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स्वावलम्बन
Swavlamban

The Project entitled

Understanding The Effects of Comorbidity Factors in Relation to Dyslexia- Holistic Cognitive Behaviour Intervention

Submitted to

Department of Empowerment of Persons with Disabilities (Divyangjan)

Ministry of Social Justice and Empowerment, Government of India

By

Project Team

Principal Investigator : Dr. Maya Rathnasabapathy

Co - Principal Investigator : Dr. Kalyani Desikan

Research Assistant : Mrs. Archika Johari P

2018

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Principal Investigator : **Dr. Maya Rathnasabapathy,**
Assistant Professor (Sr) (Psychology),
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Co - Principal Investigator : **Dr. Kalyani Desikan**

Research Assistant : **Mrs. Archika Johari P**

Declaration

I hereby declare that the project entitled "**Understanding the Effects of Comorbidity Factors in Relation to Dyslexia - Holistic Cognitive Behaviour Intervention**" was carried out by me during the period from 2016 - 2018

Place: Chennai **Signature of the Principal Investigator**

Date: **Dr. Maya Rathnasabapathy**

Acknowledgements

I wish to express my deepest gratitude to many people who have provided invaluable support and encouragement to me in the completion of this project.

I express my sincere gratitude to **Department of Empowerment of Persons with Disabilities (Divyangjan), Ministry of Social Justice and Empowerment**, **Government of India** for having given me the opportunity to work on Dyslexia

I thank **Vellore Institute of Technology**, Chennai for their academic support and the facilities provided to carry out the research work at the institute.

I sincerely thank the various School Heads especially, T. Govindarajan, Managing Director of Kovai Public School, S.Rajalaxmi Correspondent of Vrikshaa International School-Tiruppur and, Senthil who allowed to collect data for the research.

I would like to extend my thanks to **Dr. Kalyani Desikan, Professor**, Co-Principal Investigator Mathematics Division (SAS) for her timely support and valuable inputs.

Foremost, I am extremely thankful to the Project Assistnt **Mrs. Archika Johari P** for her sincere effort in data collection, analysis and writing the report.

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Chapter-I

Introduction

Dyslexia, the most common term among the learning disabilities was coined by Rudolph Berlin, a German ophthalmologist in 1887. Dyslexia was earlier called as 'word blindness' named by Adolph Kussmaul, a German neurologist in 1878, who encountered adults with neurological impairment having reading disabilities.

Dyslexia is an impairment in reading **(DSM-5).** According to IDA (International Dyslexia Association and the National Institute of Child Health and Human Development in 2002), dyslexia is defined as a difficulty with accurate and/or fluent word recognition and by poor spelling and decoding abilities. When an individual is unable to read at the level expected for age and intelligence, he/she is said to be suffering with Dyslexia or 'Impairment in Reading' (DSM-5), which can occur in one of the several forms (in which the person may suffer with one of the forms) such as difficulty in comprehending while reading silently, or with accuracy of the word recognition while reading aloud or while spelling out. Morrison, J. (2017). Learning disorders, a term that refers to delayed development in language, speech, mathematical, or motor skills is not necessarily due to any demonstrable physical or neurological defect. The best known and most widely researched of these types of problems are a variety of reading/writing difficulties collectively these types of problems as dyslexia, in which the individual is deficient in spelling and memory which cause problems in word recognition and reading comprehension Individuals with dyslexia often omit, add, and distort words and their reading is relatively very slow.(Smith-Spark & Fisk, 2007 Butcher, J. N., Mineka, S., & Hooley, J. M. (2013).

Causes Of Dyslexia

Dyslexia or the reading disability is the most prevalent type of LD affecting atleast 80% of the LD populations (Lyon, G.R. (1995). The cause of dyslexia is not definite but research studies show that the causes could be genetic. Pennington and Olson, 2005), anatomical or environmental factors. The causal factors of dyslexia are not one or two in number, but are multiple. (Pennington and Olson, 2005).About 4% of school-age children with most of them being boys are affected with dyslexia. Dyslexia is caused by a variety of environmental factors (lead poisoning, fetal alcohol syndrome, low socioeconomic status), genetic factors accounting for 30% of cases.

Dyslexia, which is alearning disorder related to language is associated with the failure of the brain development in an asymmetrical pattern with respect to the cerebral hemispheres, in particular, the left hemisphere being underdeveloped that is responsible for language functioning.(Beaton, 1997). Deficit in physiological activation of the cerebellum is also seen in the functional magnetic resonance imaging studies. (Richards et al., 2005).

Phonological Cause

The sounds of any language, which are called as phonemes are used to process spoken and written language and this is called as phonological processing. (Wagner & Torgesen, 1987). It includes three components such as phonological awareness, phonological working memory, and phonological retrieval which are important for speech production as well as the development of spoken and written language skills. Out of these three components, phonological awareness plays a major role in dyslexia because dyslexia is an impairment related to reading.Reading any alphabetical language like English requires phonological awareness. Anthony, J. L., & Francis, D. J. (2005). Phonological awareness is the the ability to consciously analyze and manipulate the sound structure of a language in a way such that the sounds of the words are converted into letters on a page (spelling) which can be further converted into something that could be heard (reading). Children with dyslexia often struggle to split the words into separate sounds or distinguish word sounds from one another which makes them difficult to spell and read. The deficit in Phonological awareness is a major cause of reading difficulties. Melby-Lervag, M., Lyster, S.,&Hulme, C. (2012). Phonological skills are strongly linked with the reading skills which essentially require decoding of words phonologically. (Shapiro, Carroll, & Solity, 2013)

Genetic Cause

One of the important causal factors of impairment in reading are the genes. Through rare chromosomal translocations two out of six candidate genes were found in individuals with dyslexia (Buonincontri, R. et al (2011).Candidate genes responsible for causing dyslexia are found on chromosome 6p21 (König IR et.al (2011), which reveals that genetic factors also play a vital role in causing dyslexia. Grigorenko, E. L., et al (1997).

The impact of multiple genes on the neurodevelopmental irregularities is a common source of all other impairments such as deficit in the auditory processing that affects vision, motor performance,

attention, learning, memory which causes variability in the phenotype of dyslexia. (Seidenberg, M. S. (2011).

