FIDGET WITH DIGITS: SPECIFIC LEARNING DISORDER WITH IMPAIRMENT IN MATHEMATICS DIAGNOSIS AND TREATMENT

What Math Involves

"Any successful execution of math competencies requires the person is attentive, organized, able to switch sets, and work quickly enough to avoid overloading working memory stores that retain information needed for on-line access of different kinds of information." (p. 210)

Fletcher, J. M., Lyon, G. Reid, Fuchs, L.S., and Barnes, M.A. (2007). Learning Disabilities: From Identification to Intervention. New York, NY: Guilford.

What Math Involves

"Mathematics involves computation, itself the product of knowledge and retrieval of facts, and application of procedural knowledge. Problem solving, particularly solving word problems, involves computation, language, reasoning, and reading skills and perhaps visual-spatial skills as well." (p. 210)

Fletcher, J. M., Lyon, G. Reid, Fuchs, L.S., and Barnes, M.A. (2007). Learning Disabilities: From Identification to Intervention. New York, NY: Guilford.

Mathematical Intuition

- **What is Mathematical Intuition?**
  - **Even in elementary arithmetic multiple cognitive areas are used for different tasks.**
  - **Exact arithmetic uses specific language areas in the left inferior frontal lobe which generates associations between words.**
  - **Symbolic arithmetic was dependent on improvement of number notations and is a cultural invention specific to humans.**

Dehaene, S., Spelke, E. , Pinel, P., Stanescu, R., and Tsivkin, S. (May 7, 1999). Sources of Mathematical Thinking: Behavioral and Brain-Imaging Evidence. Science, 284, pp. 970-974.

Mathematical Intuition

- Approximate arithmetic relies on non-verbal quantity representation implemented in visual-spatial areas of the right and left parietal lobes.
- It is possible this non-verbal representational numeral quantifying ability has a long evolutionary history dating back to pre-humans.

Dehaene, S., Spelke, E. , Pinel, P., Stanescu, R., and Tsivkin, S. (May 7, 1999). Sources of Mathematical Thinking: Behavioral and Brain-Imaging Evidence. Science, 284, pp. 970-974.

Genetics

“ …heritability in arithmetic would amount to about 50%--implying that about half the variance in arithmetical performance is due to genetic differences among individuals” (p. 142).

Dehaene, S. (2011). The Number Sense: How the Mind Creates Mathematics (Revised & Expanded Edition). New York, NY: Oxford University Press.

Genetics

- 50% to 70% of math ability is inherited
- SLD Math in SLD children 50%
- SLD Math in SLD teens and adults 60%
- About 50% with SLD in Math will persist for 3 years

Krasa, N., and Shunkwiler, S. (2009). Number Sense and Number Nonsense: Understanding The Challenges of Learning Math. Baltimore, MD: Brookes, 4 and 8.

Math Neurology

- During mental calculation the right and left angular gyrus (hIPS-Horizonal Part of the intraparietal sulcus) fire simultaneously with the right side slightly stronger.
- Also the prefrontal cortex fires strongly.

Dehaene, S. (2011). The Number Sense: How the Mind Creates Mathematics (Revised & Expanded Edition). New York, NY: Oxford University Press.

Math & The Prefrontal Cortex

"Prefrontal areas play a key role in mathematics, including arithmetic. As a rule, a prefrontal lesion does not affect most elementary operations, but it can yield a specific impairment in executing a series of operations in the appropriate order" (p. 185).

Dehaene, S. (2011). The Number Sense: How the Mind Creates Mathematics (Revised & Expanded Edition). New York, NY: Oxford University Press.

Math & The Prefrontal Cortex

"They add when they should multiply, they do not process digits in the correct order, they forget to carry over when needed, or they mix up intermediate results—often the telltale signs of a basic inability to supervise a sequence of operations" (p. 185).

Dehaene, S. (2011). The Number Sense: How the Mind Creates Mathematics (Revised & Expanded Edition). New York, NY: Oxford University Press.

Math & The Prefrontal Cortex

"The prefrontal cortex is especially vital for the on-line maintenance of intermediate results of a calculation. It provides a 'working memory', an internal representational workspace that allows the output of a computation to become the input to another" (p. 185-186).

- **This also allows for mathematical estimation and the ability to do word problems.**

Dehaene, S. (2011). The Number Sense: How the Mind Creates Mathematics (revised & Expanded Edition. New York, NY: Oxford University Press.

Math & Working Memory

"Working memory requires considerable mental energy; The brain cannot inhibit interference or retain information indefinitely, and memories slip away. Math achievement depends on using this mental energy efficiently. Most mathematical activity requires working memory, although some problems require more of it than others" (p. 123).

Krasa, N. , et al. (2009). Number Sense and Number Nonsense: Understanding the Challenges of Learning Math. Baltimore, MD: Brookes.

Math & Phonological Loop

"The phonological loop holds and rehearses verbal material, as well as certain aspects of visual information, such as objects, pictures, geometric forms, letters, and words that one may remember by their names, descriptions, and other visual associations…Verbal working memory, found to correlate with math performance at all ages plays an important role in even simple math". (p. 123).

Krasa, N. , et al. (2009). Number Sense and Number Nonsense: Understanding the Challenges of Learning Math. Baltimore, MD: Brookes.

Math & Phonological Loop

- **Phonological memory is required for:**
  - **Multiplication**
  - **Math facts**

Krasa, N. , et al. (2009). Number Sense and Number Nonsense: Understanding the Challenges of Learning Math. Baltimore, MD: Brookes.

Math and Phonological Memory

"Insofar as phonological memory impairment affects the storage of serial order information, the processing of number words may especially vulnerable…variance in counting span (i.e., a measure of concurrent object counting and storage totals) is strongly associated with mathematical development and mathematical difficulties, suggesting the possibility that working memory system(s)…

Math and Phonological Memory

"…specialized for dealing with count-based information may cause mathematical difficulties and may overlap in some cases with constraints on phonological memory" (p. 160).

Donlan, C. (2007). Mathematical Development in Children with Specific lanuage Impairments. In D.B. Berch and M.M.M. Mazzocco (Eds.), Why is Math So Hard for some Children? The Nature and origin of Mathematics Learning Difficulties and Disabilities. Baltimore, MD: Brookes.

Phonological Working Memory & Dyscalculia

Phonetic/semantic working memory allows for the representation and retrieval of math knowledge and facts. This may be part of the difficulty in those with dyscalculia.

Butterworth, B., et al. (2007). Information Processing Deficits in Dyscalculia. In D.B. Berch and M.M.M. Mazzocco (Eds.), Why is Math So Hard for some Children? The Nature and origin of Mathematics Learning Difficulties and Disabilities. Baltimore, MD: Brookes.

Math & Visual-Spatial Sketchpad

"The brain holds visual information in 'sketchpad' fashion chiefly in the right hemisphere, with iconic and spatial material coded separately along their respective visual circuits. The spatial circuit and working-memory skills it supports develop slowly and continue to mature well into adolescence. Spatial working memory impacts math-related learning very early, however" (p. 124).

Krasa, N. , et al. (2009). Number Sense and Number Nonsense: Understanding the Challenges of Learning Math. Baltimore, MD: Brookes.

Math & Visual-Spatial Sketchpad

- **Visual-Spatial Sketchpad is required for:**
  - **Vertically aligned complex calculations**
  - **Mental numerical estimates**
  - **Algebra**
  - **Subtraction**
  - **Number sense number line manipulation**

Krasa, N. , et al. (2009). Number Sense and Number Nonsense: Understanding the Challenges of Learning Math. Baltimore, MD: Brookes.

Poor Working Memory & Math

Working memory and executive function are found in those with Specific Learning Disorder with Impairment in Mathematics. "In early years, they count slowly, continue to rely on finger counting for basic computations, and fail to master basic math facts (or even 'learn' erroneous ones). These difficulties can lead to debilitating computational inefficiency and impaired learning later…"

Poor Working Memory & Math

"…Moreover, many children with additional reading or general language disorders often have phonological or visual impairments that affect their working memory for words and numbers" (p. 125).

