Math Learning Disabilities, Dyslexia and ADHD: Understanding and Remediating MLD
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Proud member of
The Association of Educational Therapists

The Association of Educational Therapists is the national professional association for educational therapists. AET defines and sets standards for the professional practice of educational therapy. Educational therapists provide a broad range of individualized educational interventions for children and adults with learning disabilities and other learning challenges.

https://www.aetonline.org/

"Pure mathematics is, in its way, the poetry of logical ideas."
--Albert Einstein
Prevalence

- Math difficulties ~ 35%
- Math disability ~ 6.4%
- As common as Dyslexia and ADHD
- Familial prevalence 10X general population

(Shalev, 52; Gersten, Clarke, and Mazzocco, 13 in Berch & Mazzocco (Eds). 2009.)

The “So What?”
The “So What?”

Agenda

- What is a math learning disability (MLD)?
  - Connections to Dyslexia & ADHD.
- What to do about it?

Agenda

- What is a math learning disability (MLD)?
  - Connections to Dyslexia & ADHD.
- What to do about it?
Math Competence

“Math competence rests, fundamentally, on the construction of a rich set of conceptual relationships among these worlds.”

(Griffin, 375-376 in Berch & Mazzocco, (Eds). 2009.)

Math Competence

Procedural knowledge

Conceptual knowledge

Factual knowledge

“The cooperation of [these] different types of knowledge leads to meaningful and efficient processing.”

(Zamarian, López-Roldán, & Delazer, 260 in Berch & Mazzocco, (Eds). 2009.)

Definitions of MLD

“Dyscalculia can best be defined as a deficit in the representation or processing of specifically numerical information.”

(quoting Landerl et al. (Jordan, 111 in Berch & Mazzocco, (Eds). 2009.)
Definitions of MLD
which "affects the ability to acquire mathematical skills despite appropriate instruction."

(Chinn & Ashcroft, 13)
(Gersten, Clarke, and Mazzocco, 22 in Berch & Mazzocco, (Eds). 2009.)

Definitions of MLD
DSM-V:
• Specific Learning Disorder with impairment in math
  – number sense
  – memorization of arithmetic facts
  – accurate or fluent calculation
  – accurate math reasoning

Definitions of MLD
• No biological markers
• No qualitative markers
"obscure term lacking distinct boundaries"

(Berch & Mazzocco, (Eds). 2009.)
Cognitive processes in math
• Domain general (Geary)
  – basic processes
  – underlie many tasks
  – overlaps with other LDs
• Domain specific (Butterworth)
  – hard-wiring for math
  – “number module”
  – MLD

Domain General Problems
• Language processing
  – Dyslexia or other language-based difficulties
  – Difficulties with information representation and manipulation in the language system
  – Deficit in the ability to retrieve facts from a semantics-based long-term memory network

Dyslexia and MLD
• 70-80% of kids with Dyslexia have MLD
• 50-66% of kids with MLD have Dyslexia
Dyslexia and MLD
- 70-80% of kids with Dyslexia have MLD
- 50-66% of kids with MLD have Dyslexia

Dyslexia and MLD
- Language center’s contribution to MLD
  - representing and manipulating verbal information
  - retrieving facts from semantics-based long-term memory
  - verbal mediation

Dyslexia and MLD
- MLD with Dyslexia or other language-based difficulties more severe than MLD alone
- May have trouble using language as a compensatory strategy (verbal mediation)
Dyslexia and MLD
• Students with language impairments need
  – Explicit instruction in language of math
    • "Shaded in"
    • Multiple ways to say same concept

15÷3

Domain General Problems
• Working memory impairments
  – Often in both Dyslexia & ADHD
  – Memorizing facts
  – Procedural breakdowns

Domain General Problems
• Memorizing facts
  – to learn math facts, parts of equation and answer must both be simultaneously active in the phonological buffer (loop).
Domain General Problems

- Memorizing facts
  - Inefficient and inaccurate retrieval of math facts one of the hallmarks of MLD
  - Domino effect on rest of math
  - Takes up precious processing power

- Need facts taught explicitly
- May not make connections on their own
- Give visual strategies
  - 100's chart
  - number line
  - blocks

Domain General Problems

- Procedural Breakdowns
  - How many steps?

0.3 \( \overline{2305} \)

(Reitsema, 221 in Berch & Mazzocco, (Eds). 2009.)
Domain General Problems

- Procedural breakdowns
  - Exacerbated by lack of automaticity
  - Processing resources filled by inefficient fact recall
  - Takes away from more complex processing

(Bull, summary, 289 in Berch & Mazzocco, (Eds). 2009.)

Where was I?