Neuro Anatomical Cause

It was in the late 1800s that dyslexia was suspected to originate from neurobiological factors. The French neurologist Dejerine (Dejerine, 1891) observed a portion of the left posterior brain region to be involved in reading. (Cited inLyon, G. R., Shaywitz, S. E., & Shaywitz, B. A. (2003). The asymmetry in the structure of the brain with one half being larger and the other half being smaller compared to the non-impaired readers suggests that neuroanatomical structure could also be the cause of dyslexia. (Duara, R., et al (1991)). Many physiological methods are used in addition with the functional neuroimaging to investigate if dyslexia is caused by the the differences in the brain. Richard Boada, Erik G. Willcutt, and Bruce F. Pennington (2012).

The function of the left hemisphere, which is responsible for the phonological and reading tasks is less specialized and the left temperoparietal regions are underactivated relative to both chronological-age and reading-age controls (Hoeft et al., 2006, 2007). The anterior system in the brains of children with dyslexia is overactivated and the two posterior systems are underactivated when compared to their counter parts. (S. Shaywitz, 2003).

Dyslexia And Comorbidities

Dyslexia, commonly referred to as reading disorder, is a specific learning disability, which affects the cognitive and academic areas such as attention (B.A. Shaywitz, Fletcher, & S.E. Shaywitz, 1994), mathematics (Fletcher & Loveland, 1986), and/or spelling and written expression (Moats, 1994)**.**60% of the children diagnosed with Dyslexia are found to exhibit atleast one comorbid condition (Willcutt & Pennington, 2000a, 2000b).

Neuropsychological Causes For Comorbidity

Severe neuropsychological weaknesses is seen in individuals having both dyslexia and ADHD than in those who have either of the two conditions. (Willcutt, 2009).

Genetic causes for Comorbidity

Family and twin studies conducted by several researchers have shown the inheritable nature of RD and ADHD (have shown that RD and ADHD are inheritable.) (Dell'homme, Kim, Loo, Yang, & Smalley, 2007). The rate of heritability of RD is found to be (40–60%) (Ziegler et al., 2005), whereas of ADHD is found to be 70-80% (Faraone et al., 2005).

Comorbidities of Dyslexia

Dyslexia is found to be associated with one or more specific learning disabilities such as (ADHD) Attention Deficit Hyperactivity Disorder (Germanò et al (2010)), dyscalculia (Landerl & Moll, 2010), dyspraxia (Dewey et al (2002), Iversen, S.,et al (2005), and dysgraphia. The co-occurrence of these developmental disorders with one another is common (Gooch, D et al (2014)).

Dyslexia and ADHD

The comorbidity between reading disability (RD, or dyslexia) and Attention Deficit Hyperactivity Disorder (ADHD), is attributed to both cognitive and genetic risk factors (McGrath et al., 2011; Willcutt et al., 2010).

ADHD (Attention-Deficit /Hyperactive Disorder)

British pediatrician Sir George Still first identified ADHD in 1902, who described it as "an abnormal defect of moral control in children."

Definition of ADHD

ADHD is a persistent pattern of inattention and/or hyperactivityimpulsivity that interferes with functioning or development, characterized by excessive or exaggerated motor activity, running or fidgeting, and difficulties in sustaining attention (Nigg et al., 2005). According to Mirsky AF, Duncan CC (2001), 4-7% of all school-age children are found to have ADHD. They may have problems with coordination and are "Motorically driven" that they have trouble sitting quietly at a place.

Characteristics of ADHD

As the name implies ADHD- Attention Deficit Hyperactivity Disorder, they lack in attention and are hyperactive due to which they have trouble sitting quietly at a place. Despite of normal intelligence, they score badly in academics as they cannot stay attentive and focus on their schoolwork. Children with ADHD have been reported to have cried more and were irritable, more than their siblings in their infancy. They were also reported to have slept relatively lesser. Some have an history of having kicked more in the mother's womb. The neuropsychological testing that are related to academic functioning are found to be poor in many children with ADHD (Biederman et al., 2004). The impulsivity and overactivity in children with ADHD poses them many social problems. They fail to fulfill the demands being placed on them by not following the instructions given to them and are highly distractible (Wender, 2000). They have difficulty in getting along with not only their peers due to their behavior problems, but also with their parents as they often fail to obey rules and are ignorant of the demands being placed on them (Hoza et al., 2005). These hyperactive behaviors decrease as one step into adolescence, but some people develop other forms of delinquent behavior.

Causes of ADHD

The extent to which the environmental or biological factors cause ADHD is still not clear and hence cannot be attributed to any of these factors in particular. (Carr et al., 2006; Hinshaw et al., 2007) but the role of genetic factors is pointed out by the researchers (Sharp et al., 2009; Ilott et al., 2010)where as the biological factors are also considered to be the precursors to some extent (Durston, 2003), where in children who had ADHD reported to be born with low birth weight than normal. Botting N, Powls A, Cooke RW,Marlow N (1997)., Whitaker AH et.al (1997). ADHD is a highly comorbid condition, (Banaschewski, Neale, Rothenberger, & Roessner, 2007) and found to co-occur with atleast one comorbid condition in 80% of children with ADHD. (Willcutt & Pennington, 2000a, 2000b). The specific learning disabilities such as impairment in reading is often seen associated in children with ADHD. ADHD is seen to run in families and a genetic association with antisocial personality disorder and somatic symptom disorder also exists in some cases of ADHD. Learning disorders, especially problems with reading are associated with it. ADHD is often a comorbid condition and is found to co-occur with oppositional defiant disorder and conduct disorder, specific learning disorders, obsessive–compulsive disorder, and tic

disorders. A new and more strongly associated condition is disruptive mood dysregulation disorder. Substance use problem and antisocial personality disorder is also seen in some adults.Interpersonal problems, alcohol or drug use, or personality disorders may persist in some adults while some others report to be lacking in concentration and are disorganized with the main symptoms such as impulsivity, overactivity, stress intolerance still persisting.

The comorbidities associated with ADHD are language disorder, DCD (developmental coordination disorder) and reading disability (Cohen et al., 2000). Learning problems associated with ADHD are varied in number Gillberg et.al (2004). (Mayes & Calhoun, 2007) Disability in written expression is seen in children having ADHD. In a study conducted by Kadesjö B, Gillberg C (1999), 50% of the children who were clinically diagnosed with ADHD were found to have DCD. (3.G.)(12)Disorder of written expression associated with dysgraphia is commonly seen in ADHD. (Elbert JC, Seale TW (1988). Dyscalculia or the mathematics disorder is 10 to 60 % prevalent in children with ADHD. (Barkley RA (1990))., Semrud-Clikeman M,et.al (1992). Some adults with various criminal behavior reported to have had ADHD symptoms in their childhood. Many other studies have shown existence of ADHD symptoms in the childhood of the adult criminals. Rasmussen P, Gillberg C (2000) (M & N)Children with ADHD, regardless of their being on medication, have found to be suffering with sleep problems. (Barkley RA (1998)., Ishii T, Takahashi O, Kawamura Y, Ohta T (2003) and involuntary movements related to sleep and restless legs syndrome are also seen in children with ADHD Picchietti DL et.al (1998, 2003). Physiological problems such as constipation, urgency, infrequent voiding, nocturnal enuresis and dysuria are also seen to exist in some children with ADHD. Duel BP et.al (2003).

