

Math LDs and NVLD

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Overview

- Introduction
- What are Math LDs and NVLD
- Anticipated Functional Impairments in PSE
- Reasonable Accommodations
- Case study
- Discussion/Questions



Regional Assessment Resource Centre (RARC)

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Our vision is to enable students with neurodevelopmental disabilities to thrive in post-secondary education.

Services provided under 4 pillars:



Transition



Research



Training



Assessment

Learning Disabilities (LDs)

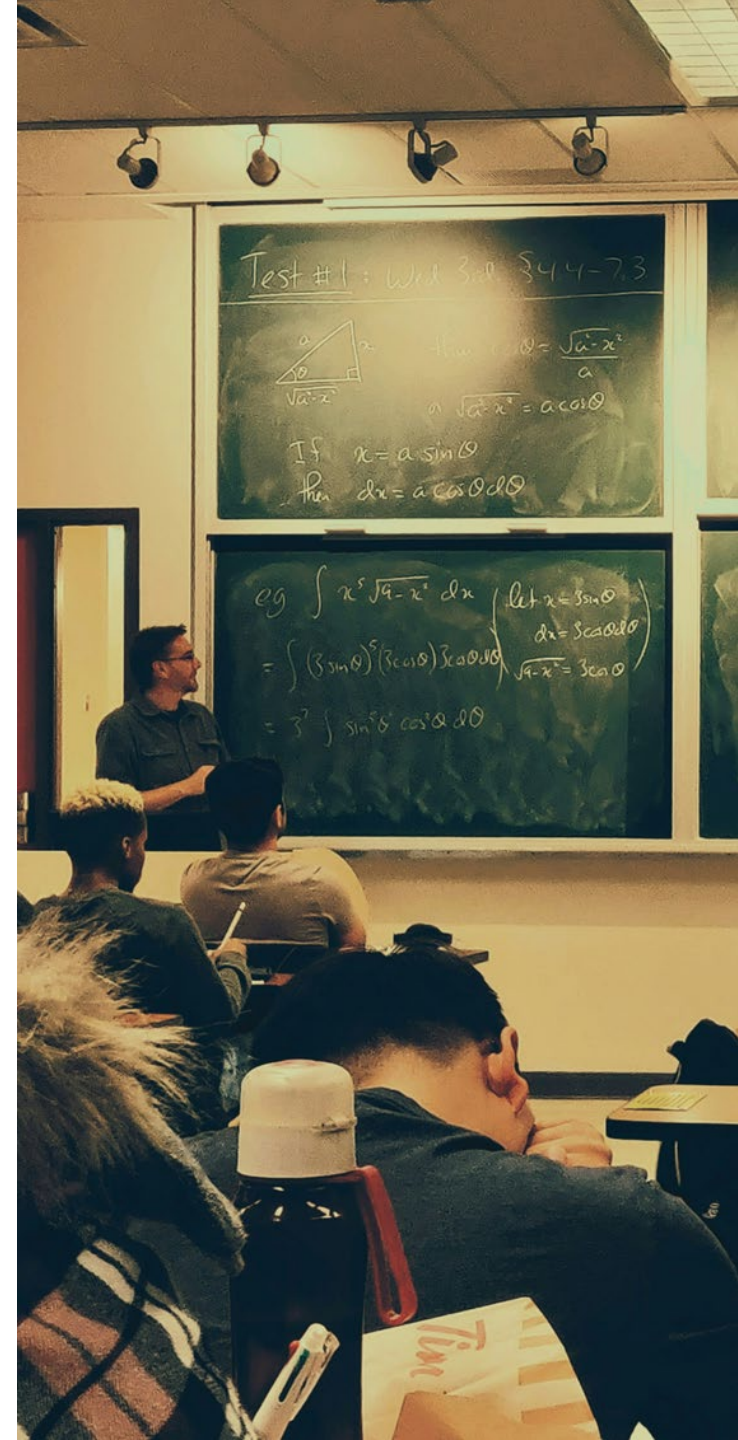
The Learning Disabilities Association criteria look for the following:

- 🔗 At least Average thinking/reasoning abilities
- 🔗 History of academic achievement issues
- 🔗 Below Average academic achievement in one or more areas (i.e., reading, writing, math)
- 🔗 Difficulties in reading, writing, or math are logically connected to deficits in cognitive processes
- 🔗 The difficulties are not primarily explained by other factors (e.g., other disorders, insufficient effort, poor instruction, linguistic diversity)

Table 1. Summary of the key differences in diagnostic criteria for specific learning disorder in mathematics (DSM-5) and mathematics disorder (DSM-IV).