Domain General Problems

- Procedural breakdowns
  - Accommodations for math facts (off-load processing)
  - Mnemonic or checklist for order of procedures
  - Sample problems
    “No offense, but I don’t listen…”

(Bull, summary, 289 in Berch & Mazzocco, (Eds). 2009.)

Where was I?

Domain General Problems

- Processing Speed
  - Often part of Dyslexia and ADHD
  - Affects decay rate in phonological loop
  - Teachers use speed as proxy for automaticity
  - For kids w/slow processing, not a good proxy

(Geary, Hoard, Nugent, Byrd-Craven, 93 in Berch & Mazzocco, (Eds). 2009.)
Domain General Problems

- Central executive
  - Main weakness in ADHD
  - Poor inhibition of irrelevant associations

(Geary, Hoard, Nugent, Byrd-Craven, 92 in Berch & Mazzocco, (Eds). 2009.)
**ADHD and MLD**

- 31% of kids with ADHD have MLD
- 25% of kids with MLD have ADHD

![Diagram showing the overlap between ADHD and MLD](image)

(Zentall, 220 & Shalev in Berch & Mazzocco, (Eds). 2009.)

**ADHD and MLD**

- Generally NOT an issue of conceptual understanding
- Biggest challenge is in memorizing and recalling math facts
- ADHD brain has weak executive functions

(Zentall, 221 in Berch & Mazzocco, (Eds). 2009.)

**ADHD and MLD**

- ADHD brain habituates to stimuli very fast
  - Difficult to maintain attention to repetitive stimulus
    - Spend less time rehearsing
    - More errors, especially during later trials of rote or overly familiar tasks

(Zentall, 221 in Berch & Mazzocco, (Eds). 2009.)

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ADHD and MLD

- Detail analysis
  - Signs, operations, exponents
  \[-4^2 + (-5^2) ÷ 7\]

(Zentall, 227 in Berch & Mazzocco, (Eds). 2009.)

ADHD and MLD

- ADHD brain low frustration tolerance
  - Pushing through difficult problems
  - Self-image more affected by mistakes

(Zentall, in Berch & Mazzocco, (Eds). 2009.)

ADHD and MLD

- ADHD brain helped by
  - color-coding
  - games
    - with public acknowledgement
    - on a computer
  - Learning self-monitoring and goal setting
    - charting progress

(Pickering & Gathercole, 2004 quoted in Zentall, 22 in Berch & Mazzocco, (Eds). 2009.)
ADHD and MLD

- ADHD brain helped by
  - Verbalizing problems
  - Sorting types of word problems
  - Music, Gum, Bouncy-ball, Utzie cushion (stimulation)

(Pickering & Gathercole, 2004 quoted in Zentall, 22 in Berch & Mazzocco, (Eds). 2009.)

ADHD and MLD

- ADHD brain helped by
  - stimulant medicine increases
  - number of attempted problems
  - number of responses correct
  - number of responses correct per minute
  - number of self-corrected errors

(Zentall, 231 in Berch & Mazzocco, (Eds). 2009.)

Domain General Problems
Domain General Problems

- Visuospatial representations
- May contribute to Dyslexia or stand alone
- Weakness in representations of number magnitude
- Influences early acquisition of calculation
- May underpin retrieval difficulties

(From Bull, summary, p.266 in Berch & Mazzocco (Eds). 2009.)

Math Anxiety Problems

The amygdala: traffic cop of the brain
Where do signals go?
Math Anxiety Problems

Frontal cortex

Math Anxiety Problems

Rear brain

Math Anxiety Problems

Diana Kennedy: Math Learning Disabilities, Dyslexia and ADAD
Association of Educational Therapists
2/14/17

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The only problem is that the amygdala cannot tell the difference between...

Math Anxiety Problems

"When parents frequently help their children with math homework, increased math anxiety in the parents leads to decreased end-of-year math achievement in their children."

Maloney et al (2015) Intergenerational effects
Math Anxiety Problems

- Anxious kids need
  - Growth mindset
    - Jo Boaler: youcubed
      https://www.youcubed.org/
  - Self-soothing techniques
  - Games
    - laughter is the anti-stress

Domain Specific Problems

- Number module
  - for detecting, comparing, manipulating 'numerosity parameter'
  - system for representing & retrieving arithmetical knowledge
  - Parietal lobes

- Verbal System:
  - Exact number; words allow representation, memory & calculation of exact numbers
  - Verbal, symbolic

(Number Module: Approximate number; allows for estimation -- Nonverbal, nonsymbolic)

(Butterworth and Reigosa in Berch & Mazzocco, (Eds). 2009.)
Domain Specific Problems

- Number module
  - Poor subitizing

(Illustration David Mills, Dyscalculia. http://mathdifficulties.blogspot.com/)

Domain Specific Problems

Subitizing: Rainman

(Illustration David Mills, Dyscalculia. http://mathdifficulties.blogspot.com/)

Domain Specific

- Number module
  - Poor comparison of amounts

(Illustration David Mills, Dyscalculia. http://mathdifficulties.blogspot.com/)

(Gersten, Clarke, and Mazzocco, 20; Jordan in Berch & Mazzocco (Eds). 2009.)
Domain Specific

- Number module
  - Poor sequencing of amounts

(Illustration http://daily.zhihu.com/story/4066465)
(Gersten, Clarke, and Mazzocco, 2009.)