Gender difference in ADHD

ADHD is a mental health condition that is frequently diagnosed in children in the United States with the condition being more predominant among the preadolescent boys than girls with the ratio being six to nine times. (Ryan-Krause et al., 2010). Among the three types of ADHD, the two types commonly seen associated with Dyslexia are inattention type and the hyperactivity / impulsivity type. The inattention type is mostly found in both the genders and is not much disruptive than the hyperactive type which occurs in only boys. (Willcutt & Pennington, 2000a), which becomes the reason for boys being taken to clinical referrals than girls and highlighting the gender ratio. (Germano., etal (2010). In a Norwegian study conducted by (Ullebo et.al.,(2011)) ,

the symptoms of ADHD were estimated to be more in males than in females with the ratio being 3:1. This male predominance was consistent with the findings of Ramtekkar et al.,(2010).

Comorbidity between Reading disorder and ADHD

Children with dyslexia are found to have ADHD (Willcutt & Pennington, 2000a) with the percentage being 18- 42% (Gayan et al., 2005) and the children with ADHD have also been found to have the reading disability (Sanson, Prior & Smart, 1996), with the percentage being 18–45%(Wisniewska, Baranowska, & Wendorff, 2007). Which indicates that both RD and ADHD are interrelated and co-occur with eachother. (Mayes, Calhoun & Crowell, 2000)

Dyslexia and Dyspraxia

Dyspraxia

The word "Dyspraxia" is derived from two Greek words, 'dys', means inability and 'Praxis' means action or practice. In the neurological context, dyspraxia is a developmental disorder. According to The Dyspraxia Foundation 2014a, Dyspraxia is defined as an impairment or immaturity of the organization of movement. It is associated with problems of perception, language and thought.' The terms Dyspraxia and Developmental coordination disorder are often interchangeably used and an element of confusion exists. (Gibbs et al., 2007). Although the two terms appear to be similar, they differ in terms of thinking and perception. DCD is an umbrella term that covers the motor difficulties, whereas dyspraxia is a form of DCD with additional difficulties in planning, organizing and carrying out movements in right order in the activities of daily living. It can also affect speech articulation, perception and thought.

Causes of Dyspraxia

Immaturity in neuron development which is related with central nervous system is seen to be one of the causes of dyspraxia which results in physical and cognitive difficulties. (Dyspraxia Foundation 2014b.) Children born with low weight are more likely to be dypsraxic (Zwicker et al, 2013) and 50% of dyspraxic children have had birth complications (Grant n.d., p.9). There has often been a hereditary cause behind the specific learning disabilities with siblings also sometimes displaying the related issues (Alison Patrick).

Comorbidity between Dyslexia and Dyspraxia

Dyspraxia affects both physical and mental make up partly and manifests comorbidity with dyslexia and ADHD. (Gibbs et al., 2007). Children with dyspraxia are found to develop learning disabilities, especially dyslexia and score lower than their peers in academics despite of above average intelligence. (Iversen, Berg, Ellertsen, & Tonnessen, 2005; Jongmans, Smits-Engelsman, & Schoemaker, 2003; Zwicker et al., 2012). More than 50% of children with reading difficulty display motor coordination difficulties (Iversen, S., et al (2005). The scores of children with Dyspraxia on measures of attention and learning (reading, writing and spelling) were significantly low (Dewey et al (2002). They were at a high risk of reading and writing delay (O'Hare and Khalid (2002). Literacy difficulties are though seen in dyspraxic children they may not necessarily be dyslexic. Difficulties in short term memory are often encountered in dyspraxia, which is also one of the features of dyslexia.

Neuroanatomical Cause of the Comorbidity betwee Reading disorder and Dyspraxia

The coordination between the two brain hemispheres is responsible for the cognitive functions, which is unusually wired in children with dyslexia and dyspraxia. According to the neurologist Dr. Norman Geschwind (cited from West 1991) the symmetry in the brains can lead not only to special abilities but also difficulties in specific areas. The handwriting skills of children with dyspraxia is affected, which, according to the Dyspraxia Foundation (2014 c) may be due to the lack of handedness preference. The indecisiveness between the two brain hemispheres results in the individuals displaying different handedness for different tasks, which causes handwriting difficulties in dyspraxics throughout their lives. Statistical prevalence of left-handedness is seen in individuals with dyspraxia. which does not determine the brain dominance. (Denckla 1984) and (Holder 2005b). Dyspraxia is found to be associated with dyslexia, ADHD and Autism spectrum disorder. Although few characteristics of Autism spectrum disorder are displayed in dyspraxia, it does not come under ASD. One of the studies suggests dyspraxia to be a fundamental feature of autism on the account of motor skills deficits (Dzuik et al.,2007) Children with dyspraxia exhibit some difficulties associated with ADHD, which are limited to the characteristics such as lack of attention, distractibility and organization skills.

Dyslexia and Dyscalculia

The term dyscalculia is a combination of two words such as ‘dys’ and ‘calculia’ which are derived from two different languages- Greek and Latin respectively. It is one of the specific learning disabilities that is associated with language processing disorders which result in difficulties learning mathematical concepts ranging from understanding the basics of numbers to applying of the rules to solve problems. It is estimated that about 5% of school children are affected with dyscalculia and is most likely to have an influence on adult functioning.(Morrison, J. (2017).) Inspite of average or above average level of intelligence, these children are unable to understand basic operations such as addition, subtraction, multiplication, division and calculating time, using money is quite challenging for the children with dyscalculia. They may also have difficulty in learning geometrical patterns which are associated with visual-spatial processing. Apart from processing errors, children with dyscalculia also face memory and retrieval difficulties and require to employ the coping strategies throughout the life.Children with dyscalculia struggle a lot than children who find mathematics alone as difficult. Those who belong to the latter group may have developed difficulty in the area of mathematics because of lack of proper instructions. Sudha, P., & Shalini, A. (2014).