	Mathematics disorder (DSM-IV)	Specific learning disorder in mathematics (DSM-5)
Relation between mathematics performance, age and IQ	Mathematics achievement is significantly below that expected for age, schooling and level of intelligence (a discrepancy of more than 2 SD between maths and IQ is expected, although sometimes a discrepancy of between 1 and 2 SDs is used)	Mathematics performance is at least 1.5 SDs below the population mean (i.e., a standard score of 78 or less), in the presence of normal levels of intellectual functioning (IQ score of at least 70 ± 5)
Persistence of difficulties	Not mentioned explicitly	Persistent difficulties in learning key academic skills (at least for 6 months), despite interventions that target those difficulties
Clinical synthesis	Not mentioned explicitly, although it is expected that the problems exist in the presence of normal schooling; in the case of co-occurring difficulties, the problems with mathematics exceed the level normally associated with the co-occurring condition	No single data source is sufficient for a diagnosis; a synthesis of the individual's medical, developmental, educational and family history is necessary; problems with mathematics should exceed the level normally associated with co-occurring conditions
Estimated prevalence	1% for mathematics disorder (for learning disorders in general the estimated prevalence rate is 2–10% with a point estimate of 5%)	Not specifically stated; between 5 and 15% including specific difficulties in reading, written expression and mathematics (prevalence in adults is approximately 4%)
Gender differences	Not mentioned in the case of mathematics disorder	Specific learning disorders are more common in males (ratios range from about 2:1 to 3:1)

- Arithmetic skills are important for children to master early in elementary school for later school and life success; however, for children with Math LDs (otherwise known as Developmental Dyscalculia (DD), learning simple arithmetic is laborious and problematic.
- Children with Math LDs have severe difficulties executing calculation procedures, often relying on immature strategies when they cannot solidify arithmetic facts in long-term memory.
- The underlying cognitive and neural manifestations leading to poor arithmetic performance in children with Math LDs are not well understood.
- Furthermore, gaps in our knowledge about the core deficits and characteristics of children with Math LDs have led to inconsistencies in defining and identifying children with this condition.



Signs of a Learning Disability ... Mathematics

Mathematics	Example
Fluency	rapid recall of basic math facts from memory
Calculation	working out numerical calculations
Applied Problem Solving	applying basic math skills to solve real-world oriented problems

Signs of Difficulty or Possible LD in mathematics:

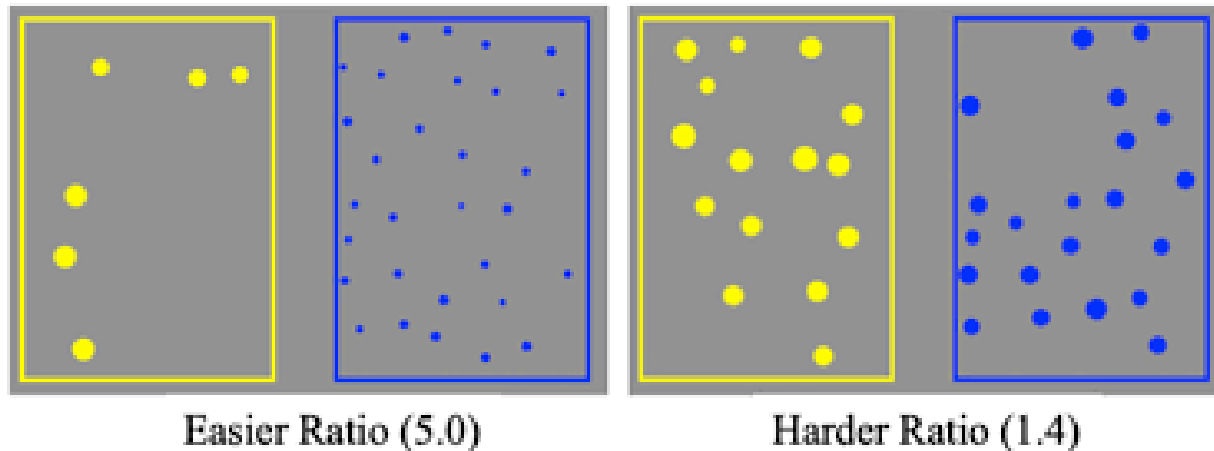
- Lose track when counting
- Use fingers as aids for simple calculations
- Struggle to estimate number of items in a group
- Poor sense of relative size of numbers
- Struggle to understand graphs
- Difficulty counting money or making change
- Forget or mix up steps in math problems
- Poor understanding of fractions
- Avoid math-based activities
- Poor sense of when calculator has produced a wrong answer