Krasa, N. , et al. (2009). Number Sense and Number Nonsense: Understanding the Challenges of Learning Math. Baltimore, MD: Brookes.

Planning & Sequencing & Math

- **The decision making part of the frontal lobe is different from calculation execution part of the frontal lobe.**
- **"Without a plan for solving a problem, and sometimes without even a clear goal in mind, student result to their only alternative: trial and error…" (p. 127).**

Krasa, N. , et al. (2009). Number Sense and Number Nonsense: Understanding the Challenges of Learning Math. Baltimore, MD: Brookes.

Self-Monitoring & Math

- **"Solving math problems …requires the insight to know when one is off course. This sort of critical judgment is useful not only in evaluating one's solution to a problem, but also in assessing the reasonableness of one's chosen strategies for achieving it" (p. 127).**
- **Students who have trouble with this: those with AD/HD and/or those with poor number sense**

Krasa, N. , et al. (2009). Number Sense and Number Nonsense: Understanding the Challenges of Learning Math. Baltimore, MD: Brookes.

Cognitive Flexibility & Math

- **"…shifting response set, is just as important for math and life as having a plan in the first place. A person's ease in abandoning irrelevant strategies in favor of more adaptive ones is the mark of mental flexibility" (p. 128).**
- **Some people are preservative.**

Krasa, N. , et al. (2009). Number Sense and Number Nonsense: Understanding the Challenges of Learning Math. Baltimore, MD: Brookes.

Language & Math

- **The left hemisphere controls language and mental calculation.**

Dehaene, S. (2011). The Number Sense: How the Mind Creates Mathematics (revised & Expanded Edition. New York, NY: Oxford University Press.

- **It also has important functions in attention, executive function, working memory and self-control. The more complex language sequencing and syntax the harder it is to comprehend a math problem.**

Krasa, N. , et al. (2009). Number Sense and Number Nonsense: Understanding the Challenges of Learning Math. Baltimore, MD: Brookes.

Past and Future Neurons

"In a sector of prefrontal cortex called the dorso-lateral region or 'area 46', neurons are known to be involved in the on-line maintenance of past or anticipated events in the absence of any external input (as when we rehearse a phone number, for instance)" (p. 201).

Dehaene, S. (2011). The Number Sense: How the Mind Creates Mathematics (Revised & Expanded Edition. New York, NY: Oxford University Press.

Math and Working Memory

"Regardless of numerical competency, deficits in working memory tasks…and executive function tasks…are commonly observed in children with math LDs" (p. 212).

Fletcher, J.M., et al. (2007). Learning Disabilities: From Identification to Intervention. New York, NY: Guilford.

Math and Working Memory

"Some studies have suggested that problems with visual-spatial working memory are more likely to characterize children with specific math disability…, whereas children with both reading and math disabilities have a more pervasive language and verbal working memory difficulties" (p. 212).

Fletcher, J.M., et al. (2007). Learning Disabilities: From Identification to Intervention. New York, NY: Guilford.

Math and Working Memory

"In typically developing children, for example, numerical working memory, depending on whether regrouping is required, but visual-spatial working memory is related to numerical estimation" (p. 213).

Fletcher, J.M., et al. (2007). Learning Disabilities: From Identification to Intervention. New York, NY: Guilford.

Reading, Speech and Math Disabilities

"The present study took an epidemiological approach to study the learning profiles of a large school age sample in language, reading, and math. Both general learning profiles reflecting good or poor performance across measures and specific learning profiles involving either weak language, weak reading, weak math, or weak math and reading were observed. These latter four profiles characterized 70% of children with some evidence of a learning disability. Low scores in phonological short-term memory characterized clusters with a language-based weakness whereas low or variable phonological awareness was associated with the reading (but not language-based) weaknesses. The low math only group did not show these phonological deficits. These findings may suggest different etiologies for language-based deficits in language, reading, and math, reading-related impairments in reading and math, and isolated math disabilities."

Reference

Archibald, L.M.D., et al. (October 14, 2013). Language, Reading, and Math Learning Profiles in an Epidemiological Sample of School Age Children. PLOS ONE. DOI: 10.1371/journal.pone.0077463.

Problems In Numerical Magnitude In Children with SLD with Impairment in Math

"Children with MD (math disorder, sic.) only showed stronger SNARC (spatial numerical response codes, sic) and second order congruency effects than did TD (typically developing, sic.) children, whereas the numerical distance effects were similar across the three groups. Finally, the first order congruency effect was associated with reading difficulties. These results showed that children with mathematical difficulties with or without reading difficulties were globally more impaired when spatial incompatibilities were presented."

Reference

Tobia, V., et al. (April 15, 2014). Numerical Magnitude Representation in Children With Mathematical Difficulties With or Without Reading Difficulties. Journal of Learning Disabilities. DOI: 0022219414529335.

Magnitude Representation and Working Memory in SLD Children

“The results showed that children with an arithmetic disability failed in a number updating task, but not in the object updating task. The opposite was true for the group with poor reading comprehension, whose performance was worse in the object than in the number updating task. It may be concluded that the problem of WM updating in children with LD is also due to a poor representation of the material to be updated. In addition, our findings suggest that the mental representation of the size of objects relates to the semantic representation of the objects’ properties and differs from the quantitative representation of numbers.”

Reference

Pelegrina, S., et al. (March 31, 2014). Magnitude Representation and Working Memory Updating in Children With Arithmetic and Reading Comprehension Disabilities. Journal of Learning Disabilities. DOI: 10.1177/0022219414527480.

Number Sense

Dehaene defined *Number Sense* as, "…the peculiar idea that we owe our mathematical intuitions to an inherited capacity that we share with other animals, namely, the rapid perception of approximate numbers of objects" (p. 237).

Dehaene, S. (2011). The Number Sense: How the Mind Creates Mathematics (revised & Expanded Edition. New York, NY: Oxford University Press.

Number Sense

- **"The human baby is born with innate mechanisms for individuating objects and for exacting the numerosity of small sets.**
- **That this 'number sense' is also present in animals, and hence that it is independent of language and has evolutionary history.**
- **That in children, numerical estimation, comparison, counting, simple addition and subtraction, all emerge spontaneously without much explicit instruction…"**

Number Sense

- **"…That the inferior parietal region of both cerebral hemispheres hosts neuronal circuits dedicated to the manipulation of numerical quantities" (p. 227).**

Dehaene, S. (2011). The Number Sense: How the Mind Creates Mathematics (Revised & Expanded Edition). New York, NY: Oxford University Press.

The Three Laws of Number Sense

1) **An object can only occupy one location at a time.**
2) **Two objects cannot be in the same location at the same time.**
3) **Objects cannot disappear and reappear and they will follow a continuous trajectory.**

Dehaene, S. (2011). The Number Sense: How the Mind Creates Mathematics (Revised & Expanded Edition). New York, NY: Oxford University Press.

Number Sense

"Children who start elementary school with difficulty associating small exact quantities of items with the printed numerals that represent those quantities are more likely to develop a math-related learning disability than are their peers, according to a study supported by the National Institutes of Health".

NIH/National Institute of Child Health and Human Development (2011, October 24). Math disability linked to problem relating quantities to numerals. ScienceDaily. Retrieved November 1, 2011, from http://www.sciencedaily.com /releases/2011/10/111024165553.htm

Number Sense

- **Dr. David Geary stated, "Our findings suggest that children who generally struggle with math -- the low achievers -- may have a poor sense of numbers, but they can narrow the achievement gap in part because most of them can memorize new math facts and, thus, learn some aspects of math as quickly as their typically achieving peers".**

NIH/National Institute of Child Health and Human Development (2011, October 24). Math disability linked to problem relating quantities to numerals. ScienceDaily. Retrieved November 1, 2011, from http://www.sciencedaily.com /releases/2011/10/111024165553.htm

Number Sense

"Dr. Geary added that, in contrast to the low achievers, students with a math learning disability not only have a poor concept of numbers, but also have difficulty memorizing math facts".

