18 2 + 2 = ? A Case for Early Identification of Dyscalculia

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A child may have difficulty in learning due to a variety of reasons, including motor impairment, nutritional factors, intellectual disability, emotional-behavioral issues, lack of proper schooling, disturbed home environment, lack of guidance from teachers and parents to name a few. The term Learning Disability or LD refers specifically to the significantly below average performance of a school child in the areas of language processing and expression and/or mathematical ability inspite of adequate educational opportunities and intellectual ability. LD is presumed to be inherent and intrinsic, i.e. due to central nervous system dysfunction but environmental factors can compound the disability.

Children with LD face difficulties not only with academics but also in basic processing of information such as perceptual problems, figure ground discrimination, memory, [visual and auditory], phonological processing deficits and visuomotor problems. They also face a host of psychological problems including low self esteem, behavioral issues, emotional disturbances, self regulatory behavior, social interaction, poor motivation and metacognitive deficits.

The word **Dyscalculia** comes from Greek and Latin which means: "counting badly". The prefix "dys" comes from Greek and means "badly". "Calculia" comes from the Latin "calculare" which means "to count". The word "calculare" again comes from "calculus", which means "pebble" or one of the counters on an abacus. Dyscalculia is a lesser known disability, similar and potentially related to dyslexia and developmental dyspraxia (a disorder that affects the initiation, organization, and performance of action).

Dyscalculia occurs in people who may have difficulties with time, measurement, and spatial reasoning. Current estimates suggest that it affects about 5% of the population.

Dyscalculia was originally identified in patients who suffered specific arithmetic disabilities as a result of damage to specific regions of the brain. Recent research suggests that dyscalculia can also occur developmentally, as a genetically-linked learning disability which affects a person's ability to understand, remember, or manipulate numbers or number facts. The term is often used to refer specifically to the inability to perform arithmetic operations, but it is also defined as a more fundamental inability to conceptualize numbers as abstract concepts of comparative quantities (a deficit in "number sense").

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Dyscalculia can be detected at a young age. Experience has proved that dyslexia can be dealt with by using a slightly different approach to teaching, interestingly, so can dyscalculia. However, dyscalculia is the lesser known of the learning disorders and so is often not recognized.

Listed below are seven prerequisite Math skills:

1. The ability to follow sequential directions.
2. A keen sense of directionality, of one's position in space, of spatial orientation and space organization. Examples include the ability to tell left from right, north/south/east/west, up/down, forward/backwards, horizontal/vertical/diagonal, etc.
3. Pattern recognition and its extension.
4. Visualization: the ability to conjure up pictures in one's mind and manipulate them. Eg. three dimensional cube

5. Estimation: The ability to form a reasonable educated guess about size, amount, number, and magnitude.

6. Deductive reasoning: the ability to reason from the general principal to a particular instance, or reasoning from stated premise to a logical conclusion.

7. Inductive reasoning: a natural understanding that is not the result of conscious attention or reasoning, easily seeing the patterns in different situations, and the interrelationships between procedures and concepts. (Sharma 1989)

Before a mathematical concept is learned fully, the student moves through six levels of learning:

1. Intuitive Connections: Student connects or relates the new concept with existing knowledge and experiences.

2. Concrete Modeling: Student looks for concrete material with which to construct a model or show a manifestation of the concept.

3. Pictorial or Representational: Student draws to illustrate the concept. In this way he connects the concrete (or vividly imagined) example to the symbolic picture or representation.

4. Abstract or Symbolic: Student translates the concept into mathematical notation, using number symbols, operational signs, formulas, and equations.

5. Application: Student applies the concept successfully to real world situations, story problems, and projects.

6. Communication: Student can teach the concept successfully to others, or can communicate it on a test. (Sharma 1989)

Curricula in the pre-school and early elementary years should focus on the development of the prerequisite Math-readiness skills. The principle problem here is the way Mathematics is taught to children; this often leads to fear or dislike of Math leading to poor Math performance which is not dyscalculia but similar to it.