Symptoms of Dyscalculia

Children with dyscalculia have difficulty working with numbers, basic operations such as adding, subtracting, multiplying and dividing. They reverse the numbers often., eg. 73 as 37, get confused with the symbols such as (+ and x), have difficulty telling the time and directions while playing games, difficulty in estimation and approximation, understanding and remembering the math concepts, counting with fingers. They find mental calculation difficult. Sudha, P., & Shalini, A. (2014).

Causes of Dyscalculia

The shared environmental correlation is .96 and the non-shared environmental correlation is .08. Dyscalculia may be attributed to various factors such as innate, genetic, or developmental causes. Deficits in the capacity of the memory has also been the cause of dyscalculia as understanding mathematics requires a set of rules to be followed sequentially which is dependent on memory to remember the order of operations (Sood, V. (2013). This reduced capacity of the working memory and not generally found in dyscalculics but rather seen specifically for numerical

information(McLean and Hitch (1999). The disruption in the function of the intra parietal sulcus located in the parietal lobe of the brain and the numerical magnitude is seen in children with dyscalculia. (Ansari, 2008).The concepts pertaining to mathematics are attributed to both the left and right hemispheres of the brain and any disfunction to either of the two hemispheres may cause difficulty in comprehending arithmetics. The difficulty in understanding the properties of quantities and spatial concepts such as using place value is related to the dysfunction of the right hemisphere, whereas, difficulty in carrying out maths operations, sequencing numerically and comprehending abstract meanings of numbers is related to the dysfunction of left hemisphere. [cited in sudha shalini]

Comorbidity between Reading disorder and Dyscalculia

30-70% of children with either RD or MD appear to co-occur with each other (Kovas et al., 2007; Landerl & Moll, 2010, Ashkenazi, S.(2012).Developmental dyscalculia affects the ability of approximately 3-6% of individuals to acquire school-level arithmetic skills (Price, G. R., & Ansari, D. (2013). Rd and md are influenced by both genetic and environmental factors with correlation being .67 and .96 respectively (Kovas, Y. et al (2007). It is also seen to co-occur frequently with ADHD (Capano, Minden, Chen, Schacher, & Ickowicz, 2008).

A genetic correlation between reading disability and mathematics disability was found to be 0.67, suggesting that they are affected largely by the same genetic factors. (Kovas, Y. et al (2007).

Dyslexia and Dysgraphia

Dysgraphia

The word ‘dysgraphia’ is derived from Greek words which means a condition of an impaired handwriting. Dysgraphia is a specific learning disorder with impairment in written expression in which the individuals have problems with grammar, punctuation, spelling, and developing their ideas in writing. Children with dysgraphia find difficult to translate the auditory information to a written form which may be too hard to follow. This problem is believed to appear after the onset of SLD in reading which is usually after grade two or later, as the writing demands gradually increases after the acquisition of the reading skills. If the child is poorly co-ordinated, as in the case of DCD, which is more or less synonymous with dyspraxia, the diagnosis has to be very carefully done. Children with dyslexia and dysgraphia produce very irregular and/or unreadable

writing during word production, despite the absence of motor disorders.(Valdois et al., 2011). Some children with dyslexia find writing task to be more difficult than reading (Berninger, 2006; Mortimore &Crozier, 2006) and are often slow in the writing task that they are unable to cope up with the speed of their peers and lag begind in their work. Sumner et.al.,(2012). Apart from writing slowly (Søvik, N., & Arntzen, O. (1986), they commit a large number of spelling mistakes which clearly shows that they are poor spellers. (Afonso, O., Suárez-Coalla, P., & Cuetos, F. (2015).

Comorbidity between Dyslexia and Dysgraphia

Children with dyslexia are not only slow in writing tasks(Søvik, N., & Arntzen, O. (1986)., but also commit spelling mistakes. e.g., Afonso, Suárez-Coalla, et al., 2015; Chilosi et al., 2009).
A large number of spelling deficits is also seen in children with dyslexia which clearly shows that they are poor spellers. Afonso, O., Suárez-Coalla, P., & Cuetos, F. (2015).

Recommendations

Early identification of dyslexia can help in improving the reading accuracy with fluency being a problem into maturity. Reading for pleasure is often not seen among dyslexics as it is a tiring chore to interest the population of dyslexia. Psychometric testing with reading tests, intelligence tests such as the WISC-III are required in cases where learning problems continue to exist.

Impact of Comorbidity on Academics

The children with comorbid conditions exhibited higher impairment in academics and social skills than the children with only one of the conditions due to which they were at higher risk of being retained in the school. (Willcutt et al., 2007b).

Impact of Comorbidity on other Aspects

(Secondary problems such as low self-esteem, behavioral problems, and dropping out of school are commonly seen in children with comorbid problems than the children with a single comorbid condition. (Willcutt et al., 2001). Possibility of conduct disorder in children with comorbid problems is advocated by (Chadwick et al., 1999). It is beneficial to cover a small set of phonics to motivate the poor readers. Chen & Savage, 2014).

Chapter-II

Review of Litrature

Neurobiology: Asymmetry as a Cause of Dyslexia

P. Tamboer et al. (2015) conducted a study on students with and without dyslexia who belonged to a mean age of 20. They found a negative correlation between the volume of the gray matter in the left posterior part of the cerebellum and a factor pertaining to spelling performances. They found the caudate nucleus to be involved which was relatively a new finding. They suggested that based on the subtypes of dyslexia, the experiences influence the anatomical alterations.

P. Tamboer et al. (2015) compared two different groups on the grounds of their intelligence. Of the two groups, one consisted of 37 students suffering from dyslexia and the other consisted of 57 students without dyslexia. The Intelligence level of the students was measured using the Guilford's structure-of-intellect model and Raven's Progressive Matrices. The performance of the non-dyslexic group was better than the dyslexic group on the four subtests of the Guilford's cognitive battery whereas the two groups did not significantly differ in the Raven's Progressive Matrices.

Clark, K. A et al (2014) conducted a longitudinal study on 27 Norwegian children. These children were explored from their early childhood when they began to learn reading through their late childhood until they were eleven years old when they were diagnosed with dyslexia. It was found that the primary neuroanatomical abnormalities are in lower-level areas responsible for auditory and visual processing and core executive functions rather than in reading network itself. The abnormalities in the reading network, which were observed at the age of 11 were due to different reading experiences. It was concluded from the structural magnetic resonance imaging (MRI)scans that the cortical thickness was significantly lesser for children with dyslexia than those without dyslexia.

Many children with dyslexia have excellent IQ, memory, visual perception, speech, hearing and/or balance. Different levels of severity exist in developmental dyslexia, which affects the cognitive aspects and functions of children which may not necessarily be an obstacle in achieving success. People with dyslexia may be creative, good with number sense, may be active and healthy and

some may have a high IQ, which indicates of the condition being associated with the coordinated functions of the brain rather than its structures.