NIH/National Institute of Child Health and Human Development (2011, October 24). Math disability linked to problem relating quantities to numerals. ScienceDaily. Retrieved November 1, 2011, from http://www.sciencedaily.com /releases/2011/10/111024165553.htm

Number Sense

David C. Geary, Mary K. Hoard, Lara Nugent, Drew H. Bailey. Mathematical cognition deficits in children with learning disabilities and persistent low achievement: A five-year prospective study.. *Journal of Educational Psychology*, 2011; DOI: 10.1037/a0025398

Number Sense Summary

- **“That the human baby is born with inate mechanical mechanisms for individuating objects and for exacting the numerosity of small sets.**
- **This ‘number sense’ is also present in animals, and hence that it is independent of language and has a long evolutionary history.**
- **That in children, numerical estimation, comparison, counting, simple addition and subtraction, all emerge spontaneously without much explicit instruction…”**

Number Sense Summary

- **"…That the inferior parietal region of both cerebral hemispheres hosts neuronal curcuits dedicated to the mental manipulation of numerical quantities" (p. 227)**

Dehaene, S. (2011). The Number Sense: How the Mind Creates Mathematics (Revised & Expanded Edition). New York, NY: Oxford University Press.

Subtypes of Dyscalculia

“The GD (general dyscalculia, sic.) group displayed weaknesses with both symbolic and nonsymbolic number processing, whereas the AFD (arithmetic fact dyscalculia, sic.) group displayed problems only with symbolic number processing. These findings provide evidence that the origins of DD (developmental dyscalculia, sic.) in children with different profiles of mathematical problems diverge. Children with GD have impairment in the innate approximate number system, whereas children with AFD suffer from an access deficit. These findings have implications for researchers’ selection procedures when studying dyscalculia, and also for practitioners in the educational setting.”

Reference

Skagerlund, K., et al. (March 5, 2014). Number Processing and Heterogeneity of Developmental Dyscalculia: Subtypes With Different Cognitive Profiles and Deficits. Journal of Learning Disabilities. DOI: 10.1177/0022219414522707.

Mathematics

"Unlike reading, which needs to be taught, children have a biologically based propensity to acquire arithmetic skills (e.g., counting, adding, and comparing and understanding quantities) without formal schooling. Interestingly, the computational basis for numeric abilities is not exclusive to Homo Sapiens and has been demonstrated in monkeys as well." (p. 766)

Infants can tell small quantities from large ones.

Shalev, R.S. (October, 2004). Developmental Dyscalculia. Journal of Child Neurology, 19 (10), pp. 765-771.

Mathematics Disorder

"Unlike reading, math is a discipline. It is the only discipline that is taught kindergarten through 12th grade. It is varied (think of measurement, geometry, data analysis, algebra, and rational numbers), cumulative in nature, and as you move across grade levels, it becomes increasingly complex." (p. 10)

Woodward, J.P. (Spring, 2008). Theme Editor's Summary - Dialogue is Important: Language in Mathematics Classrooms. Perspectives, 24 (2), p. 9-10.

Specific Learning Disorder with Impairment in Mathematics

Typical Symptoms

- Frequently malformed or reversed numbers and symbols
- Reading Disorder-Dyslexia
- Inability to sum integers
- Inability to recognize operation signs
- Because of their spacing and order, inability to read accurately the correct value of multi-digit numbers

Gaddes, W.H., and Edgell, D. (1994). Learning Disabilities and Brain Function: A Neuropsychological Approach (Third Edition). New York, NY: Springer-Verlag, pp. 422.

Levine, M. (1987). Developmental Variation and Learning Disorders. Cambridge, MA: Educator Publishing Service.

Specific Learning Disorder with Impairment in Mathematics

- Poor memory for basic number facts
- Failure to carry numbers
- Inaccurate ordering and spacing of numbers in problems
- Also working memory and simultaneous processing problems

Gaddes, W.H., and Edgell, D. (1994). Learning Disabilities and Brain Function: A Neuropsychological Approach (Third Edition). New York, NY: Springer-Verlag, pp. 422.

Levine, M. (1987). Developmental Variation and Learning Disorders. Cambridge, MA: Educator Publishing Service.

Specific Learning Disorder with Impairment in Mathematics

Geary indicated there are 3 subtypes of Mathematics Disorder

1. **Semantic Memory Problems: This includes inconsistent retrieval from memory of math facts, and inconsistent processing time.**
2. **Procedural Problems: students use, "…immature procedures…frequent errors in the execution of procedures…potential delay in the understanding of concepts underlying procedural use…" (p. 6)**

Geary, D.C. (2000). Mathematical Disorders an Overview for Educators. Perspectives, 26(3), pp. 6-9.

Specific Learning Disorder with Impairment in Mathematics

3. **Visuospatial Problems: "…include the misalignment of numerals in multi-column arithmetic problems, numerical omissions, numeral rotation, misreading arithmetical operation signs and difficulties with place value and decimals…Other studies suggest that spatial deficits will also influence the ability to solve other types of mathematical problems, such as word problems and certain types of geometry problems." (p. 9)**

Geary, D.C. (2000). Mathematical Disorders an Overview for Educators. Perspectives, 26(3), pp. 6-9.

Specific Learning Disorder with Impairment in Mathematics

- **Those with Semantic Memory Problems tend not to remember as many math facts as their non-disabled peers.**
- **They will not outgrow problems.**
- **At first they have trouble encoding math facts into long term memory; later they have problems retrieving such information.**
- **Trouble inhibiting unneeded math facts**

Geary, D.C. (July 11, 2002). Mathematical Disabilities: What We Know and Don't Know. From website: http://www.ldonline.org/ld_indepth/math_skills/geary_math_dis.html , pp. 1-7.

Specific Learning Disorder with Impairment in Mathematics

Some of this may be related to the Rapid Automatized Naming problems in those with Specific Learning Disorder with Impairment in Reading/Dyslexia.

Geary, D.C. (July 11, 2002). Mathematical Disabilities: What We Know and Don't Know. From website: http://www.ldonline.org/ld_indepth/math_skills/geary_math_dis.html , pp. 1-7.

Specific Learning Disorder with Impairment in Mathematics

- **Those with Mathematics Disorder tend to use immature problem solving strategies with math.**
- **This may be due to developmental delays.**

Geary, D.C. (July 11, 2002). Mathematical Disabilities: What We Know and Don't Know. From website: http://www.ldonline.org/ld_indepth/math_skills/geary_math_dis.html , pp. 1-7.

Specific Learning Disorder with Impairment in Mathematics

- **Comorbidities:**
- **50% Reading Disorder-Dyslexia (Geary, 2000)**
- **AD/HD**
- **NVLD**
- **Autism Spectrum Disorder**
- **Synesthesias (Cytowic, 1999)**

Geary, D.C. (2000). Mathematical Disorders an Overview for Educators. Perspectives, 26 (3), pp. 6-9.

Cytowic, R.E. (August 5,1999). Synesthesia: Phenomenology and Neuropsychology-A Review of Current Knowledge. Psyche: An Interdisciplinary Journal of Research on Consciousness, 2 (10), July 1995, pp. 1-18/Available on web at: http://www. Psyche.cs.monash.au/v2/psyche-2-10-cytowic.html.

