Xournals

Academic Journal of Mathematical Sciences

ISSN UA | Volume 01 | Issue 01 | June-2018

Mathematical Disability: Dyscalculia & Developmental Dyscalculia

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Available online at: www.xournals.com

Received 19th January 2018 | Revised 15th February 2018 | Accepted 19th April 2018

Abstract:

Today's world needs us to process extraordinary altitudes of numerical information. Smartphones, computers financial and healthcare information dealing out are just a few of the many modern hassles requiring our numerical smoothness. It is essential, for continuous development of effective quantifiable learning and mathematical learning methods, that we should understand the sources of such extensive and debilitating numerical and mathematical deficiencies. Dyscalculia eventually arises from Developmental Dyscalculia and it can be because of a wide range of reasons, from poor teaching, to behavioral devotion problems, to low socio-economic status. However, a subdivision of children with math problems, possibly with the most-severe deficiencies, seems to suffer from a developmental learning disorder that challenges the skill to process basic numerical magnitude information. Many elements such as educational experience, IQ and other cognitive aptitudes, and motivation may weaken or challenge the growth of numeracy skills, one key potential impediment is a developmental learning disorder that is specific to numeracy. Developmental Dyscalculia (DD) is such a learning disorder that specifically affects the capability to attain school-level arithmetic skills. The following article will recapitulate the current situation of awareness regarding DD, drawing from a variety of experiential studies. In order to cover its awareness importance, things that has been outlined are behavioral characteristic, causes, difficulties, and highlight the status of distinguishing between primary and secondary DD in future research along with the Dyscalculia.

Keywords: *Dyscalculia, Mathematics, Struggle, Problem, Developmental Dyscalculia.*

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Introduction

What is Dyscalculia and Developmental Dyscalculia?

Dyscalculia is kind of unique and explicit learning problems. There occurs a diversity of descriptions of dyscalculia. The variances in definitions imitate the different speculative and research viewpoints of diverse experts. Some experts define dyscalculia in terms of an underlying alleged genetic, constitutional or neuroanatomical ingenuousness in particular areas of the brain. While some definitions of dyscalculia are more wide-ranging and do not accept any genetic or underlying neuroanatomical factor. Dyscalculia is universally expressed as a disorder that affects the capability to attain arithmetical skills. Dyscalculic beginners may have trouble understanding simple number perceptions, have problems in learning facts about number and processes and lack an instinctive grasp of numbers. Even if they yield a correct solution or use a precise method, they may do so mechanically and deprived of confidence **(Appleford School).**

Developmental Dyscalculia (DD) is a disorder of learning, affecting the ability to attain school-level calculation skills and can possibly occur 3-6% of individuals among the population. Development in understanding the cause of DD seems the only option in order to overcome the problem. However, recent years have witnessed noteworthy growth in the field, and a growing body of behavioral and neuroimaging evidence now points to a fundamental scarcity in the depiction and processing of numerical extent information as a probable core insufficiency in DD. An additional creation of the recent progress in understanding DD is the rebirth of a dissimilarity between 'primary' and 'secondary' developmental dyscalculia. The first appears related to the compact development of brain mechanisms for handling numerical level information, while the latter mentions to mathematical insufficiencies restricting from external influences such as poor teaching, low socio-economic status, and behavioral courtesy problems or domain-general reasoning or intellectual deficits. Amplified awareness of this dissimilarity going forward, in amalgamation with longitudinal empirical research, offers great prospective for extending our understanding of the disorder and emerging effective educational intercessions. (**Price and Ansari, 2013)**

What are the grounds of Dyscalculia?

Research for investigating dyscalculia and its possible causing are least known because of least researches. For many of those experts who study that dyscalculia is a term reserved for definite individuals who do not have one or more of the factors that are already known, dyscalculia is well-thought-out to have a genetic factor. As for example, if one identical twin bears dyscalculia then there are chances of 70% that his twin will also be Dyscalculic, while for non-identical twins the likelihood is 55% only. These statistics designate that inheritance shows vital part but is not the complete answer to the actual problem. There is some immaturity in the inferior parietal cortex and its interconnections with further areas of the brain. **(Appleford School).**

