The Assessment of a Math Disorder: A Focus on Dyscalculia

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If you go to the store...

- You buy a few groceries for the week.
- They cost $19.90.
- You have a $20 bill.
- Do you have enough to pay?
- How much change should you expect?

Sometimes you write numbers...

- Swapped
- Out of order 132 for 123

When you look at a math problem...

- The first time you solve it like this...
- The second time you solve it like this...

What is Dyscalculia?

- Affects approximately 6% of population
- Brain-Based Condition
  - Evidence showing poor communication between brain hemispheres (Integration of multiple skills)
  - Difficulty making sense of numbers and math concepts (Often can’t grasp basic number concepts).
  - Children may know what to do in math class but don’t understand why they’re doing it.
  - Less developed mental number line leads to a reduced number sense
  - Poor automaticity
- The brain areas that specialize in processing of numbers are underdeveloped by approx. 4 to 6 years in children with difficulties compared to those without difficulties.

Automated Math Skills

- Which amount has more circles?
  - What is 7 + 5?
  - How much is 11*10?
  - Count backwards from 342.
Dyscalculia Webinar 10/19/17
Adam Scheller, Ph.D.

Hierarchical Development
Biological Influence

- System of Magnitudes
- Number Words
- Arabic Numbers
- Mental Number Line (ordinal system)

Parietal left pre-frontal occipital

Brain Development
Children: show strong activation in frontal brain areas when doing math
Adults: Stronger activation in parietal areas
- Calculation tasks are automatized
- Functional specification in the brain

Dyscalculics: show this non-automatized patterns; automation delayed by 4 to 6 years

4-Step-Model
Hierarchical development of representations

Brain area: Ability

- Higher strain on working memory and attention

Link to Affected Life Functioning

- People with dyscalculia:
  - Have difficulty functioning in daily life skills (paying bills, getting correct change)
  - Earn less and spend less money
  - Fall ill more often
  - Are more often in conflict with the law
  - Need more assistance at school
  - May be more anxious than others


How do we define a math learning disability?

1. Individuals with Disabilities Education Act (2004)(§ 300.8):
   - a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations, . . .

2. Dyscalculia
   - Medical/Clinical term for the “condition.”
   - Term not often used in American Public Schools

Dyscalculia vs. SLD-Math?
- Differences between “diagnosis” of neurobiological condition and educational condition
- Dyscalculia (as a medically diagnosed condition) can qualify a student for 504 plan.
- However, Dyscalculia (identified in either school as a learning disorder or medically) can qualify a student for special education with a Learning Disability in Math if...
  - ...student also has documented impact in classroom/educational performance.

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Challenges for Schools

- Helping children with difficulties:
  - Hardly any efficient material
  - Little time of professionals
  - No means to train independently
- "Practice makes perfect":
  - Math skills are automated
  - Automation requires practice (like a piano artist)
  - But: Regular training hard to organize


Math Anxiety

- Children may become so worried about doing math that fear and nervousness can lead to poor performance on math tests.
  - Anxiety can lead to math "performance" problems, not typically "understanding" problems.
- Some children may have both math anxiety and dyscalculia.
  - Poor performance and underlying disability in the presence of increased expectations often lead to academic related emotional conditions, such as anxiety.
  - Anxiety also inhibits the neurotransmission and hence reduces the capacity for learning

www.understood.org (8/17/16).

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Dyslexia

- ... neurobiological in origin... characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities... typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction...
- Children often receive diagnoses of both dyslexia and dyscalculia.
  - Approximately 43–65 percent of children with math disabilities also have reading disabilities.


ADHD

- Some children exhibit characteristics of both dyscalculia and ADHD.
  - Often diagnosed with both
- However, care needs to be taken when analyzing math errors in these cases.
  - These children exhibit impulse dyscontrol and inattention in math, often better explaining their errors.
  - Best practice is to evaluate math after ADHD symptoms are controlled

What areas should you screen for Math?

- Oral Reading Fluency
- Comprehension
- Early Literacy
- Early Numeracy
- Math Computation
- Math Concepts
- Written Language
- Behavior

Limitations of a Screener

- Can not be used to provide a diagnosis
- Is not designed to identify the degree of impairment
- Can not be used to identify pattern of strengths or weaknesses
- Potential to identify “higher” number of students
  - Depends on instrument design and prevalence data.
  - Can be limited by “smart” screening
- What question are you trying to answer?

What do I do with the students who are “at-risk”?

- Check/collect additional “body of evidence” to ensure that student is genuinely at-risk in that skill area. For example:
  - Ensure that core instruction has:
    - been delivered with fidelity
    - a research base to address concerns
  - Does the student have underlying attendance, home, language, or behavioral concerns that may be impacting academics.
  - If everything checks out, you will most likely need to move to Tier 2 for additional supports

Conduct Universal Screening

- Abby’s classroom teacher administered the:
  - AIMSweb Math Computation
    - MCOMP
  - AIMSweb Math Concepts and Applications
    - MCAP

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A big red light goes off…who is Abby?

- Abby is a 10 yr. old student living in the southeastern US.
- Daughter of an artist and chemical engineer; her family history is academically very strong except for some admitted math weaknesses on the paternal side.
- Nothing throws up a red flag when it comes to learning or cognitive disabilities in the family.
- Higher than average ability, but has not been successful in her pursuit to acquire and apply math knowledge.
- Frequently fails her 4th grade math tests and homework is a constant struggle.
- Not only is math tough, but she recently began exhibiting anxiety any time the subject is addressed.
- Attended math summer tutoring 2nd and 3rd grades
- Below the 20th% on both MCAP and MCOMP

How can Abby’s school help her learn?