Gerstmann's Syndrome

"Gerstmann's syndrome is a cognitive impairment that results from damage to a specific area of the brain -- the left parietal lobe in the region of the angular gyrus. It may occur after a stroke or in association with damage to the parietal lobe. It is characterized by four primary symptoms: a writing disability (agraphia or dysgraphia), a lack of understanding of the rules for calculation or arithmetic (acalculia or dyscalculia), an inability to distinguish right from left, and an inability to identify fingers (finger agnosia). The disorder should not be confused with *Gerstmann-Sträussler-Scheinker disease*, a type of transmissible spongiform encephalopathy.

Author (July 2, 2008). NINDS Gerstmann's Syndrome Information Page. National Institute of Neurological Disorders and Stroke: Washington, DC. From website: http://www.ninds.nih.gov/disorders/gerstmanns/gerstmanns.htm.

Specific Learning Disorder with Impairment in Mathematics

- **Dyslexia and Mathematics Disorder**
  - **Dyslexics have different math problems than those with MD who are not dyslexic.**
  - **Dyslexics have trouble with:**
    - **Memorizing math facts**
    - **Comprehending word problems**
    - **Mis-sequencing numbers as they write**

BUT

Pennington, B. (1991). Diagnosing Learning Disorders: A Neuropsychological Framework. New York, NY: Guilford.

Specific Learning Disorder with Impairment in Mathematics

- **Dyslexics without MD do not tend to have trouble with:**
  - **Basic computational problems**
  - **Fundamental conceptual problems with math comprehension**
  - **No secondary right hemisphere deficit of spatial cognition**

Pennington, B. (1991). Diagnosing Learning Disorders: A Neuropsychological Framework. New York, NY: Guilford.

Dyslexia and Specific Learning Disorder with Impairment in Mathematics

"Too frequently and too readily, individuals with dyslexia who have difficulty with mathematics are misdiagnosed as having dyscalculia-literally trouble with calculating, a neurologically based disability. True dyscalculia is rare…We know that for individuals with dyslexia, learning mathematical concepts and vocabulary and the ability to use mathematical symbols can be impeded by problems similar to those that interfered with their acquisition of written language." (p. 14)

Tomey, H.A. (Fall, 1998). Mathematics and Dyslexia. Perspectives, 24 (4), pp. 14-15.

Specific Learning Disorder with Impairment in Mathematics

"It is proposed that weak phonological processing abilities underlie the learning difficulties of MD/RD children, and that weak number sense is a causal factor in the math-fact learning of MD only and some MD/RD children." (p. 81)

Robinson, C.S., Menchetti, B.M., and Torgesen, J.K. (2002). Toward a Two-Factor Theory of One Type of Mathematics Disabilities. Learning Disabilities Research & Practice, 17(2). 81-89.

Specific Learning Disorder with Impairment in Mathematics

- **Those with Combined Type AD/HD have significant difficulty with mathematical calculation and applied math.**
- **Those with Inattentive AD/HD (Sluggish Cognitive Tempo) have pervasive problems with mathematical calculations in particular.**
- **The Combined Type AD/HD tend to have problems with verbal sequences and mental calculations.**

Marshall, R.M., Schafer, V.A., O'Donnell, l., Elliot, J. and Handwerk, M.L. (1999).Arithmetic Disabilities and ADD Subtypes: Implications for DSM-IV. Journal of Learning Disabilities, 32 (3), pp. 239-247.)

Barkley, R.A. (February 18-20, 2002). ADHD and Oppositional Defiant Children. Seminar presented in Phoenix, AZ The Institute for Continuing Education, P.O. Box 1269, Fairhope, AL 33633.

Specific Learning Disorder with Impairment in Mathematics

Rourke stated that deficits in math calculation and reasoning are highly related to weaknesses in visual-perceptual and visual-spatial reasoning. He indicated this could be related to Nonverbal Learning Disorders (NVLD) (Social Communication Disorder – DSM-5, sic).

Rourke, B.P. (1985). Neuropsychology of Learning Disabilities: Essentials of Subtype Analysis. New York, NY: Guilford.

Specific Learning Disorder with Impairment in Mathematics

Today as students advance in grades they are expected to be able to use and understand the vocabulary of mathematics more and more. Many students have difficulty with math vocabulary; especially those with Specific Learning Disorders.

Woodward, J.P. (Spring, 2008). Theme Editor's Summary - Dialogue is Important: Language in Mathematics Classrooms. Perspectives, 24 (2), p. 9-10.

Not all Students Who get the Correct Answer but Cannot Show Their Work Are Cheating

- **Some synaesthetes (60%) calculate by seeing numbers in space around them often in a number line.**
- **The correct answer just appears to them; they cannot explain why, or how it does. It just does.**
- **They are not cheating. Test and proctor them by themselves.**

Author (June, 2008). Derek Tastes of Earwax. BBC-Home. Science and Nature Follow-up: http://www.bbc.co.uk/sn/tvradio/programmes/horizon/derek_qa.shtml

Specific Learning Disorder with Impairment in Mathematics

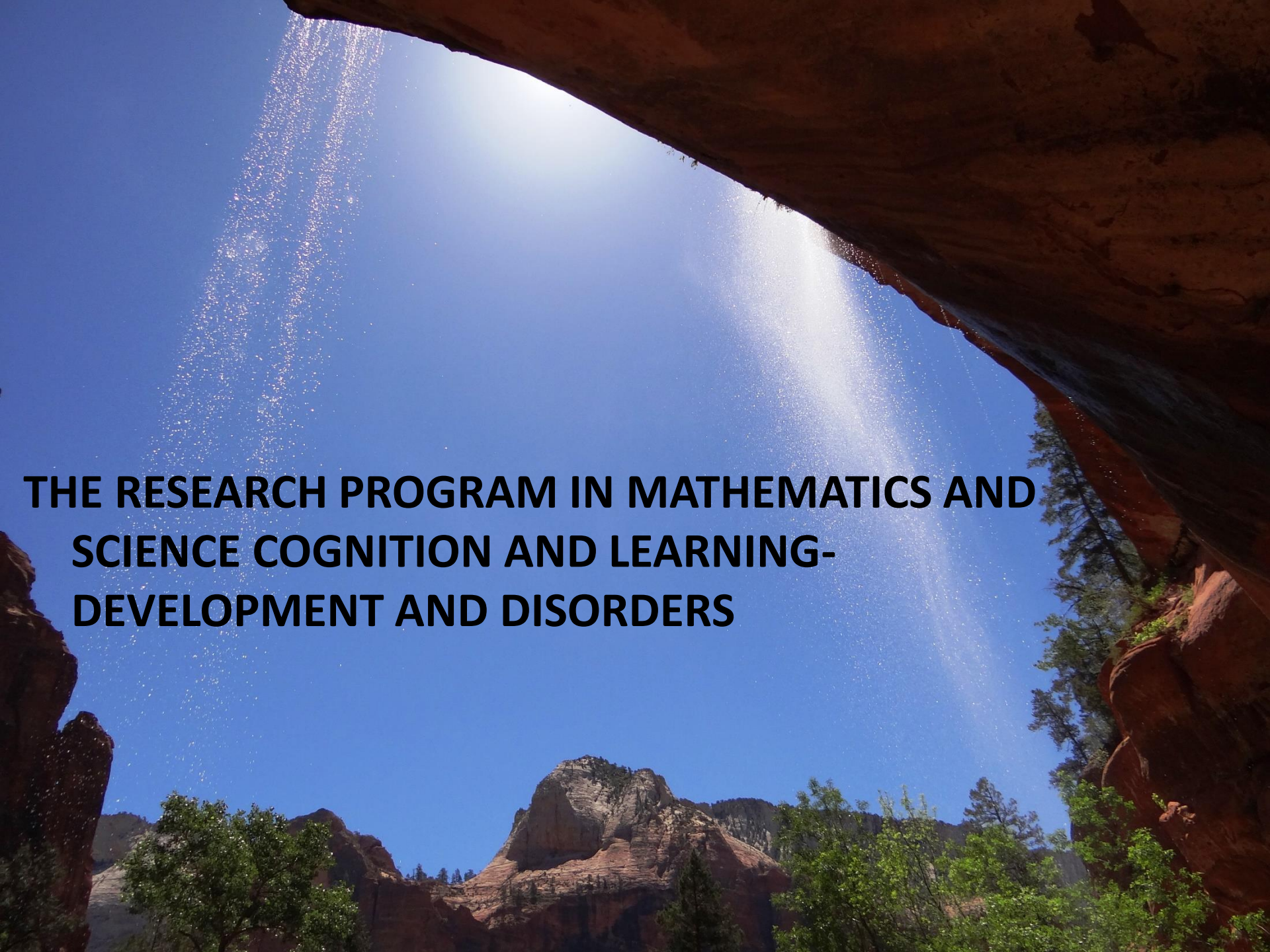
"It is suggested that assessment move away from a system that seeks only correct responses and move toward a system that seeks information concerning student ability to communicate mathematics principles, reason, prove and explain mathematics, and demonstrate connections between mathematics and other subjects." (p. 47)