What Cognitive Processing Deficits Underlie Math LDs?

- Math LDs are heterogeneous but working memory (WM) is often indicated.
- The **phonological loop** holds intermediate arithmetic results in the form of linguistic information and plays a role in mathematical abilities that involve the articulation of numbers, such as counting, problem-solving, and arithmetic fact retrieval.
- The **visuospatial sketchpad** supports the construction of visual representations of numerical information and is, thus, related to spatial aspects of calculation, such as decomposition strategies.
- The **central executive** coordinates and monitors simultaneous processing and keeps track of math tasks that have already been performed

What Cognitive Processing Deficits Underlie Math LDs?

- More recent research have also indicated:
 - **'Approximate Number System'** (ANS; Piazza, Facoetti, Trussardi, Berteletti, Conte *et al.*, [2010](#); Piazza, [2010](#)), a system responsible for manipulating and discriminating approximate numerical quantities. The ANS is thought to be a phylogenetic precursor to developing exact symbolic representations (e.g. number words and Arabic numerals), which enables children to perform basic arithmetic problems and higher order mathematics (Piazza, [2010](#)). Consequently, deficiencies in the ANS would lead to imprecise symbolic representations and poor arithmetic knowledge.



Nonverbal Learning Disabilities (NVLD) ...a specific type of Math LD

NVLD

- The majority of LDs involve reading or language deficits, often caused by deficits in language-based processes.
- Less commonly occurring are LDs involving nonverbal cognitive processes, such as visual perception, visual-spatial reasoning, visual-motor coordination, and problem-solving involving visual imagery.
- Numerous studies have found that when nonverbal cognitive processes are selectively impaired, the individual often demonstrates an academic profile of better developed reading and spelling than math skills.
- Deficits in social perception, as well as interpersonal skills and emotional adjustment have also been commonly reported.
- This pattern has been referred to as developmental right-hemisphere syndrome, right-hemisphere deficit syndrome, syndrome of nonverbal learning disabilities, and nonverbal learning disorder. Not included in any formal diagnostic framework.

Assets	Deficits
<p>Primary neuropsychological Auditory perception Simple motor Rote material</p> <p>↓</p> <p>Secondary neuropsychological Auditory attention Verbal attention</p> <p>↓</p> <p>Tertiary neuropsychological Auditory memory Verbal memory</p> <p>↓</p> <p>Verbal neuropsychological Phonology Verbal reception Verbal repetition Verbal storage Verbal associations Verbal output</p> <p>↓</p> <p>Academic Graphomotor (later school years) Word decoding Spelling Verbal memory</p> <p>Psychosocial and adaptive None?</p>	<p>Primary neuropsychological Tactile perception Visual perception Complex psychomotor Novel material</p> <p>↓</p> <p>Secondary neuropsychological Tactile attention Visual attention Exploratory behaviour</p> <p>↓</p> <p>Tertiary neuropsychological Tactile memory Visual memory Concept formation Problem solving</p> <p>↓</p> <p>Verbal neuropsychological Oral-motor praxis Prosody Phonology-semantics Content Pragmatics Function</p> <p>↓</p> <p>Academic Graphomotor (early school years) Reading comprehension Mechanical arithmetic Mathematics Science</p> <p>Psychosocial and adaptive Adaptation to novelty Social competence Emotional stability Activity level</p>

Summary of Assets and Deficits Associated with NVLD

Note: Adapted from Rourke (1989).