Tier 1 intervention: Trial 1

- Mrs. Smith works with Abby in a small group for 10 minutes each day reviewing the day’s lesson.
- During this time, she was encouraged to ask questions.
- Her performance was erratic, she may know the concept one day and not the next.

Tier 1 intervention

Trial 2:

- Beginning in December, Abby goes to after school tutoring twice weekly for 30 minutes each.
- Her tutor helped her complete assignments and did progress monitoring weekly
- Evaluate her progress...

Trial 3:

- Due to slow progress and lack of response, tutoring was increased to three times per week, 30 minutes per session.
- Evaluate Progress...

Analyze Screening and Class artifacts

- What errors are being made?

- Abby appeared engaged during lesson
- Did not volunteer to answer or ask questions
- Students were assigned 5 problems in 10 minutes
  - Abby did not complete any of them

- She was not impulsive but was limited by the number of alternative strategies she used.
- She relied on verbal rehearsal to recall information
- She was unable to explain reasoning for strategies, even when response was correct.
Where to next?

Additional Assessments

- Every academic concern needs more information to better plan a way to fix it.
- For a math difficulty is it?
  - Computation
    - Addition
    - Subtraction
    - Multiplication
  - Problem solving
  - Concepts
  - Etc.

Moving into Tier 2:
Some Assessment Questions:

- Why has Abby not shown adequate progress to Tier 1 Interventions?
- How do we make intervention more productive?
- Does she have specific needs/strengths that can the focus to improve skill acquisition?

Tier 2 Standardized Testing

<table>
<thead>
<tr>
<th>Domains</th>
<th>Score</th>
<th>Percentile Rank</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basics Concepts</td>
<td>79</td>
<td>8th</td>
<td>Below Average</td>
</tr>
<tr>
<td>Operations Score</td>
<td>78</td>
<td>7th</td>
<td>Below Average</td>
</tr>
<tr>
<td>Applications Score</td>
<td>83</td>
<td>13th</td>
<td>Below Average</td>
</tr>
<tr>
<td>Total Composite</td>
<td>79</td>
<td>8th</td>
<td>Below Average</td>
</tr>
</tbody>
</table>

Challenges for Schools in Helping Students with Math Difficulties

- Helping children with difficulties:
  - Hardly any efficient material
  - Little time of professionals
  - No means to train independently
- “Practice makes perfect”:
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Interventions

Calcularis Overview

- Dybuster Calcularis is mathematical learning software for school and home.
- Assists the brain in essential learning and maturation processes.
- Combines cutting-edge findings from neuroscience and neuropsychology with tried-and-tested principles from the field of computer science.

Calcularis Outcomes

Increase of number of correctly solved mental tasks in 10 minutes after 6 and 12 weeks (same type of tasks – different numbers)

Teaching Recommendations

Improving Automaticity

To help Amy to commit math facts to automatic recall, allow her to practice them with different combinations of input (looking or listening) and output (writing or saying).

- Present the math fact visually. Amy looks at the math fact and then writes the sum, difference, product, or quotient.
- Present the math fact visually. Amy looks at the math fact and then says the sum, difference, product, or quotient.
- Present the math fact audibly. Amy listens to the math fact and then writes the sum, difference, product, or quotient in writing.
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(Berninger, 2007)

Executive Working Memory Interventions

Dual Encoding

- Strategies utilizing concurrent visual and verbal encoding.
- Some dual encoding occurs naturally (e.g., number naming).
- In the classroom, visual and verbal materials should be utilized.
Executive Working Memory Interventions

Organizational Strategies
- Fitting existing information into an organized structure (semantic category).
- Structuring and organizing information reduces the processing load on WM, thereby allowing more efficient encoding.
- Organizing information involves rehearsal and the processing of information at a deeper level.

Further down the diagnostic testing rabbit hole…

1: Rule in/Rule out
2: Learning Pattern

WIAT–III Results

<table>
<thead>
<tr>
<th>Subtest</th>
<th>Standard Score</th>
<th>Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math Problem Solving</td>
<td>76</td>
<td>5th</td>
</tr>
<tr>
<td>Numerical Operations</td>
<td>79</td>
<td>8th</td>
</tr>
<tr>
<td>Math Fluency</td>
<td>68</td>
<td>2nd</td>
</tr>
</tbody>
</table>

Pattern of Strengths and Weaknesses Analysis

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Relative Strength Score</th>
<th>Relative Weakness Score</th>
<th>Diff.</th>
<th>Critical Value</th>
<th>Sign. Diff.</th>
<th>Y / N</th>
<th>Supports SLD Hypothesis?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Processing Strength / Achievement Weakness</td>
<td>114 (VCI)</td>
<td>79 (NS)</td>
<td>35</td>
<td>8.62</td>
<td>Y</td>
<td>Yes</td>
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<tr>
<td>B Processing Strength / Processing Weakness</td>
<td>114 (VCI)</td>
<td>80 (WMI)</td>
<td>34</td>
<td>10.18</td>
<td>Y</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

- The PSW model is intended to help practitioners generate hypotheses regarding clinical diagnoses.
- This analysis should always be used within a comprehensive evaluation that incorporates multiple sources of information.

Abby’s Assessment Summary

- Strengths: verbal fluid reasoning, lexical and semantic knowledge, and oral expression
- Needs:
  1. Math-related processing deficits
  2. Math-specific skill deficits
  3. Behavior impacting math performance - Anxiety
- Error patterns
  - Large amount of both Math Fact and Algorithm errors

Thanks for attending this webinar!!

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