Cawley, J.F., and Foley, T.E. (2001). Enhancing the Quality of Mathematics for Students with Learning Disabilities: Illustrations from Subtraction. Learning Disabilities, 11 (2), pp. 47-59.

AD/HD & Math Difficulties

"In fact, a comprehensive study found that attention was the most robust factor affecting first graders math performance" (p. 121).

Krasa, N. , et al. (2009). Number Sense and Number Nonsense: Understanding the Challenges of Learning Math. Baltimore, MD: Brookes.



THE RESEARCH PROGRAM IN MATHEMATICS AND SCIENCE COGNITION AND LEARNING- DEVELOPMENT AND DISORDERS

Mathematics and Science Cognition and Learning: Development and Disorders (MSCL) Program

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Your Tax Dollars At Work

- Study the biology and genetics of math learning
- Longitudinal study of number estimation
- Study Subtypes of Specific Learning Disorder with Impairment in Mathematics
- Study normative development of math abilities
- Study Classroom interventions for those with AD/HD, Reading Disorder, Turner Syndrome, Fragile X, Williams Syndrome and Specific Learning Disorder with Impairment in Mathematics

Lyon, G.R. (March 25, 2004). United States Department of Health and Human Services. Testimony on Headstart before the Subcommittee on Labor, HHS, & Education and Related Agencies. Committee on Appropriations, U.S. House of Representatives: www.hhs.gov/asl/testify/t040325.html .

THE RESEARCH PROGRAM IN MATHEMATICS AND SCIENCE COGNITION AND LEARNING- DEVELOPMENT AND DISORDERS

Research into etiology, classification, diagnosis, prevention, treatment, genetics, longitudinal aspects and comorbidity of Specific Learning Disorder with Impairment in Mathematics
www.nichd.nih.gov/CRMC/cdb/math.htm#interest

Specific Learning Disorder with Impairment in Mathematics : Prevalence

- **3 to 5% have Specific Learning Disorder with Impairment in Mathematics**
- **There is an equal number of males and females who have it.**
- **¼ of those with Dyslexia and ¼ with AD/HD have Specific Learning Disorder with Impairment in Mathematics.**
- **Those with Reading Disorder-Dyslexia and Specific Learning Disorder with Impairment in Mathematics are the most impaired.**

Shalev, R.S. (October, 2004). Developmental Dyscalculia. Journal of Child Neurology, 19 (10), pp. 765-771.

Specific Learning Disorder with Impairment in Mathematics & Nonverbal Learning Disabilities (Social Communication Disorder)

- **Most people who do not have Reading Disorder-Dyslexia but have Mathematics Disorder have symptoms similar to NVLD.**
- **NVLD is not the same as Mathematics Disorder.**
- **Those with Reading Disorder-Dyslexia represent the majority of those who have problems with arithmetic, but they usually do not meet criterion for Mathematics Disorder.**
- **Approximately 65% of those 9 to 15 years old with NVLD will have Mathematics Disorder.**

Rourke, B.P. (2006). Question # 8: "Is "specific arithmetic disability" (SAD) the same as NLD? Do all persons with NLD exhibit SAD? From Website: www.nld-bprourke.ca/BPR8.html .

Number Sense

"Much of math ability is learned, but it's quite possible that an inborn factor influences both the understanding of quantities as well as makes learning math easier for some people. This study doesn't imply or prove that math abilities aren't learned," Mazzocco said.

Author (June 17, 2011). Difficulty Estimating Quantity Linked to Math Learning Disability. National Institute of Health News. From website: http://www.nichd.nih.gov/news/releases/061711-math-disabilities-test.cfm

Math Learning Disorder=Problems With "Number Sense"

"Many children have significant mathematical learning disabilities (MLD, or dyscalculia) despite adequate schooling. We hypothesize that MLD partly results from a deficiency in the Approximate Number System (ANS) that supports nonverbal numerical representations across species and throughout development. Here we show that ninth grade students with MLD have significantly poorer ANS precision than students in all other mathematics achievement groups (low-, typical-, and high-achieving), as measured by psychophysical assessments of ANS acuity (*w) and of the mappings between ANS representations and number words (covar). This relationship persists even when controlling for domain-general abilities. Furthermore, this ANS precision does not differentiate low- from typical-achieving students, suggesting an ANS deficit".*

Mazzocco, M.M., Feigenson, L. and Halberda, J (In Press) Impaired acuity of the approximate number system underlies mathematical learning disability. Child Development. From website: http://www.psy.jhu.edu/~halberda/publications/MLD_ANS_final.pdf

Specific Learning Disorder with Impairment in Mathematics =Problems With "Number Sense"

Michèle Mazzocco, Ph.D., whose research was funded by the NIH's NICHD found that children with Specific Learning Disorder with Impairment in Mathematics /dyscalculia had the worst number estimation scores. About 10% of children have persistent problems with math. Poor number sense appear to be the core difficulty of those with dyscalculia, but not those who are low math achievers as a whole.

Author (June 17, 2011). Difficulty Estimating Quantity Linked to Math Learning Disability. National Instute of Health News. From website: http://www.nichd.nih.gov/news/releases/061711-math-disabilities-test.cfm

National Mathematics Advisory Panel Final Report: March 13, 2008

National Mathematics Advisory Panel Final Report: March 13, 2008

"This report represents the first comprehensive analysis of math education to be based on sound science…The National Math Advisory Panel's findings and recommendations make very clear what must be done to help our children succeed in math. We must teach number and math concepts early, we must help our students believe they can improve their math skills and we must insure…"

National Mathematics Advisory Panel Final Report: March 13, 2008

…they fully comprehend algebra concepts by the time they graduate high school. The Panel's work will benefit generations of American students" (Margaret Spellings, U.S. Secretary of Education, March 13, 2008).

Spellings, M. (March 13, 2008). U.S. Secretary of Education Margaret Spellings Highlights Findings of the National Mathematics Advisory Panel (Press Release). From: http://www.ed.gov/news/pressrelease/2008/03/03132008.html

National Mathematics Advisory Panel Final Report: March 13, 2008

- **Testimony of over 200 scientists**
- **Over 150 organizations involved**
- **Reviewed over 16,000 research studies**

Spellings, M. (March 13, 2008). U.S. Secretary of Education Margaret Spellings Highlights Findings of the National Mathematics Advisory Panel (Press Release). From: http://www.ed.gov/news/pressrelease/2008/03/03132008.html

National Mathematics Advisory Panel Final Report: March 13, 2008

- **Needs of Math Students:**
  - **Rapid recall of arithmetic facts in elementary school**
  - **Mastering fractions in middle school**
  - **Rigorous algebra instruction in high school**
  - **The algebra instruction is most important to insure good college and career success.**

Spellings, M. (March 13, 2008). U.S. Secretary of Education Margaret Spellings Highlights Findings of the National Mathematics Advisory Panel (Press Release). From: http://www.ed.gov/news/pressrelease/2008/03/03132008.html

National Mathematics Advisory Panel Final Report: March 13, 2008

"There is not a sufficient number of studies with children of various ages and grades to draw strong conclusions about schooling and mathematical development, but the research that has been conducted thus far suggests a similar pattern, that is, decreased involvement of the prefrontal/working memory regions and increased involvement of the angular gyrus with increasing grade level and mathematical experience".