The Features of a Dyscalculic Learner

Dyscalculic beginners may show diverse personalities. They basically express no feel for numbers, pitiable skill to estimation and cannot even understand whether a response to a mathematical charge is reasonable or not. The problems experienced by Dyscalculic learners also includes- subitizing, recalling number facts, estimating, counting backward, understanding, understanding money, sequencing and applying the concept of time, direction (left/right) and even sometimes noticing number arrangements and understanding and applying mathematics language also. Mathematics Nervousness may also have a crucial role in the way these learners perform because it may block their skill to involve in mathematics tasks. Such adverse feelings may hinder Dyscalculic learners from the accomplishment of their full potential. **(Zerafa, 2013)**

Behavioral Features

Conventionally, the defining features of DD have been defined as reduced recovery of arithmetic facts from memory and the tedious use of undeveloped calculation strategies. Though, a growing body of behavioral and neuroimaging sign, emerging over the last decade may suggest that DD may be entrenched in deficiencies of a neurobiological system for processing numerical extents and that it is this impairment that, over the course of knowledge and development, gives growth to the problems in the repossession of arithmetic facts. Debate still exists, yet, as to the role of the territory of general cognitive factors, such as working-memory or spatial consideration, in the etiology of DD. (**Price and Ansari, 2013)**

Arithmetic

The most reliably observed behavioral symbol of DD is impaired arithmetic fact recovery. Typically developing children experience an evolving shift in their calculation tactics. They initiate by solving modest problems through procedural methods like counting, but eventually with the next coming grades, they already have developed a stock of arithmetic facts

in their memory, from which they can rapidly memorize the solution for specific given problem. While children with DD, typically flop to grow such fluent fact-retrieval mechanisms, unending into employ procedural approaches long after their typically emerging peers have developed to memory-based strategies. As a pointer of the severity of the fact-retrieval shortage in DD children. Typically developing children have been found to evoke an average of three times as many arithmetic facts as those with DD (**Price and Ansari, 2013).**

Processing Of Basic Number

In early studies to examine undeveloped numerical processing in children regarding mathematical learning complications. It was reported that typically developing children do not display the same intrusion from numerical information while judging two numbers presented in diverse formats are same or not. The extent of numeric information is not stimulated automatically in DD children as it is in their naturally developing peers. The proposal of compact automatic initiation of semantic numerical representations in DD. Lack of facilitation from numerical evidence in DD kids during a numerical Stroop task. Lack of default processing the numerical information does not itself specify whether the fundamental semantic depiction is reduced, or whether there is a shortage in the relation between the semantic representations and their figurative referents (Arabic digits) (**Price and Ansari, 2013).**

The mathematical language

Math's thinking is to a significant extent which is dependent on the language that is used in mathematics. This language prerequisites to be learned carefully in order for a child to be effective in math. For example, the division sign (÷) can be defined in the following words 'divide', 'division', 'goes into', 'share', 'group', 'split', 'apportion', 'quotient' etc. In the same way, the number 3 can be described as follows 'three', 'one third', 'treble', 'triple', 'tri-', etc. **(Appleford School).**

Anxiety

When it comes to math, even in the time where sophisticated technologies rule human mind many people still face difficulties in mathematics and is what we might call a mathematical anxiety. This is typically a secondary reaction to the child observing himself to be poor at math. It can be a collective problem which is self-reinforcing like, the more the child fails, the more anxious he gets, which then leads to more failure and lowered self-esteem. **(Appleford School).**

Signs of Dyscalculic Children in Pre-School:

- Has anxiety learning to count, particularly when it approaches to allocating a number to items in a group.
- Has distress distinguishing number signs.
- Has to put extreme efforts to connect a number to a real-life state.
- Has trouble memorizing numbers and avoids numbers long after other children of the same age can count and think of numbers in the right order.
- Finds it tough to identify patterns and sort items by shape, size or color.
- Avoids playing games that involve number, counting or any kind of other activity that includes mathematical concept.

Signs of Dyscalculia in Primary School:

- Suffer while recognizing numbers and symbols. For example, making the connection between '7' and the word 'seven'.
- Has distress writing numbers clearly or putting them in the correct instruction or the correct column.
- Has trouble coming up with a plan to solve a math question.
- Struggles to understand words related to math such as 'greater than' and 'less than'.
- Can have trouble telling left from right and has a poor sense of direction.
- Has exertion remembering phone numbers or even game scores.
- Has trouble learning and recalling basic math facts.
- Struggles to identify mathematical symbols like +, -, ×, ÷ and even in using them correctly.
- May still use fingers to count instead of using more sophisticated strategies.
- Has trouble telling the time.