Functional Assets and Deficits (Casey, 2012)

Functional Assets

1. Visual, auditory, and tactile sensation.
2. Basic motor skills that are acquired through simple repetitive activities.
3. Auditory-linguistic abilities, such as phonological awareness and sound-symbol correspondence.
4. Fundamental listening comprehension and oral expression (basic receptive and expressive language skills), including word knowledge and wealth of general factual information.
5. Auditory attention and rote verbal memory.
6. Near age-appropriate or better word reading and spelling skills, with misspellings that are phonetically accurate (e.g., formilyor instead of familiar).

Functional Deficits

1. The processing of complex tactile information (tactile perception)—usually more marked on the left side (e.g., left hand).
2. Gross and fine motor coordination—When the upper extremities are tested separately, the impairment is usually greater on the left side of the body.
3. Visual-perceptual and visual-spatial reasoning abilities.
4. Nonverbal problem-solving and concept-formation abilities, including problems with using feedback to guide behaviour in novel or otherwise complex situations.
5. Difficulty adapting to novel, complex, or changing situations.
6. The ability to understand the more complex aspects of verbal material, especially that which is abstract or that requires verbal reasoning abilities such as making inferences and understanding cause–effect relationships.
7. An overreliance on basic oral language as a means for relating socially and coping with anxiety.
8. Weak mechanical arithmetic and math reasoning skills in conjunction with better developed word-reading and spelling skills.
9. Weak social skills reflecting difficulties with social perception, social judgment, social withdrawal, and interpersonal relationships.
10. Increased risk for experiencing excessive anxiety and depression.

