005)
- dyscalculia is notoriously underdiagnosed in the UK and in other countries; dyslexia is about 100 times more likely to be diagnosed (e.g., Morsanyi et al., 2018)

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Why is a diagnosis of dyscalculia important?

- with no official diagnosis, students are not eligible to specialist support (including financial support), reasonable adjustments or any recognition of their disability
- because this group does not appear in official statistics, there are no specific government-funded programmes aimed at supporting them
- once people are officially diagnosed, they can meet and share their experiences. This could lead to improved self-esteem, and a potential to learn about effective intervention methods
- dyscalculia is often associated with anxiety and depression, and these problems may be alleviated if people feel part of a dyscalculic community
- increased diagnosis rates could accelerate research into the remediation and, potentially, the prevention of dyscalculia

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Key indicators of dyscalculia

- persistent, substantial difficulties in mathematics learning and using academic skills, despite adequate teaching and access to appropriate interventions
- these problems cause significant interference with academic or occupational performance, or with activities of daily living
- diagnosis should be obtained on the basis of standardized achievement measures and comprehensive clinical assessment
- "clinical synthesis" should occur based on the individual's developmental, medical, family, and educational histories, school reports, and psycho-educational assessment
- the difficulties must not be better explained by intellectual disabilities, mental, neurological, sensory (vision or hearing) or motor disorders
- the difficulties must not be better explained by psychosocial adversity, lack of proficiency in language of academic instruction, or inadequate educational instruction
- severity levels may vary

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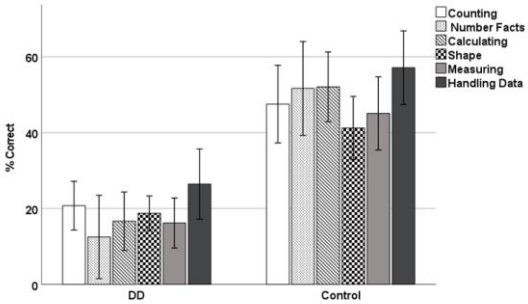
Are all areas of mathematics impacted?
(Roulstone et al., *in prep.*)

- 9-10-year-old children with and without dyscalculia
- performance on a curriculum-based mathematics test



group differences larger for open-ended than for MCQ questions

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I have never had a formal diagnosis of dyscalculia, but all my experiences with mathematics, time, orientation, etc., point towards this being a condition that I suffer from. Still to this day, I'll find myself at a location (the right location!) on the right day and at the right time, only to find I have the date wrong. This has resulted in many tearful sessions hugging the car steering wheel! When I went through school, I struggled with both arithmetic and telling the time. I was only able to (somewhat) conquer my time issues when I got a digital watch at age 12. At seven, I remember standing in the school gymnasium trying to decipher the time for the teacher from the large clock, but the second hand completely messed up all my attempts, which weren't necessarily getting me anywhere to begin with. I used to get numbers back to front (still do) and would regularly fail all the math drills, although at one point I did get put into the higher fractions class.

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Typical *non-maths-related* problems associated with dyscalculia

- low self-esteem, anxiety and depression (DSM-5)
- externalising/conduct problems (e.g., Haberstroh & Schulte-Körne, 2019)
- co-morbidities (dyslexia, ADHD, communication difficulties)

General cognitive skills that may be affected in dyscalculia:

- verbal and visual working memory (e.g., Attout & Majerus, 2015; Morsanyi et al., 2018; Szucs et al., 2013)
- inhibitory function (e.g., Blair & Razza, 2007; Szucs et al., 2013)
- attentional function (Ashkenazi et al., 2009)
- ordering/sequencing skills, including temporal order and learning movement sequences (Morsanyi et al., 2018)
- logical reasoning skills (Morsanyi et al., 2013)

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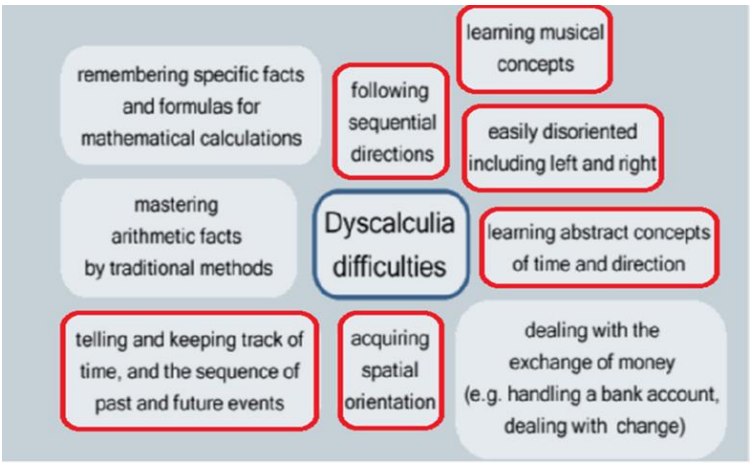
Typical problems in dyscalculia