Signs of Dyscalculia in High School and adults:

- Anxiety whenever it comes to numbers and counting.
- Struggles to apply mathematical concepts in everyday life. This includes money matters such as estimating

the total cost, working exact change and working out a tip.

- Has anxiety measuring things like ingredients in a simple recipe. Would struggle to double or halve quantities in a recipe.
- Struggles with finding their way around and worries about getting lost.
- Face a hard time in grasping information shown on graphs or charts.
- Has trouble finding different approaches to the same math problem.
- Lacks confidence in activities that require guessing speed and distance, such as playing sports and learning to drive.
- Put efforts to read scales such as thermometers. (www.dyslexiascotland.org.uk)

Review of Literature

Kosc (1974), discussed developmental dyscalculia, stressing the hereditary or congenital affection of the brain substrate of mathematical functions, is put forth. This disorder is clearly distinguished from other forms of disturbed mathematical abilities. A classification of developmental dyscalculia is then outlined, distinguishing the following forms: verbal, prognostic, lexical, graphical, diagnostical and operational developmental dyscalculia. Finally, an investigation is presented of mathematical abilities and disabilities in eleven-year-old pupils from normal schools in Bratislava, Czechoslovakia. A number of tests measuring symbolic functions were applied to 66 suspected dyscalculics with normal IQs who had neurological examinations. The tests are characterized and the results briefly described; some examples of concrete pathological solutions to test items are given. This investigation suggests that nearly 6% of children of the so-called normal population can be justifiably expected to have symptoms of developmental dyscalculia as defined in this study.

Rubinsten and Tannock (2010), defined as a negative affective response to mathematics, is known to have deleterious effects on math performance in the general population. However, the assumption that math anxiety is directly related to math performance, has not yet been validated. Thus, our primary objective was to investigate the effects of math anxiety on numerical processing in children with specific deficits in the acquisition of math skills (Developmental Dyscalculia; DD) by using a novel affective priming task as an indirect measure. Several studies have found that math anxiety and math achievement are negatively correlated It was found for example, that across junior and senior high school, initial low math achievement is significantly related to later high math anxiety, but initial high math anxiety seems not to be strongly linked to later low math achievement. In primary school children, however, there was no clear developmental increase in the relationship of math anxiety and calculation abilities. In a later publication a structural equation modeling found no effect of math anxiety on calculation ability. In the current study, our premise is that in Developmental Dyscalculia (DD; a deficit in processing numerical information) poor initial math abilities may precede and give rise to math anxiety, creating a vicious cycle.

Participants with DD responded faster to targets that were preceded by both negative primes and math-related primes. A reversed pattern was seen in the control group. Their results reveal a direct link between emotions, arithmetic and low achievement in math. It is also suggested that arithmetic-affective priming might be used as an indirect measure of math anxiety. Although not clearly discussed or scientifically studied, math anxiety is thought as specific to math context and therefore distinct and occurring in the absence of generalized anxiety who extended predictions about generalized anxiety and working memory to math anxiety. Accordingly, math anxiety seems to be a very prevalent singularity approach.

Doyle (2010), examined the neurological, cognitive and environmental features of dyscalculia, which is a specific learning difficulty in the area of processing numerical concepts. A review of the literature around the etiology of dyscalculia, methods for assessment and diagnosis, the global incidence of this condition and prevalence and type of intervention programs is included. In addition, the nature of dyscalculia was investigated within the Irish context, with respect to (a) the structure of the Mathematics curriculum, (b) access to learning support, (c) equality of access to the Mathematics curriculum, (d) reasonable accommodations and State examinations, and (e) implications for transition to higher education. Provision of Mathematics support in third level institutions is discussed in order to highlight aspects of best practice which might usefully be applied to other educational contexts.
(PDF) Dyscalculia and mathematical difficulties: Implications for the transition to Higher Education.

Kaufmann *et al.* (2013) , Developmental dyscalculia (DD) and its treatment are receiving increasing research attention. A *PsycINFO* search for peer-reviewed articles with *dyscalculia* as a title word reveals 31 papers published from 1991–2001, versus 74 papers published from 2002–2012. Still, these

small counts reproduce the paucity of research on DD compared to dyslexia, despite the prevalence of mathematical difficulties. In the UK, 22% of adults have mathematical difficulties sufficient to impose severe practical and occupational restrictions. It is unlikely that all of these individuals with mathematical difficulties have DD, but criteria for defining and diagnosing dyscalculia remain ambiguous. What is treated as DD in one study may be conceptualized as another form of mathematical impairment in another study. Furthermore, they also shared that, DD is frequently—but, we believe, mistakenly- considered a largely homogeneous disorder and advocate a differential and developmental perspective on DD focused on identifying behavioral, cognitive, and neural sources of individual differences that contribute to our understanding of what DD is and what it is not.