Author (March 8, 2008). DRAFT Task Group Reports of the National Mathematics Advisory Panel: Report of the Task Group on Learning Processes. From: http://www.ed.gov/about/bdscomm/list/mathpanel/report/learning-processes.pdf

National Mathematics Advisory Panel Final Report: March 13, 2008

- **Between 5 to 10 percent of students will be identified as having a Specific Learning Disorder with Impairment in Mathematics before finishing high school.**
- **Most of the research on Specific Learning Disorder with Impairment in Mathematics has been conducted with elementary aged children.**

Author (March 13, 2008). DRAFT Task Group Reports of the National Mathematics Advisory Panel: Report of the Task Group on Instructional Practices. From: http://www.ed.gov/about/bdscomm/list/mathpanel/report/ip.pdf

National Mathematics Advisory Panel Final Report: March 13, 2008

- **Several "chronic" Specific Learning Disorder with Impairment in Mathematics :**
  - **Inefficient retrieval of math facts**
  - **Inefficient counting strategies (i.e., do not use "counting-on strategies")**
  - **Limited Working Memory Problems**
  - **Problems with Number Sense**
    - **Can't quickly visualize number lines for magnitude comparison and transforming word problems into equations**

Author (March 13, 2008). DRAFT Task Group Reports of the National Mathematics Advisory Panel: Report of the Task Group on Instructional Practices. From: http://www.ed.gov/about/bdscomm/list/mathpanel/report/ip.pdf

National Mathematics Advisory Panel Final Report: March 13, 2008

- **Contributions to Low Math Achievement:**
  - **Deficient math instruction**
  - **Limited informal math teaching in the home**
  - **Problems with sustained mental effort (i.e., AD/HD, etc.)**
  - **Weak motivation**

Author (March 13, 2008). DRAFT Task Group Reports of the National Mathematics Advisory Panel: Report of the Task Group on Instructional Practices. From: http://www.ed.gov/about/bdscomm/list/mathpanel/report/ip.pdf

National Mathematics Advisory Panel Final Report: March 13, 2008

- **Explicit Instruction for Specific Learning Disorder with Impairment in Mathematics:**

  "Explicit instruction involves step-by-step plans for solving a problem. The teacher demonstrates a specific plan for a set of problems (as opposed to a general problem-solving heuristic strategy) and students are asked to use the same procedures/steps demonstrated by the teacher to solve the problem." (p. 4-69)

Author (March 13, 2008). DRAFT Task Group Reports of the National Mathematics Advisory Panel: Report of the Task Group on Instructional Practices. From: http://www.ed.gov/about/bdscomm/list/mathpanel/report/ip.pdf

National Mathematics Advisory Panel Final Report: March 13, 2008

"Generally, clear consistent modeling of step-by-step strategies through teacher explanation, modeling and demonstration; planful sequencing of teaching and practice examples; and specified procedures for providing corrective feedback characterize explicit systematic instruction…In addition, this set of studies also demonstrates how explicit instruction has evolved over time to incorporate more innovative instructional features that support and encourage interaction, flexibility, and generalization." (p. 4-73)

Author (March 13, 2008). DRAFT Task Group Reports of the National Mathematics Advisory Panel: Report of the Task Group on Instructional Practices. From: http://www.ed.gov/about/bdscomm/list/mathpanel/report/ip.pdf

National Mathematics Advisory Panel Final Report: March 13, 2008

- **Classroom strategies to help those with Specific Learning Disorder with Impairment in Mathematics :**
  - **Concrete and visual representations**
  - **Explanations by teachers**
  - **Problem solving aloud; individually and as a group**
  - **Student group work**
  - **Carefully orchestrated practice and feedback**
  - **High but reasonable expectations**

Author (March 13, 2008). DRAFT Task Group Reports of the National Mathematics Advisory Panel: Report of the Task Group on Instructional Practices. From: http://www.ed.gov/about/bdscomm/list/mathpanel/report/ip.pdf

National Mathematics Advisory Panel Final Report: March 13, 2008

Educational Benchmarks:

- **By the end of 5th Grade:**
  - **Multiplication and division of whole numbers**
  - **Comparing fractions, decimals and common-percent plus: addition and subtraction of same**
  - **Solve problems related to perimeter and area of triangles and quadrilaterals having at least one pair of parallel sides**

Author (March 13, 2008). National Mathematics Advisory Panel: Final Report. From: http://www.ed.gov/about/bdscomm/list/mathpanel/report/final-report.pdf

National Mathematics Advisory Panel Final Report: March 13, 2008

- **Benchmarks by the end of 6th Grade:**
  - **Multiplication of fractions and decimals**
  - **All operations with positive and negative integers**
  - **Analyze properties of two-dimensional shapes and solve problems of perimeter and area**
  - **Analyze properties of three-dimensional shapes and solve problems of surface area and volume**

Author (March 13, 2008). National Mathematics Advisory Panel: Final Report. From: http://www.ed.gov/about/bdscomm/list/mathpanel/report/final-report.pdf

National Mathematics Advisory Panel Final Report: March 13, 2008

- **Benchmarks by the end of 7th Grade:**
  - **All operations of positive and negative fractions**
  - **Solve problems involving percent, ratio, and rate and extend this work to proportionality**
  - **Familiarity with the relationship between similar triangles and the concept of the slope of a line**

Author (March 13, 2008). National Mathematics Advisory Panel: Final Report. From: http://www.ed.gov/about/bdscomm/list/mathpanel/report/final-report.pdf

Treating Specific Learning Disorder with Impairment in Mathematics

Treating Math Problems in Those with AD/HD

"Evidence from this review further suggests emphasizing concept development and problem solving. That is, students with ADHD may perform better on applied problems than on fact retrieval, indicating that difficulties with computation do not preclude math problem solving. Even so, accommodations can be made available for tasks involving math fact fluency (e.g., using color, background nonvocal music, computer games) to enhance the effective stimulation or arousal needed for sustained attention…"

Treating Math Problems in Those with AD/HD

"…Psychostimulant medication can also improve math fact performance of students with ADHD, but it does not improve higher level skills such as concept development or the comprehension of math, reading, or language tasks"…However, placing color strategically on relevant dimensions could be used to direct attention, decrease working memory requirements, and improve multiple-step problem performance. Finally, interventions for problem solving in a meaningful peer context could reduce a widening achievement gap; students with ADHD need less emphasis on memorizing and convergent solutions and more emphasis on math and its communicative and persuasive possibilities" (p. 236).

Zentall, S. (2007). Math Performance of Students with ADHD: Cognitive and Behavioral Interventions. In D.B. Berch and M.M.M. Mazzocco (Eds.), Why is Math So Hard for some Children? The Nature and origin of Mathematics Learning Difficulties and Disabilities. Baltimore, MD: Brookes.