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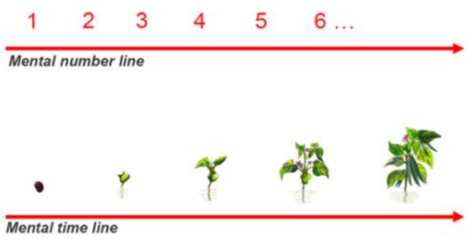


Bonato et al., 2012

A theory of magnitude...

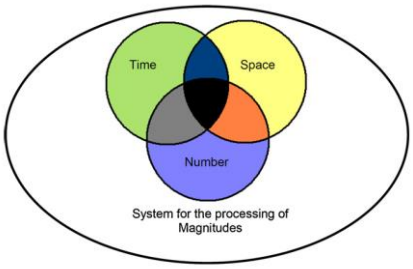
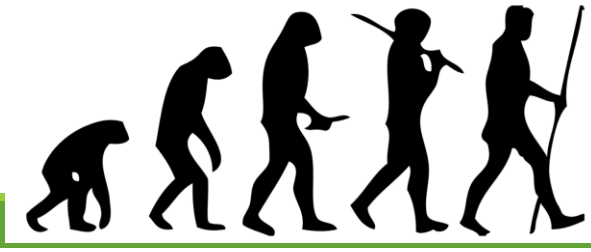


Fig. 3. A schematic representation of the ATOM theory. Adapted from Walsh (2003).



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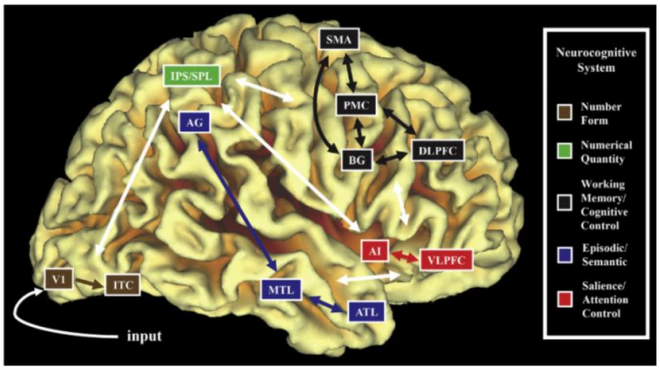
Multiple neural components of dyscalculia (Fias et al., 2013)

- Mathematical problem-solving is built on multiple neurocognitive components that are implemented by distinct and overlapping brain systems.
- Heterogeneity and comorbidities observed in dyscalculia are a natural consequence of such a multicomponent system



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Common co-occurring conditions with dyscalculia (Morsanyi et al., 2018)

	Male	Female	Total	Percentage	Percentage in non-SLDM children	Odds ratio
Cognitive and learning difficulties	28	35	63	45.3	10.4	6.65
Speech and language difficulties	10	6	16	11.5	2.3	5.27
Dyslexia	4	4	8	5.6	4.1	1.33
Social, emotional, and behavioural difficulties	3	3	6	4.3	2.9	1.41
Autism spectrum disorders	2	2	4	2.8	0.6	4.48
Communication and interaction	1	2	3	2.2	0.3	7.17
Attention deficit (and hyperactivity) disorder	2	0	2	1.4	0.2	5.54
Other (medical or physical) conditions	5	1	6	4.4	1.1	3.51
Other (unspecified) conditions	3	1	4	2.2	0.4	6.73
Total	58	54	112	80.6	22.3	16.24

- Comorbidity between developmental disorders is the rule rather than the exception (e.g., Williams & Lind, 2013). However, most people only receive **one** diagnostic label.