Teachers and students need to be aware of and able to accommodate the different learning styles or "Math learning personalities" and the corresponding teaching methods that address each style. It must be emphasised that most children at the beginning levels of Mathematics may reverse numbers, write mirror images of numbers or have difficulty with mathematical concepts. However, when these symptoms persist beyond the grade when most students outgrow them, we must suspect dyscalculia. When a child is not cognitively ready to learn Math concepts, their early introduction will only result in negative experiences and attitudes toward Mathematics, and eventually, Math anxiety. Parents and teachers must wait until the child is developmentally ready. In the mean time, varied informal experiences are to be provided. Gender differences in Math skills have been reported in most cultures. It is hypothesized that these are due to social forces as much as gender-specific brain construction and function. Gender differences can be eliminated by equalizing the activities and experiences of both boys and girls at every level of development leading to neurological sophistication of both genders equally. (Sharma 1989)

Diagnosing Dyscalculia

Dysfunction in Math, in individuals with normal mental functioning with discrepancy 1-2 standard deviations below the mean, between their mental age and Math age indicates a clear retardation in mathematical ability:

1. Quantitative dyscalculia is a deficit in the skills of counting and calculating.

2. Qualitative dyscalculia is the result of difficulties in comprehension of instructions or the failure to master the skills required for an operation.

3. Intermediate dyscalculia involves the inability to operate with symbols, or numbers.

Potential symptoms

1. Numerical difficulties with counting, recognizing numbers, manipulating Math symbols mentally and/or in writing, sequential memory for numbers and operations, mixing up numbers in reading, writing, recalling, and auditory processing, memory.

2. May transpose (mix up) [21 as 12], interchange similar digits [6 and 9], inappropriately insert, or omit digits, words, and signs or read without acknowledging place value: 5007 as "five hundred seven," or 576 and "five seven six".
3. Difficulty with everyday tasks like checking change and reading analog clocks.
4. Inability to comprehend financial planning or budgeting, sometimes even at a basic level; for example, estimating the cost of the items in a shopping basket or balancing a checkbook.
5. Difficulty with multiplication-tables, subtraction, addition, division, mental arithmetic, etc.
6. Particular problems with differentiating between left and right.
7. Difficulty navigating or mentally "turning" the map to face the current direction rather than the common North=Top usage.
8. Having particular difficulty mentally estimating the measurement of an object or distance.
9. The condition may lead in extreme cases to a phobia or durable anxiety of Mathematics and mathematic-numeric devices/coherences.
10. May be able to read and write numbers but is oblivious to their meaning.
11. Cannot identify a specified number of items.
12. Frequent errors include: mixing up operations like +/-, -/÷ , x/÷ , x/+; mistaken or oversimplification of complex operations; needing written computation over mental calculation, using fingers to assist mental or written computation.
13. Inability to learn and apply the rules for addition, subtraction, multiplication and division resulting in a disability to successfully perform Math operations.
14. Poor memory for counting sequences, operational sequences, Math facts, time, direction, schedules.

Potential cause

Scientists have yet to understand the causes of dyscalculia. Investigations indicate that it could be neurological as dyscalculia has been associated with lesions to the supramarginal and angular gyri at the junction between the temporal and parietal lobes of the cerebral cortex,or due to deficits in working memory. Other causes may be short term memory being disturbed or reduced, making it difficult to remember calculations. Children and adults subject to dyscalculia nevertheless tend to be of normal intelligence, but often present an uneven picture in their results on intelligence tests. The majority of children and adults who are subject to dyscalculia have the ability to read and the ability to understand what is read unimpaired, although about 20–30 % of those who are subject to dyscalculia are characterized by having difficulties reading and with Mathematics. They may require extensive mental training to carry out even simple arithmetic tasks.

A child may have only a limited understanding of either numbers as such or numerical symbols. Another form of dyscalculia involves planning difficulties that lead to the child's failure to carry out computations effectively. The child has difficulties with following a clear strategy in solving arithmetic problems, losing track of her mental position among the fundamental mechanics of the mathematical problem. Dyscalculia may also be based on problems with visual perception that lead to difficulties with tasks involving logical thinking as well as in carrying out computations. Eg. learning to read an ordinary clock and understand how the position of the hands is to be interpreted.

Difficulties with Mathematics are associated with the child having general problems with learning, in the area of Mathematics as well as others, learning tends to take longer than normal.