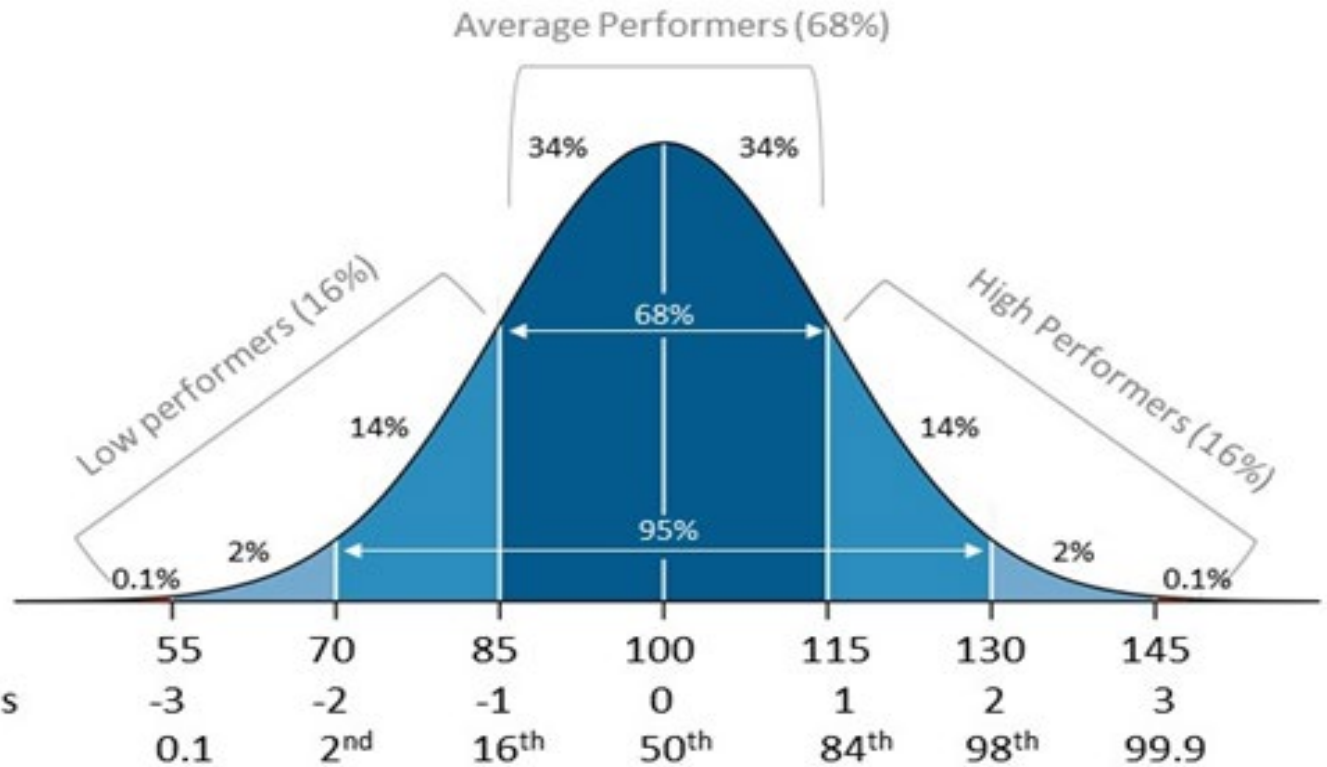


Typical Impacts (Casey & Strang, 1994)

- Individuals with NLD usually come to the attention of professionals because of problems with social skills and the weak arithmetic skills.
- Often, they are described as odd, socially awkward, overly anxious, withdrawn, unkempt, and clumsy.
- Because of their problems with gross motor coordination, they often avoid participating in sports or other physical activities.
- Problems with fasteners, such as buttons, shoelaces, or bread bag ties, are examples of their poor fine motor skills (activity limitations).
- They frequently have difficulty negotiating the premises of buildings, such as a shopping mall or the corridors of buildings, even their own school, a finding consistent with their impairment in visual-spatial perception and reasoning.
- Clinical experience suggests that very few adults with NLD drive a car (restrictions in participation), an impression that awaits empirical verification.



Determining Functional Impairment





Anticipated Functional Impairments

- Difficulty retrieving math facts from memory.
- Difficulty performing mental math calculations.
- Challenges performing numerical calculations by hand.
- Difficulty interpreting visual-spatial diagrams, such as graphs.
- Challenges learning math concepts due to poor conceptual understanding.

Linking functional impairments identified to evidence-based accommodations

Functional Impairment	Reasonable Accommodation
Difficulty efficiently retrieving math facts from memory.	Calculator or extra time
Difficulty performing mental math calculations.	Scratch pad to perform calculations/Calculator
Challenges performing numerical calculations by hand.	Calculator
Difficulty interpreting visual-spatial diagrams, such as graphs.	Learning Strategies support to learn strategies to simplify and talk through visual-spatial stimuli
Challenges learning math concepts due to poor conceptual understanding.	Tutoring/Support from Academic Skills Centre for math coursework. Support breaking math concepts into a series of steps to work through sequentially.

Case Example

- Jim- 26-year-old male who was starting the Carpentry program at a College
- History of delays in fine-motor coordination, visual-spatial orientation, attention, and peer interactions.
- A Psychoeducational Assessment conducted in grade four- High Average to Superior verbal abilities but Borderline performance skills. Academic skills were Borderline/Low Average for math calculation and applied problem solving, and his handwriting was quite poor (affecting the intelligibility of his written output). Diagnosed with “a specific learning disability in the visual perceptual area, with very weak writing skills.”
- Subsequently had accommodations- extra time and computer access.



Case Example

- Struggled in math courses in secondary school but graduated high school.
- Worked as a framer/labourer but struggled substantially in the position, always needing others to check his work. Boss recommended that he pursue further education.
- Issues in his first term of the Carpentry program included:
 - Challenges with handwriting
 - Poor mental math
 - Difficulties understanding figures/designs on slides and in text
 - Issues mentally picturing and reorienting wood to ensure cutting appropriately.