Annett,M (2011), who developed the right shift theory of handedness and cerebral dominance, has revealed the findings after repeated research that the dyslexics who have a phonological deficit are more likely to be left-handed whereas those who are dyseidetic are more likely to be right-handed. It was suggested from the Right Shift Analysis that different types of problems emerge from different patterns of brain asymmetry based on which every child varies from one another and hence clear distinctions must be made between them so as to give them the appropriate remedial strategies.

According to the perceptual anchor theory, deficits in auditory and phonological tasks is seen in children with dyslexia, which is not because of any impairments in auditory or phonological processes, but is due to their inability to form a 'perceptual anchor' in tasks that depend on a small set of repeated stimuli. The objective of the study was to compare the prediction made by the perceptual anchor theory that deficits in rapid naming should be present in only small sets of repeated items rather than the larger sets of unrepeated items. The findings of the study were contrary to the predictions made by the theory which clearly revealed that deficits were present in both small and large sets of items with the latter set displaying larger deficits.(Di Filippo, et al (2008))

There is a variation in the structural and functional basis of dyslexia depending on the type of language an individual is exposed to. For example the individuals with dyslexia who are exposed to alphabetic-languages such as English, show an abnormality in the volumetric gray matter present in the posterior brain systems which are found to be normal in the individuals who are exposed to non-alphabetic languages such as Chinese (Siok, W. T et.,al (2008).

Neurobiological studies using postmortem brain specimens and various imaging techniques such as magnetic resonance imaging (MRI), functional brain imaging, and electrophysiology reveal that the impaired and non-impaired readers differ in the temporo-parieto-occipital regions of the brain.

The functions of the posterior brain systems in the left hemisphere were improper in adults with dyslexia in fMRI studies Shaywitz, S. E., & Shaywitz, B. A. (2007).

Heikki Lyytinen* et al (2004), found the neuronal markers of dyslexia from the review of brain imaging studies, which revealed that the neuronal basis of language problems associated with difficulties in reading are due to auditory processes involved in speech perception. Event-related potentials (ERPs) was found to be effective in not only finding out if the child is at risk of dyslexia or not at an early age itself with the help of brain responses (ERPs) to speech sounds but also in predicting the development of languageand acquisition of reading skills in the later period.

The neurobiology of reading disability suggests that the asymmetrical differences in the planum temporal play a significant role in the functions. Also a strong relationship is seen between the planar asymmetry, hand preference, and general verbal skills. Eckert, M. A., & Leonard, C. M. (2000).

Neurobiological studies have focused on measuring the size and asymmetry of temporal lobe auditory structures as reading disability (RD) is considered a disorder of language, rather than vision. Leftward asymmetry of the planum temporale in the superior bank of the sylvian fissure, posterior to primary auditory cortex is well documented in the anatomical correlates of the language dominance in the left hemisphere.

In a study conducted on 21 dyslexic and 29 control students using magnetic resonance images Duara, R., et al (1991) found asymmetrical brain structures among dyslexics with the right side being larger in the frontal half of the horizontal brain section and the left side being larger in the occipital polar segment which is in the posterior part of the brain. The midposterior segment that corresponds to the angular gyrus was found to be asymmetrical with the right side being larger and the splenium in the corpus callosum was also found to be larger among the dyslexics than their counterparts. This suggests that anatomical differences exist in in the dyslexics. A gender difference was also seen among them with a larger splenium in the females than in males.

Maguire, E. A (1999) examined brain activations associated with the components of story processing. The anterior and ventral parts of the medial parietal/posterior cingulate cortex were found to be activated while hearing unusual stories, the medial parietal cortex (precuneus) and left prefrontal cortex activations were observed during story repetition and the medial ventral

orbitofrontal cortex and left temporal pole activations were found to be associated for the general aspects of comprehension.

Hier (1978) found asymmetry in the parieto-occipital area among 24 subjects suffering with dyslexia, out of which 16 subjects showed rightward asymmetry and ten subjects displayed a significantly lower verbal IQ than the subjects who displayed leftward symmetry.

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on chromosome 6p22 with exact gene contributing to its susceptibility being latent. Poelmans, G et.al (2009)

König IR et.al (2011) identified risk loci for dyslexia from 246 German families having dyslexia. They have evidently found a major locus of dyslexia on chromosome 6p21 which affects the cognitive traits. Apart from the existing dyslexia candidate genes such as DCDC2 and KIAA0319, they have identified an additional risk gene related to dyslexia.

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To investigate the relation between phonological processing abilities among poor readers, Kalaiah, M. K. (2015). conducted a study on 20 children aged between 7-12 years who were divided into two groups of ten participants each on the basis of their reading ability. The poor readers showed a significant deficit in the perception of speech and phonological processing abilities such as phonological awareness, verbal short-term memory and rapid automatized naming when compared to the other group. It was concluded that the phonological processing deficits that lead to reading difficulties may be due to a deficit in speech perception.

Wybrow, D. P., & Hanley, J. R. (2015). have challenged the previous studies who have shown phonological dyslexia to be more prevalent than surface dyslexia. The sample consisted of 41 dyslexic children of age 10-13 years. A control group was generated by matching the reading ability of the participants. The prevalence of surface dyslexia and phonological dyslexia was assessed by comparing their performance with that of the matched control groups of their opposite type. In other words, the prevalence of surface dyslexia was assessed by comparing it with the matched control group of phonological dyslexia and vice versa. The comparison with the opposite matched control groups led to the identification of children with surface and phonological dyslexia to be equal in number. It was concluded that children with dyslexia classified as a surface or phonological one were fairly similar when compared on the basis of chronological age and reading ability.

Children with dyslexia often show an impairment in auditory timing perception in which temporal grouping plays a vital role. Eveline Geiser et.,al (2014) investigated the effect of the impaired

temporal processing on the organizational structure of speech which is referred to as prosody, that affects the interpretation of the syntax and the comprehension in children with dyslexia. The researchers conducted this study on two groups of children, one with dyslexia and the other without dyslexia of age 6-8 years. The children's efficiency of sentence processing for temporary syntactic ambiguities was examined for their prosodic facilitation and the results showed that the temporal processing or the prosodic phrase boundaries usage for speech processing is not impaired in children with dyslexia.