Habilitation

Khan Academy: **"Practice math at your own pace with our adaptive assessment environment. You can start at 1 + 1 and work your way into calculus or jump right into whatever topic needs some brushing up. Each problem is randomly generated, so you never run out of practice material. If you need a hint, every single problem can be broken down, step-by-step, with one click. If you need more help, you can always watch a related video."**

https://www.khanacademy.org/about

Specific Learning Disorder with Impairment in Mathematics

- **Habituation:**
  - **Remedial work to help them master process and/or facts they have missed.**
  - **Work to overcome mathematics anxiety (counseling, etc.)**
  - **Teach them specific skills to solve problems.**
  - **Remedial work with math facts**
  - **Multi-sensory teaching**
  - **Use flash cards with math facts**
  - **When teaching math relate it to the 'real world'.**

Specific Learning Disorder with Impairment in Mathematics

- **Use graph paper for calculations.**
- **Teach mnemonics.**
- **Use a pocket sized flip chart or Personal Data Assistant (i.e., smartphone, etc.) with basic math facts and/or procedures needed contained within it.**
- **Teach them to acknowledge their computational strengths and weaknesses and how to work with them.**

Specific Learning Disorder with Impairment in Mathematics

- **Teach them to self-monitor their work.**
- **Have them work with others who may be skilled in math.**
- **Encourage the student to do math orally and have them monitor for errors and questions as they do.**
- **For AD/HD consider medications**

Specific Learning Disorder with Impairment in Mathematics

- **Lerner made the following suggestions for Secondary Students with Mathematics Disorder:**
  - **"Provide many examples**
  - **provide practice in discriminating various problem types.**
  - **provide explicit instruction.**
  - **separate confusing elements." (pp. 504-505)**

Lerner, J. (1997). Learning Disabilities: Theories, Diagnosis, and Teaching Strategies (Seventh Edition). New York, NY: Houghton Mifflin.

Math Accommodations

- **Chisanbop Korean Finger Math, etc.**

  http://www.cs.iupui.edu/~aharris/chis/chis.html
  http://scienceblogs.com/goodmath/2006/10/no_abacus_handy_use_your_hands.php

- **Technological Accommodation:**
  - **Talking Calculator – May need study a carol/headphones to prevent distracting others while using it.**

  http://www.lssproducts.com/category/talking-calculators

- **Abacus**
- **Slide Rule**

Possible Working Memory Treatment

www.cogmed.com

- **Working Memory Training:**
  - **Torkel Klingberg, M.D., Ph.D.**
  - **Karolinska Institute- Stockholm, Sweden**
  - **CogMed software company**
  - **AD/HD deficient in visual spatial working memory. Gets worse with age.**
  - ***MAY* help relieve executive functioning difficulties in Combined Type AD/HD.**
  - ***More Research is needed!***

Klingberg, T. (February, 2006). Training Working Memory. AD/HD Report, 14 (1), pp. 6-8.

Barkley, R. (February, 2006). Editorial Commentary Issues in Working Memory Training in ADHD. ADHD Report, 14 (1), pp. 9-11.

Ingersoll, B. (October 26, 2006). Complementary Treatments for AD/HD. Paper Presented at the 18th Annual CHADD International Conference, Chicago, IL.

Literature Review of Working Memory Training

"The literature review highlights several findings that warrant further research but ultimately concludes that there is a need to directly demonstrate that WM capacity increases in response to training. Specifically, we argue that transfer of training to WM must be demonstrated using a wider variety of tasks, thus eliminating the possibility that results can be explained by task specific learning. Additionally, we express concern that many of the most promising results (e.g., increased intelligence) cannot be readily attributed to changes in WM capacity. Thus, a critical goal for future research is to uncover the mechanisms that lead to transfer of training."

Shipstead, Z., Redick, T.S. and Randall, W.E. (2012). Is Working Memory Training Effective? Psychological Bulletin, DOI: 10.1037/a0027473.

Math Computer Training Programs

"For distractible children, computer fact drill can be effective, particularly when it includes immediate feedback, rewards, and occasional competition…" (p. 136).

Krasa, N. , et al. (2009). Number Sense and Number Nonsense: Understanding the Challenges of Learning Math. Baltimore, MD: Brookes.

Spatial-Temporal (ST)-Math: Mind Institute

"What is Spatial-Temporal Reasoning? Born out of neuroscience research at the University of California, Irvine, MIND's unique approach accesses the brain's innate "spatial-temporal" reasoning ability. This ability, which lies at the core of innovative thinking and sophisticated problem-solving, allows the brain to hold visual, mental representations in short-term memory and to evolve them in both space and time, thinking multiple steps ahead. MIND's approach consists of language-independent, animated representations of math concepts delivered via the Spatial-Temporal (ST) Math® software games…"

Reference

Author (No Date). Reimagining Math Education. Mind Research Institute. From website: http://www.mindresearch.net/programs/

What Can I Do In The Classroom With Combined Type AD/HD Kids With Math Problems?

- **They benefit less from practice, hence they are not as fluent.**
- **They need more novelty in the classroom.**
- **Touch Math (Multisensory Math) – Example: www.MakingMathReal.org; etc.**
- **Teach how to use an abacus/finger math.**
- **Use competition in the classroom.**
- **Allow them to think aloud. Remember they are delayed in internalized speech!**

Zentall, S. (2006). Translating Your Student's Attentional and Behavioral Style into Academic and Social Success. Paper presented at the 18th Annual CHADD International Conference, Chicago, IL, October 25-28, 2006.

What Can I Do In The Classroom With Combined Type AD/HD Kids With Math Problems? (Continued)

- **Don't waste time mastering basic skills since they do not tend to generalize:**
  - **They have a problem with fluency.**
  - **They have sequential memory problems.**
- **Focus on their problem solving in math.**
- **The higher level skills are the most important for them to learn.**
- **Use graph paper for written problems.**
- **Use calculators.**
- **Play music without lyrics.**

Zentall, S. (2006). Translating Your Student's Attentional and Behavioral Style into Academic and Social Success. Paper presented at the 18th Annual CHADD International Conference, Chicago, IL, October 25-28, 2006.

Specific Learning Disorder with Impairment in Mathematics

Broody and Ginsberg wrote of messages students with Mathematics Disorders hold. They are as follows:

- **"Only geniuses can understand mathematics. Just do as you are told. You are not really smart enough to understand it."**
- **Mathematics is a bunch of facts and procedures. Normal children memorize it quickly. You're dumb if you can't."**

Specific Learning Disorder with Impairment in Mathematics

- **In mathematics, there is one correct method for doing things. Good children can follow directions. You're bad if you use an unacceptable procedure like counting." (p. 193)**

Broody, A.J., and Ginsburg, H.P. (1991). A Cognitive Approach to Assessing the Mathematical Difficulties in Children Labeled "Learning Disabled". In H.L. Seanson (Ed.), Handbook on the Assessment of Learning Disabilities: Theory, Research and Practice. Austin, TX: ProEd. pp. 177-227.

"Solve It" Word Problem Solving Routine

1. Read for understanding
2. Paraphrasing or putting the problem into one's own words
3. Visualizing by drawing a schematic representation that shows the relationships among the problem parts
4. Hypothesizing or setting up a plan

"Solve It" Word Problem Solving Routine

5. **Estimating or predicting the answer**
6. **Computing or doing the arithmetic**
7. **Checking to make sure the problem was done correctly**

Montague, M., Krawec, J., Sweeney, C. (Spring, 2008). Promoting Self-Talk to Improve Student's Mathematical Problem Solving. Perspectives, 34 (2), p. 15.

How to Solve Word Problems

- **"Solve It": A cognitive routine to solve word problems**
  - **Teacher thinks aloud while demonstrating a mathematical task.**
  - **Student verbalizes thought process while solving problems**
  - **Teacher monitors student's thought process and gives encouragement and corrective feedback.**

Montague, M., Krawec, J., Sweeney, C. (Spring, 2008). Promoting Self-Talk to Improve Student's Mathematical Problem Solving. Perspectives, 34 (2), p. 13-17.

Solving Word Problems

LD students often need, "…intensive interventions that emphasize understanding the language and factual information in the problem, using relevant information to generate an adequate mathematical model or representation, devising and monitoring a solution plan, and executing procedural calculations." (p. 20)

Jitendra, A. (Spring, 2008). Using Schema-Based Instruction to Make Appropriate Sense of Word Problems. Perspectives, 34 (2), p. 20-24.