Arithmetic difficulties can reflect individual differences in both numerical and non-numerical functions. The numerical functions comprise many aspects of "number sense" such as spontaneous focusing on the number, comparing numerical quantities represented non-symbolically, processing numbers, or linking non-symbolic representations to symbols such as number words and Arabic numerals. These individual differences in "number sense" may reflect the difference in neural pathways involved in even quite rudimentary aspects of numerical cognition (e.g., single digit arithmetic). Studies of functional activation during magnitude comparison reflect developmental variations over time and suggest variation in development rather than in comparable but delayed trajectories.

Skagerlund *et al.* (2014), the study investigated if developmental dyscalculia (DD) in children with different profiles of mathematical deficits has the same or different cognitive origins. The defective approximate number system hypothesis and the access deficit hypothesis were tested using two different groups of children with DD (11–13 years old): a group with arithmetic fact dyscalculia (AFD) and a group with general dyscalculia (GD). Several different aspects of number magnitude processing were assessed in these two groups and compared with age-matched typically achieving children. The GD group displayed weaknesses with both symbolic and non-symbolic number processing, whereas the AFD group displayed problems only with symbolic number processing. These findings provide evidence that the origins of DD 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.

Zerafa (2014), described Dyscalculia as a specific learning difficulty which hampers learners from developing the basic number concepts which are required for getting hold of mathematics. The study was to explore strategies which would help children with dyscalculia overcome some of their barriers. After an initial assessment of 15 children. Twenty 15-minute sessions were carried out with each child, using the Catchup Numeracy programme. Post-assessment was then carried out. Results suggested that appropriate intervention can allow dyscalculic learners to succeed at acquiring the basic number concepts needed for mathematics learning. Additionally, it was noted that such intervention could greatly impact the affective domain of children, raising self-esteem and developing a more positive attitude to the learning of mathematics. Dyscalculic learners may exhibit different traits. However, dyscalculics indicates as they usually have 'no feel for numbers', poor ability to estimate and cannot understand whether an answer to a mathematical task is reasonable or not. The difficulties experienced by dyscalculic learners include: subitising, estimating, recalling number facts, counting backwards, understanding and applying the concept of time, understanding money, sequencing, direction (left/right), noticing number patterns and understanding and applying mathematics language Additionally there was a shift in their attitudes towards mathematics from negative ones to more positive ones. These results corroborate other research both using the Catchup Numeracy programme and another programme which focuses on similar numerical and conceptual knowledge. Further research on such intervention strategies is undoubtedly crucial but it seems that through the right intervention strategies encouraging results may be noted. Mathematics Anxiety may also have a key role in the way these learners perform because it may block their ability to engage in mathematics tasks. Such negative feelings may hinder dyscalculic learners from reaching their full potential

Conclusion

This disorder, "primary developmental dyscalculia," should not be confused with "secondary developmental dyscalculia," which states to mathematical insufficiencies stemming from external factors such as those described above. Instead, primary DD is related with the impaired development of brain mechanisms for dealing out numerical magnitude information and is thus determined by endogenous neurodevelopmental elements. It must be remembered that research in this region is in relative infancy when compared to research investigating developmental

dyslexia, and That is why, progress to date is exciting, with promises of rich future recompenses. Significant steps in maximizing the outcomes of this research are for future studies to focus on the causal relationship 11 Price and Ansari: Dyscalculia Published by Scholar Commons, 2013 between numerical magnitude processing and later math skills, and on the role of development in the design of effective intervention tools. Despite the obvious importance of numerical and mathematical skills for life accomplishment and a dominance rate equivalent to that of developing dyslexia, Dyscalculia has been regularly understudied, with studies on dyslexia outnumbering those on DD by approximately 14:1. The significance of this under-attention is that the cognitive reasons for DD are currently poorly understood. It should be noted that DD often co-occurs (is comorbid) with other learning problems such as Developmental Dyslexia and Attention Deficit Hyperactivity Disorder (ADHD).

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