In a study, the remedial effect of a training involving a nonverbal auditory-visual matching task on reading skills in developmental dyslexia was examined by Törmänen, M. R. K. & Takala, M. (2009). The sample for the study consisted of 41 children between the ages of 7 and 12. The pretest/post-test design was used and the training sessions of 15 minutes each was conducted twice weekly for a period of eight weeks. The results showed that the children scored better on the reading tests which included reading nonsense words and they also improved their speed in reading during the training period. It was concluded that it is the perceptual difficulties from which the reading difficulties partly emerge.

Ramus, F., et al (2003), conducted a multiple case study to evaluate the three theories of developmental dyslexia such as(i) the phonological theory, (ii) the magnocellular (auditory and visual) theory and (iii) the cerebellar theory among the adults. A battery of psychometric, phonological, auditory, visual and cerebellar tests were administered on the two groups of 16 adults each with one group of adults having dyslexia and the other group without dyslexia. It was found from the phonological subtest of the battery that all the 16 adults with dyslexia lacked the phonological component,whereas the other subtests of the battery such as auditory, visual and cerebellar tests showed deficits in their respective areas with varying number of adults in each category. The results supported the phonological theory by indicating that the deficit in phonological component is adequate enough to cause literacy impairment.

The causal relationships between pre-reading phonological awareness (PA) and reading success in first and third grades was explored by Kozminsky, L., & Kozminsky, E. (1995). These first and third grade children completed their kindergarten classes in the same school where they were pre-

trained with phonological awareness for a period of eight months. The effectiveness of the training was assessed three times with one being assessed during the training, the second time being assessed at the end of kindergarten and then at the end of the first grade. Reading comprehension was assessed at the end of the first and third grades. It was found that the initial phoneme isolation and sound deletion tasks of phonological awareness were the high predictors of success in reading acquisition in first-grade children.

Children with dyslexia have difficulties in fluent word recognition and spelling, which ultimately results in problems related to reading and comprehension. These difficulties are attributed to the deficit in the phonological component of language which not only impedes the vocabulary and knowledge development, but also affects their educational and vocational achievement to an extent that the disorder remains a life long condition even after intensive remediation . Richard Boada, Erik G. Willcutt, and Bruce F. Pennington (2012).

Nelson, J. M (2012), explored the relationship between phonological processing abilities and basic reading among 116 kindergarten and first grade children. Phonological awareness and rapid automatized naming were found to be inconsistent with word reading though rapid automatized naming is not much used practically.

Morris et al., 1998 attempted to identify the subtypes of reading disability in 232 children using cluster analysis which produced 7 subtypes of dyslexia. Out of these 7 subtypes, two displayed a deficit in language skills and the 4 subtypes displayed a relative variations in verbal short-term memory and rapid serial naming and a deficit in phonological awareness. The remaining one subtype was found to have a deficit in verbal and nonverbal measures associated with the processing rate of oral reading. It was concluded that children with dyslexia have deficit in phonological awareness.

Environmental causes

SES is lower for children with RD

Erik G. Willcutt and Bruce F. Pennington conducted a study on the four factors such as age, socioeconomic status (SES), IQ, and academic achievement among boys and girls with and without RD. The results indicated that the four groups did not differ with respect to age. The SES of the family and scores in the general cognitive ability and academic achievement were also lower for the children with RD than their counterparts.

The early stimulation required for childhood development is less likely to be received by the socially disadvantaged children and are hence especially at risk. Educational levels of the parents and the child's overall intellectual capabilities are the other causal factors of dyslexia. Morrison, J. (2017).

ADHD

RD and ADHD association and gender difference

Willcutt EG , Pennington BF (2000) conducted a comparative study to assess the relationship between ADHD and RD among the twins with and without reading disabilities. The sample of the study was 867 out of which 494 twins(223 girls, 271 boys) werewith reading disabilities and 373 were without reading disabilities (189 girls, 184 boys). They classified the symptoms of ADHD into teo types such as inattention and hyperactivity-impulsivity (H/I)based on DSM-III and DSM-IV critreria. Results indicated that individuals with RD were more likely than individuals without RD to meet criteria for ADHD and that the association between RD and ADHD was stronger for symptoms of inattention than for symptoms of H/I. it was found from the study that the criteria of ADHD were more likely to be met by the individuals having reading disabilities than the individuals without reading disabilities. A strong relationship between RD and the inattention type of ADHD was seen both in boys and girls whereas the relationship between RD and hyperactivity-impulsivity (H/I) type of ADHD is seen only in boys which is supportive in explaining the gender difference with the ratio being four boys to one girl.

Gender Difference

In a comparative study conducted among the children with and without RD it was seen that the criteria for DSM-III ADD / WO was met by the children of both the genders having dyslexia than the children of the same gender without dyslexia. The children with RD were compared with their same gender counterparts on two dimensions of ADD such as inattention and hyperactivity/impulsivity, in which both the boys and girls with RD scored more on the inattention type of ADD than their respective counterparts. In the second dimension, namely hyperactivity/impulsivity, the boys with RD showed a significant difference than the boys without RD whereas, there was no significant difference between the girls of the two groups.

Comorbidity between Rd and ADHD

RD and ADHD

Novita, S. (2016). Attempted to compare the relationship between dyslexia and its secondary symptoms such as high anxiety and low self-esteem among children with and without dyslexia. The sample for the study constituted of 124 school children of age ranging from eight to eleven years whose IQ and the reading and writing ability were also measured. The results showed that issues related to anxiety and self-esteem exist in children with dyslexia in a particular domain but not in general.

Sumner et al (2014), attempted to differentiate the developing children with the dyslexic children based on their spelling ability and found that the writing task is restricted due to their spelling ability.

Vieira, S.,et al (2013) compared the space representation among children with and without dyslexia by carrying out two tasks such as line bisection task and circle centering task. In the line bisection task, rightward bias was seen in central and right sided locations and leftward bias was seen for the left sided locations among the children with dyslexia, whereas no bias was observed among the other group of children. The groups also differed on the grounds of processing in the context of space, wherein the children with dyslexia exhibited an asymmetrical processing with more inclination towards the left side, whereas the children without dyslexia showed a clear symmetry in the processing. It was concluded from the findings that the two groups differed in their behavior based on the task.

The comorbidity between reading disability (RD, or dyslexia) and Attention Deficit Hyperactivity Disorder (ADHD), is attributed to both cognitive and genetic risk factors (McGrath et al., 2011; Willcutt et al., 2010).

McGrath, L. M et al (2011) examined a multiple cognitive deficit model of reading disability (RD), attention-deficit/hyperactivity disorder (ADHD), and their comorbidity. phonological awareness and response inhibition were involved in the model as a unique predictor of RD and ADHD respectively. The processing speed, naming speed, and verbal working memory were found to be potential shared cognitive deficits. It was concluded that the processing speed was the important factor for the phenotypic co-occurrence between reading and inattention.