Case Example

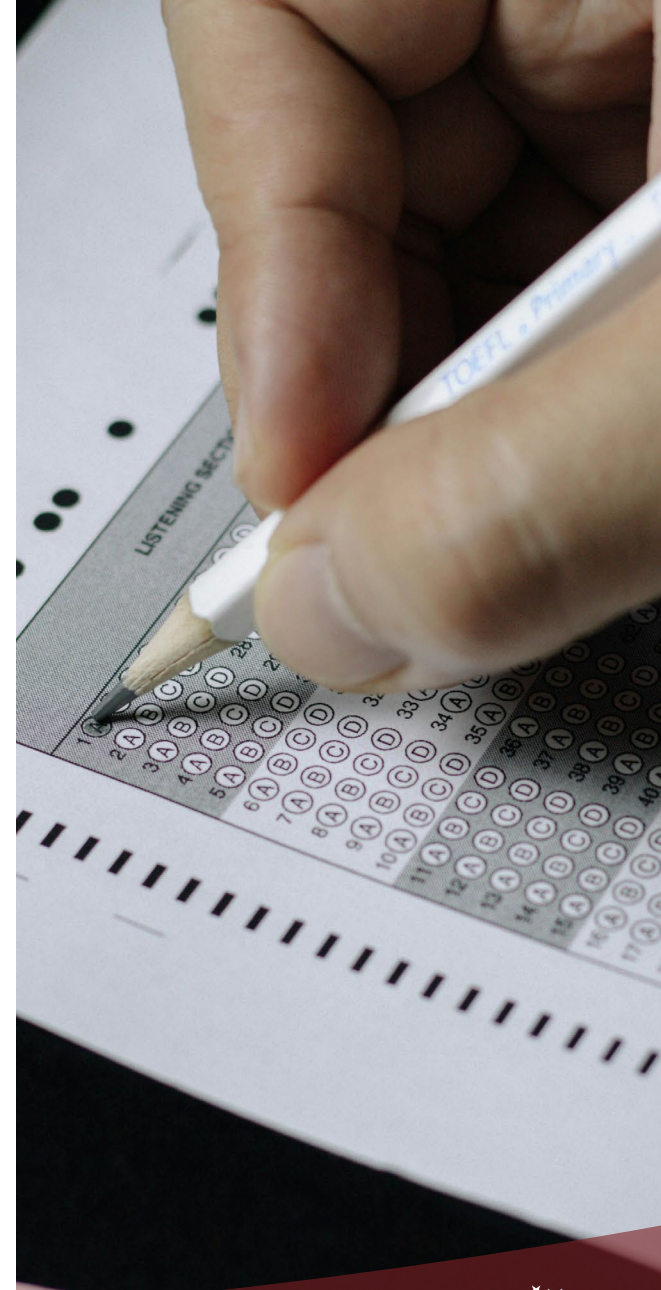
- Passed all measures of performance validity
- WAIS-IV- Overall IQ at 23rd percentile
 - VCI 82nd
 - PRI 12th (Block Design and Visual Puzzles both at 5th)
 - WMI 13th (Arithmetic 9th)
 - PSI 5th
- Beery-Buktenica VMI- 13th percentile
- WMS-IV
 - Verbal Paired Associates (Imm 75th, delayed 84th)
 - Story (Imm 25th, delayed 37th)
 - Visual Reproduction (Imm 9th, delay 5th, rec 5th)
 - Designs (Imm 2nd, delay 5th, rec 2nd)

Case Example

- DKEFS
 - Trails 2 (9th), Trails 3 (9th), Trails 4 (5th)
 - Card Sorting (9th)
 - Tower (5th)
- BRIEF-A
 - Both Self and Informant noted issues with the organization of materials.
- WIAT-III
 - Word Reading 45th
 - Oral Reading Fluency 27th
 - Reading Comprehension 23rd
 - Spelling 18th
 - Sentence Composition 56th
 - Essay Composition 19th percentile
 - Numerical Operations 12th
 - Math Problem Solving 6th

Case Example

- Questionnaires
 - Retro- 4 symptoms of inattention; 1 symptom of hyperactivity
 - CAARS- S and O- negative for ADHD
 - PAI- Very mild issues with anxiety, peer relationships, and social support



Case Example

- Diagnostic Conclusion: **Specific Learning Disorder with impairment in mathematics** (reminiscent of a Nonverbal Learning Disability), with persistent fine-motor delays.
- Recommendations:
 - Discussion of strengths/weaknesses and program/career choice.
 - Extra time (1.25) for tests and exams with a great deal of visual processing (diagrams/charts).
 - Use of a computer to type written output.
 - Learning strategies support.
 - Academic skills centre for support with mathematical coursework.



Questions?



Thank You!

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