Agenda

- What is a math learning disability (MLD)?
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- What to do about it?

What to do about an MLD?

- Concept-procedure integration
- Explicit, explicit, explicit
- Increment, increment, increment
- Games
- Accommodations
Concept-procedure integration

"Math wars"
- Not either / or
- Need to bridge all three
- Language as the bridge

Procedural knowledge
Conceptual knowledge
Factual knowledge

Concept-procedure integration

- Bring out the base ten blocks!
- The missing piece: making the connection

Concrete ➔
Semi-concrete ➔
Semi-abstract ➔
Abstract

David Berg, Making Math Real™ http://www.makingmathreal.org/
Concept-procedure integration
• Concrete = Manipulatives
• Record (color-coded) what the manipulatives demonstrate

![Image](http://www.makingmathreal.org/)

Concept-procedure integration
• Make explicit that manipulatives and symbols “Tell the same story.”
• Language becomes the bridge

![Image](http://www.makingmathreal.org/)

Concept-procedure integration
• Semi-concrete
  – Part I: go through the concrete steps
  – Part II: redo the problem with just the math prompts
  – To give student practice with only symbols, but with manipulatives and recording fresh in memory

![Image](http://www.makingmathreal.org/)
Concept-procedure integration

• Semi-abstract
  – Just symbols
  – Color-coded

56
+ 33
89

David Berg, Making Math Real™ http://www.makingmathreal.org/

Concept-procedure integration

• Abstract
  – Just the symbols without color-coding
  – If student loses the picture, go back to earlier stage
  – This is where most textbooks and worksheets start

56
+ 33
89

David Berg, Making Math Real™ http://www.makingmathreal.org/

Explicit, explicit, explicit!

• Facts
• Problem solving strategies
• Self-monitoring
• Checking work
• Using accommodations
• Anything else you can think of!
Explicit, explicit, explicit!

- Problem solving strategies
  - Explicitly teach problem solving strategy
  - Once mastered, explicitly teach how to transfer to novel situations, structure
  - Explicitly teach categorization
  - Best when taught with self-regulated learning strategies

(Fuchs and Fuchs in Berch, D.B. & Mazzocco, M.M. (Eds). 2009.)

Increment, increment, increment

- Task analysis
  - How many new concepts are introduced between the first and the second problem?

  243  
  +415  
  803  
  +419

Increment, increment, increment

- Task analysis
  - Understand which changes represent a new concept
  - Explicitly teach one new concept at a time
  - New concept, old content; new content, old concept
  - If kids are confused, break it down further
Games

• Why games?
  – ADHD attention
  – Anxiety and laughter
  – Makes overlearning fun
  – "Need to know"

Games

• Make sure you are targeting what you want to target
  – Simply fact memorization?
  – Concept?
  – Procedure?
  – Number sense?

Games

• General purpose
  – Problems on board with sticky ball
  – Teacher/Parent vs student
  – Sports ball
  – Game board
Games

• Card games
  – Go fish
  – Slap jack
  – Memory

Adding Tens

1. Roll the die.
2. Choose which number goes in the ones place and which goes in the tens place.
3. Add ten.
4. Your partner does the same.
5. The person with the higher number wins that turn.
6. Who won the most turns?

Turn 1:    __  __             I won ____, My partner won ____.  

Turn 2:    __  __             I won ____, My partner won ____.  

Turn 3:    __  __             I won ____, My partner won ____.  

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20 Questions

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Assignments and tests need discrete goals
Use accommodations to support non-goal tasks

Accommodations
Accommodations

• Effective accommodations
  – need to be taught explicitly
  – some are disposable crutches
  – some are lifetime supports
  – integrate throughout classes & at home

Accommodations

• Extended time
• Modified homework load (time-based versus length-based)
  – Check in with students: “Sasha”
• Number line
• Multiplication chart or nine-lines

Accommodations

FAIR

does not mean

Same
"Mathematics is one of the essential emanations of the human spirit--a thing to be valued in and for itself, like art or poetry."

--Oswald Veblen
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6, 12
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8, 12
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Race to a Dollar!

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20 Questions

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Bibliography