There is a frequent co-occurrence of complex disorders such as ADHD and RD in childhood with the etiology being unrevealed. Willcutt et al., (2010) conducted a study to find the causes of RD, ADHD, and related disorders on 457twin pairs. Two groups with and without RD and ADHD were compared to find the causes for the association between any cognitive weaknesses and the disorders. It was found from the phenotypic analysis that both RD and ADHD are caused not by a single primary cognitive deficit, but multiple cognitive deficits. A deficit in cognitive factors such as phonemic awareness, verbal reasoning, and working memory was associated with RD and genetic factors were found to be associated with ADHD. The twin analysis revealed that the processing speed was the only cognitive factor that was commonly found in both RD and ADHD, thereby attributing it to the genetic influences.

Writing or copying is a complicated task for children with dyslexia as it requires both reading and writing tasks to coordinate sequentially which is rather thought to operate independently. Martlew (1992) examined the process of writing using a digitizing writing tablet among four groups of children who were categorized based on whether they were dyslexic, or were eight or ten year olds, or were in their typical developmental stage. The speed of eight year old children was quite slower than the ten year olds, whereas the children with dyslexia were found to commit more errors than the developing children which showed that children with dyslexia struggle with the process of spelling.

Dyscalculia

A deficit in the ability to generate and use a mental number line and in spatial orientation was observed in the individuals who have got injured in their right parietal cortex. (Zorzi et al. (2002) A deficit in spatial working memory task was seen in children with dyscalculia with the cause behind it being unclear such that it is caused either due to a deficit in executive function or inability to represent information in visuospatial systems. McLean, J. F., & Hitch, G. J. (1999).

Neurodevelopmental Changes During Mental Arithmetics:

Robin L. Peterson et al (2016) examined the unique and shared influences of multiple-cognitive predictors on word reading, math ability, and attention on a sample of 636 twins of age ranging from 8-16 years. The results indicated that the overlap between both reading and attention as well as math and attention was due to processing speed, while the overlap between reading and math was due to verbal comprehension. The difference in the variation of the predictors between the younger and older children was quite less.

Dyscalculia, a specific Learning Disorder with impairment in mathematics is a part of a larger nonverbal learning disability in which the individuals have difficulty in the number sense and the representation of numbers. They have difficulty in understanding the mathematical concepts and performing mathematical operations such as counting, recognizing symbols, learning multiplication tables, performing operations as simple as addition. It is estimated that about 5% of school children are affected with dyscalculia and is most likely to have an influence on adult functioning.

Landerl, K., & Moll, K. (2010). tested the preponderance and gender differences of specific learning disorders and their comorbidities in 293 elementary school children who were selected on the basis of presence of atleast one learning disorder. The data was collected from the parents through survey method. The comorbidity of arithmetic and reading disorder was found to be less mediated than the comorbidity of arithmetic and spelling disorder. With respect to isolated conditions, gender differences were found such as arithmetic disorders in girls and spelling disorder in boys while comorbid conditions were found to be stable in both the genders.

Capano, L.,et al (2008), assessed the predominance of dyscalculia compared to reading disorders and the influence of other factors such as age, sex and the subtype of ADHD on 476 children with

ADHD. Intelligence, academic attainment, and language abilities of the children were assessed using standardized tools and semi structured interviews from teachers and parents. The sample was divided into four groups based on the presence of co-existing learning disorders such as ADHD + RD, ADHD + dyscalculia, ADHD +dyscalculia + RD, and ADHD only. IQ, academic achievement and language abilities were found to be lower for ADHD children with either dyscalculia or reading disorder than in children with ADHD only. Deficits in receptive and expressive language were clearly observed in children who had all the three conditions such as ADHD, dyscalculia, and RD. Dyscalculia was found to be prevalent in children with ADHD and was also frequently found to be associated with RD.

Rivera, S. M., et al (2005) evaluated the neurodevelopmental changes in children aged 8-19 years while performing mental arithmetics. Greater activation in the left parietal cortex, along the supramarginal gyrus and adjoining anterior intra-parietal sulcus as well as the left lateral occipital temporal cortex was seen among the older subjects, whereas the prefrontal cortex, including the dorsolateral and ventrolateral prefrontal cortex and the anterior cingulate cortex was found to be activated among the younger subjects. There was no alteration in the density of gray matter, among the older subjects which clearly indicates functional maturation with age. The parts of the cortex that are shown to be activated in the younger children suggests that working memory and attentional resources are required relatively more to achieve similar levels of mental arithmetic performance.

Hanich et al. (2001) examined the mathematical cognition of 210 2nd grade children. They divided them into four groups in different combinations based on their achievement in mathematics and reading. Children who had difficulty in mathematics but not in reading surpassed the group of children with difficulty in both mathematics as well as reading in the tasks of problem solving and combination of arithmetic problems. Children having difficulty in both the areas were found to be inferior than the children having mathematical difficulty only in the areas that involved language but not in other areas which required visuospatial processing, automaticity and numerical magnitudes.

Dehaene et al., 1999 showed evidently that human capacity depend on both linguistic competence and visuo-spatial representations for mathematical intuition. Language dependence was examined between exact arithmetic and approximate arithmetic problems and was found that acquiring exact arithmetic is dependent on language and relies on the networks involved in word-association processes whereas the approximate arithmetic is not dependent on language and involves the bilateral areas of the parietal lobes involved in visuo-spatial processing.

DYSPRAXIA

The cognitive strengths of the individuals with dyspraxia may outweigh their physical weaknesses (Geschwind 1982). Their verbal intelligence is very higher than their performance IQ and hence they have a strong vocabulary which serves as an aid for some individuals to become highly literate despite of their slow auditory and visual processing rates. Gubbay, S. S. (1975)

Developmental coordination disorder is a neurologically based disorder that is characterized by difficulty in motor coordination and in performing daily activities that require motor skills. (Cermack, et al., 2002)

A dysfunction in the mirror neuron system which is also known as fronto-parietal circuit is also linked with the impairments associated with DCD. (Werner et al.,2012)

According to the National Institute of neurological Disorders and Stroke 2005, dyspraxia occurs when the messages are not efficiently passed from the brain to the body due to underdeveloped neurons. The neural pathways are not formed properly, which helps in performing tasks.