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Dyslexia and dyscalculia

- substantial overlap in genetic influences on reading and mathematics, suggesting a role of generalist genes (Haworth et al., 2009)
- strong correlations between these skills in population-based samples (e.g., Morsanyi et al., 2018)
- DSM-5 lists dyslexia and dyscalculia under the same umbrella term of "specific learning disorders"
- However, some studies suggest distinct cognitive profiles:
- two separate profiles of maths difficulties: (1) with reading problems and verbal working memory impairments; (2) without reading problems, but with visuo-spatial working memory problems (Szűcs, 2016)
- whereas the phonological processing deficits in dyslexia impair some aspects of mathematics, other skills that rely less on verbal codes are unimpaired (e.g. Jordan et al., 2010)

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Are there gender differences in dyscalculia rates?

- Specific learning disorders are more common in males (ratios range from about 2:1 to 3:1) – according to the DSM-5; no information is given about dyscalculia specifically
- Most studies on dyscalculia report no gender differences (e.g., Desoete, Roeyers, & De Clercq, 2004; Devine et al., 2013; Gross-Tsur et al., 1996; Hein, Bzufka, &Neumarker, 2000; Koumoula et al., 2004; Lewis et al., 1994; Mazzocco & Myers, 2003)
- The proportion of male and female pupils with an SLDM profile was not significantly different (i.e., 6% of male pupils and 5.5% of female pupils had SLDM; Morsanyi et al., 2018)
- The proportion of male and female students with extremely high maths performance (upper 5-6% of the population) also did not differ (Morsanyi et al., 2018)

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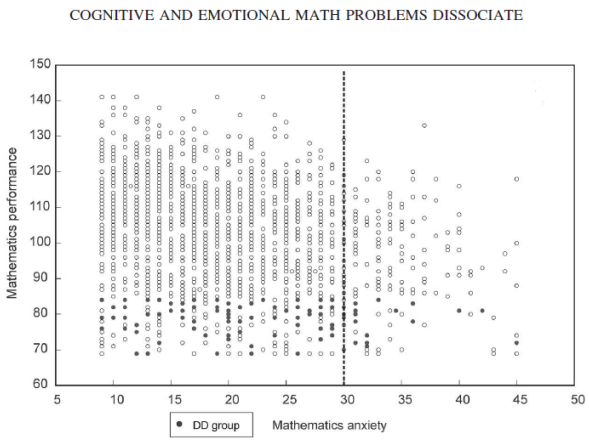
What is the relation between dyscalculia and maths anxiety? (Devine et al., 2018)



- dyscalculic people may have high or low mathematics anxiety
- 80% of students with very high levels of maths anxiety still have mathematics performance in the average range

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What does research say about support for dyscalculia?

- Consider the heterogeneity of dyscalculia, co-morbid difficulties and cognitive profile (i.e., processing speed, memory, attentional problems, etc.)
- The lowest achieving pupils' knowledge will lag several years behind their school grades (e.g., OECD, 2015): assessment and intervention should focus on basic/foundational skills
- Early diagnosis and intervention is key to bridge the gap between pupils' knowledge and age-appropriate conceptual and procedural skills
- Dyscalculia is the very low end of the mathematics skills continuum: no evidence that interventions for dyscalculic pupils should be different from interventions for other pupils (e.g., Peters & Ansari, 2019)
- assistive technology

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VOLUNTEERS NEEDED

Loughborough University
Mathematics Education Centre

CALLING ALL ADULTS IN THE UK (OVER 18) WITH DYSLEXIA

https://lborocmc.fra1.qualtrics.com/jfe/form/SV_bjX7X8pQ1BghbFA

Benefits

- £10 Amazon Voucher!
- Help adult dyscalculia research
- Only takes about 1 hour (60 minutes)

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Thank you!

Contact: k.e.morsanyi@lboro.ac.uk

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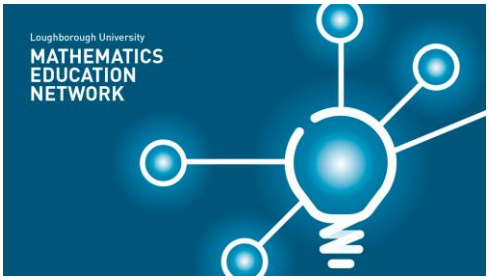

Relevant blog posts:

Dyscalculia: 'maths dyslexia' or why so many children struggle with numbers (theconversation.com)

What a fear of maths does to children – new research (theconversation.com)

More maths testing could be good for primary schoolchildren – if done in the right way (theconversation.com)

#177 Research in Action 24: Dyscalculia latest developments with Kinga Morsanyi - Mr Barton Maths Podcast

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