Dyscalculia affects individuals over their life span. Children with dyscalculia fall behind early in primary school, and may develop anxiety or a strong dislike towards Math. In secondary school they are likely to struggle to pass Math and science courses and find their career options reduced. The student can be overwhelmed and this may result in emotional distress. In adult life, they may earn less, and have difficulties managing their everyday finances. For individuals with dyscalculia, Mathematics can be a traumatic experience and emotionally charged because of past failures.

Many people think because LD is considered a central nervous system dysfunction, it can't be changed. However, we now know that the brain is very adaptable (or plastic),

especially during childhood. Research has already shown that training programs can increase functioning in brain areas involved in reading. The same is likely for dyscalculia. There is still a lot we do not know about dyscalculia, because research is a good 30 years behind as compared to dyslexia. This situation has started to improve, especially in recent times.

Mitigative Strategies

Although dyscalculia may be difficult to diagnose, there are strategies that teachers and parents should know about to aid students in learning Mathematics.

1. A child of this category is usually best helped by being allowed to work at a slow pace and by being given simplified learning material.
2. Provide examples and try to relate problems to real-life situations.
3. Encourage student to work extra hard to "visualize" Mathematics problems. Draw them or have her draw a picture to help understand the problem, and make sure that she takes the time to look at any visual information that is provided (picture, chart, graph, etc.)
4. Have the student read problems out loud and listen very carefully. This allows the use of auditory skills.
5. Provide younger students with squared paper and encourage them to use it in order to keep the numbers in line.
6. Provide extra worksheets so that the student is not overwhelmed by too much visual information (visual pollution). Especially on tests, allow scrap paper with lines and ample room for uncluttered computation.
7. Dyscalculia students must spend extra time memorizing Mathematics facts. Repetition is very important. Use rhythm or music to help memorize.
8. Many students need one-on-one attention to fully grasp certain concepts. Have students work with a tutor, a parent, or a teacher after school hours in a one-on-one environment.
9. If possible, allow the student to take the exam on a one-to-one basis.
10. The student might require a chance to do the problem once again when she is wrong. Often mistakes are the result of "seeing" the problem wrong.
11. In early stages, design the test problems to test only the required skills. In their early learning, they must be free of large numbers and unnecessary calculations.
12. Allow more time to complete problems and reassure the student so that he does not succumb to anxiety. Be patient and positive.
13. Assign extra problems for practice and maybe a special teaching assistant or special educator to assist the student.
14. When presenting new material, make sure the student with dyscalculia is able to write each step down.

Technology And Resources

The technology for remediating and accommodating students with Mathematics disabilities is not as readily available as the technology for reading and writing.

The limited technology can be of help, especially to those who have problems writing numbers down in the correct order. The most common currently available tools include the following:

1. hand-held calculators that can help a learner who has problems writing numbers in the correct order
2. talking calculators that vocalize data resulting in calculations through speech synthesis
3. special-feature calculators that enable the user to select options to speak and simultaneously display numbers, functions, entire equations and results
4. on - screen computer calculator programs with speech synthesis
5. large display screens for calculators and adding machines
6. color coding for maintaining columns
7. big number buttons and large keypads
8. textbooks on CD-ROM and video-taped Mathematics lessons
9. Computer-assisted Instruction (CAI) Mathematics courses (instruction targeted for special students)

Dyscalculia in children can present in a variety of ways.

Initially, the child may have a difficulty or reluctance towards Mathematics. The teacher or parent should immediately be alerted to the possibility of a learning disability in the early grades itself. This is the time when the appropriate intervention is most effective. The thrust of recent research in this area is on early identification. Once a child is identified on the basis of the above, one needs to investigate further. The extent and severity of the learning disability as well as the strength of various contributing factors viz., physical, psychological, socio-emotional, scholastic and familial factors have to be identified so that appropriate actions can be taken to help the child. Our primary focus should be the child and care should be taken to help him so that he can grow up and realize his potential as an adult. Early identification also helps prevent poor school performance and emotional-behavioral problems.

Summary: Early intervention in Math is as important as early intervention for Dyslexia. A diagnostic evaluation at any age in a student's Math development should pinpoint the problem areas, provide a plan for Math intervention, and offer recommendations for Math remediation.

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