Solving Word Problems

"Despite plenty of practice, student with LD continue to encounter difficulties solving word problems when they have learned the keyword approach. The keyword approach focuses on the solution strategy; hence, it requires less effort (of the teacher) than modeling or representing the problem situation." (p. 20)

Jitendra, A. (Spring, 2008). Using Schema-Based Instruction to Make Appropriate Sense of Word Problems. Perspectives, 34 (2), p. 20-24.

Solving Word Problems

"Schema-based instruction addresses the weakness of the keyword and the general heuristic approaches by using a conceptual teaching approach that integrates mathematical problem solving and reading comprehension." (p. 20)

Jitendra, A. (Spring, 2008). Using Schema-Based Instruction to Make Appropriate Sense of Word Problems. Perspectives, 34 (2), p. 20-24.

Schema Based Problem Solving

Jose and his father gathered 10 pounds of wool from a sheep. So far some of the wool has been used to make a sweater. Now there are 5 pounds of wool left. How many pounds of wool have been used?

Jitendra, A. (Spring, 2008). Using Schema-Based Instruction to Make Appropriate Sense of Word Problems. Perspectives, 34 (2), p. 20-24.

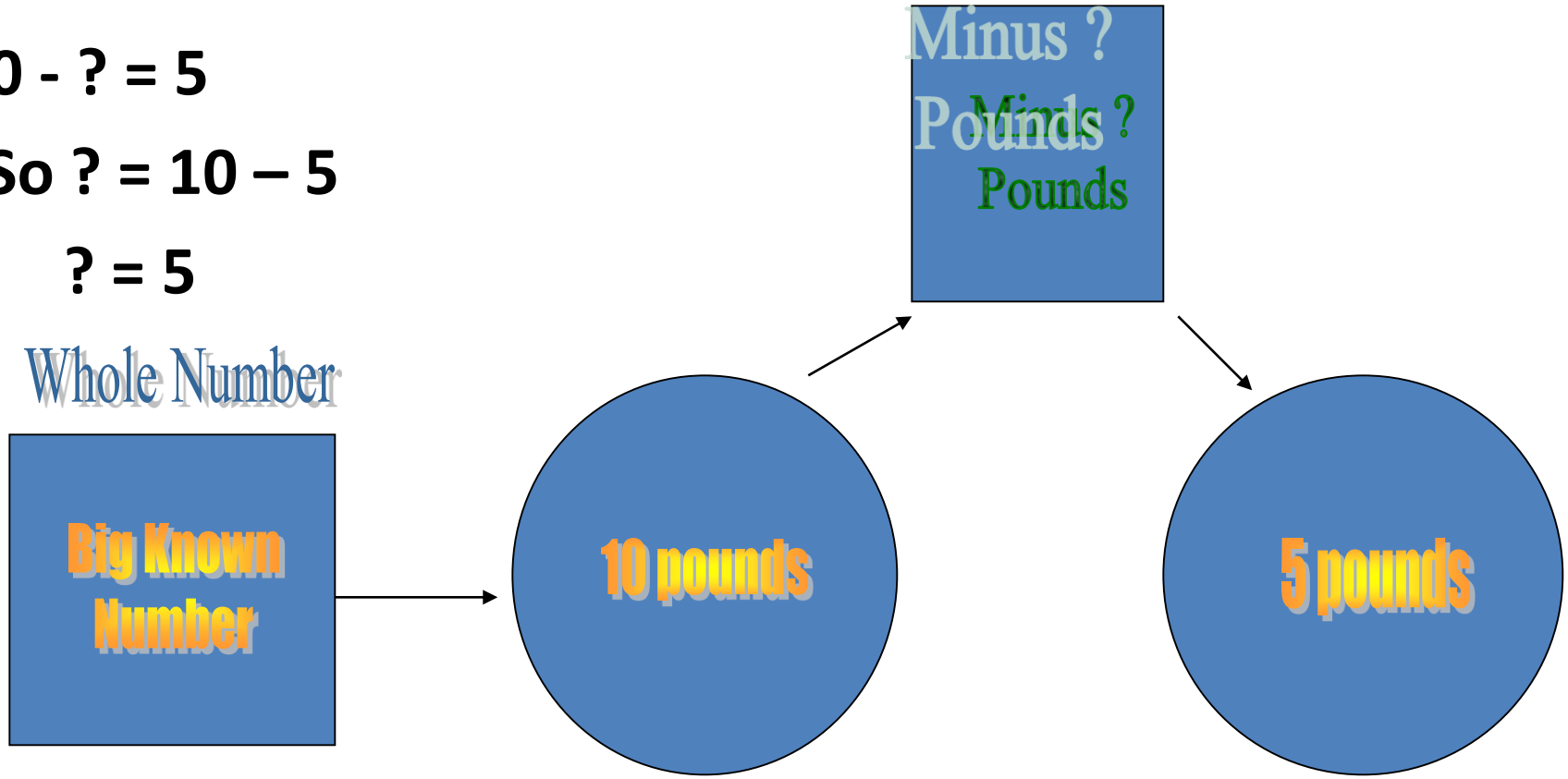
Schema Based Problem Solving

Jitendra, A. (Spring, 2008). Using Schema-Based Instruction to Make Appropriate Sense of Word Problems. Perspectives, 34 (2), p. 21.

10 - ? = 5

So ? = 10 – 5

? = 5



Solving Word Problems

"Problem compensation involves modeling or representing the problem situation, which requires going beyond direct translation of the problem text from words to equations (e.g., the keyword *altogether* is translated into addition) to understanding the mathematical problem structure. Understanding is evident when semantic cues (e.g., both red pens and blue pens are subsets, and all pens are supersets)." (p. 21)

Jitendra, A. (Spring, 2008). Using Schema-Based Instruction to Make Appropriate Sense of Word Problems. Perspectives, 34 (2), p. 20-24.

Solving Word Problems

"Instruction is appropriately scaffolded so that a) teacher-mediated instruction is followed by paired partner learning and independent learning activities, b) tasks begin with story situations followed by word problems with unknown information, and c) visual diagrams and checklists are initially provided to support learning and are gradually removed or replaced by student constructed diagrams." (p. 21)

Jitendra, A. (Spring, 2008). Using Schema-Based Instruction to Make Appropriate Sense of Word Problems. Perspectives, 34 (2), p. 20-24.

Solving Word Problems

- ***FOPS***
  - **F: Find the type of problem**
  - **O: Organize the information using problem diagram**
  - **P: Plan to solve problem**
  - **S: Solve problem**

Jitendra, A. (Spring, 2008). Using Schema-Based Instruction to Make Appropriate Sense of Word Problems. Perspectives, 34 (2), p. 20-24.

Student-Teacher Math Diaries

- **Have the students write a daily math diary of questions and comments about class, assignments, etc.**
- **This encourages "non-talkers in class" to interact with the teacher, so he/she can better monitor their progress.**

Baxter, J.A. (Spring, 2008). Writing in Mathematics: Alternative Form of Discourse for Academically Low-Achieving Students. Perspectives, 34 (2), p. 37-40.

Specific Learning Disorder with Impairment in Mathematics

- **General Accommodations for College:**
  - **Allow calculator use in class.**
  - **Provide tutoring**
  - **Academic advisement with disability in mind**
  - **Multi-sensory teaching of math**
  - **Course substitution**
  - **Kerper added that students with MD should be allowed to take tests alone with professors to ask questions.**

Kerper, C. (2002). Students with Dyscalculia May Need Additional Math Coaching. Disability Compliance for Higher Education. 7 (8), p. 7.

Specific Learning Disorder with Impairment in Mathematics

- **A Good Resource On Mathematics Disorder Is:**
  - **Marolda, M.R. (Summer, 2000). Challenger in Learning & Teaching Mathematics. Perspectives, 26 (3), entire issue. Available from: International Dyslexia Association, 8600 LaSalle Road, Chester Bldg., Suite 383, Baltimore, MD 21286-2044; 410-296-0232.**