The study conducted by Gillberg (1999) was supported by Dewey D, (2002) et.al., who also found half of the children with DCD suffering with the symptoms of ADHD. Attention deficit symptoms of ADHD, reading and writing disorders are generally found to be associated with DCD.

Perceptual problems and symptoms of DCD are commonly seen in ADHD, regardless of the associated existence of learning disability. Raggio DJ (1999) ., Pitcher TM, Piek JP, Hay DA (2003)

Studies have shown the co- existence of ADHD and DCD with dyslexia. Dyslexia or the reading disorder is seen associated with ADHD and DCD. Empirical evidence have shown 50-80% of those diagnosed with both ADHD and DCD and 25-40% of children with only ADHD to be having reading disorders. Kadesjö B (2000).

Dyslexia and Dysgraphia:

The time taken to copy sentences is more in children with dyslexia than the children of their age Søvik, N., & Arntzen, O. (1986). And a variety of spelling deficits are also seen . A large number of spelling deficits is also seen in children with dyslexia which clearly shows that they are poor spellers. Afonso, O., Suárez-Coalla, P., & Cuetos, F. (2015).

Children of age 5-8 years write slowly and focus on reproducing the letters as written by the teacher. This process of reproducing the letters elaborate the sensory-motor maps for each letter which becomes stable by practice. (Halsband & Lange, 2006).

Interrelation of Comorbidity:

Mayes and coll. insisted that learning and attention problems are severe in children with deficits in reading, math, or spelling along with ADHD when compared to those who have only one of the deficits. Mayes, S. D.,et.al (2000)

Need for Early Intervention

In an attempt to evaluate the effectiveness of the intervention on the phonological skills and the effect of academic improvement on the behavioral and social skills, Lane, K. L., et al (2007) conducted a study on 24 students of first-grade. Out of 24 participants, 18 were boys and 6 were girls whose reading skills were poor and had emotional and behavioral disorders. It was found that the group which received the intervention improved significantly in the phonemic skills with moderate improvement in word attack skills but the behavioral and social skills did not show any difference. Gender difference was also not observed.

Academic underachievement is associated with ADHD in childhood and delinquency in adulthood. Intervention is essential in the early stage itself because of the learning problems and behavioral problems that appear in the early childhood and the negative course that emerges due to the comorbid conditions associated. Hinshaw, S. P. (1992).

Remedies for Academic Performance

The behavior of the children can be improved and the symptoms of dyslexia can be reduced with the help of supplements that are rich in omega-3 fatty acids.

Physical exercise helps in not only attaining a good health, but also in improving the academic performance.

A range of neurodevelopmental disorders such as developmental dyslexia, ADD and ASDs involves the use of substrates such as Omega-3-fatty acids, which are unsaturated and are necessary for neural development and function.

In a report submitted by Donnelly, J. E. et al (2009), on Physical Activity Across the Curriculum (PAAC) approach, a significant improvement was seen in the academic performance of the elementary children. (California Dept of Ed, 2001)

Physical activity and Academic Performance:

Donnelly, J. E. et al (2009), conducted a study for three years using Physical Activity Across the Curriculum (PAAC) approach which was a cluster randomized, controlled trial. 26 elementary schools received the physically active academic lessons, as part of the PAAC approach for 90 min/week that ranged from moderate to vigorous levels. The findings showed significant changes in the academic achievement scores.

Carlson, S. A et al (2008), conducted a longitudinal study on kindergarten children through fifth grade to explore the relationship between academic performance and the time spent on physical activities. An item response theory scale was used to assess the academic performance, especially in mathematics and reading and the time spent in physical activities was obtained from the respective teachers. There was a gender difference in the benefits attained in the academic performance by the involvement in physical activities. Girls showed a significant difference from boys in the academic benefits attained by involving more in the physical education.

Effectiveness of Phonological Awareness in Reading Achievement

Treutlein, A., et al (2008) attempted to examine the phonological awareness training effects on the reading achievement of children for which an experimental and control group of 107 participants each was taken. The phonological awareness training was given to the experimental group and was later compared with the control group to evaluate its effectiveness. It was found from the study that girls were benefitted from the training sooner than the boys and that that the preschool training in phonological awareness facilitates reading acquisition.

Chapter-II

Review of Litrature

Neurobiology: Asymmetry as a Cause of Dyslexia

P. Tamboer et al. (2015) conducted a study on students with and without dyslexia who belonged to a mean age of 20. They found a negative correlation between the volume of the gray matter in the left posterior part of the cerebellum and a factor pertaining to spelling performances. They found the caudate nucleus to be involved which was relatively a new finding. They suggested that based on the subtypes of dyslexia, the experiences influence the anatomical alterations.

P. Tamboer et al. (2015) compared two different groups on the grounds of their intelligence. Of the two groups, one consisted of 37 students suffering from dyslexia and the other consisted of 57 students without dyslexia. The Intelligence level of the students was measured using the Guilford's structure-of-intellect model and Raven's Progressive Matrices. The performance of the non-dyslexic group was better than the dyslexic group on the four subtests of the Guilford's cognitive battery whereas the two groups did not significantly differ in the Raven's Progressive Matrices.

Clark, K. A et al (2014) conducted a longitudinal study on 27 Norwegian children. These children were explored from their early childhood when they began to learn reading through their late childhood until they were eleven years old when they were diagnosed with dyslexia. It was found that the primary neuroanatomical abnormalities are in lower-level areas responsible for auditory and visual processing and core executive functions rather than in reading network itself. The abnormalities in the reading network, which were observed at the age of 11 were due to different reading experiences. It was concluded from the structural magnetic resonance imaging (MRI)scans that the cortical thickness was significantly lesser for children with dyslexia than those without dyslexia.

Many children with dyslexia have excellent IQ, memory, visual perception, speech, hearing and/or balance. Different levels of severity exist in developmental dyslexia, which affects the cognitive aspects and functions of children which may not necessarily be an obstacle in achieving success.

People with dyslexia may be creative, good with number sense, may be active and healthy and some may have a high IQ, which indicates of the condition being associated with the coordinated functions of the brain rather than its structures.

Annett,M (2011), who developed the right shift theory of handedness and cerebral dominance, has revealed the findings after repeated research that the dyslexics who have a phonological deficit are more likely to be left-handed whereas those who are dyseidetic are more likely to be right-handed. It was suggested from the Right Shift Analysis that different types of problems emerge from different patterns of brain asymmetry based on which every child varies from one another and hence clear distinctions must be made between them so as to give them the appropriate remedial strategies.

According to the perceptual anchor theory, deficits in auditory and phonological tasks is seen in children with dyslexia, which is not because of any impairments in auditory or phonological processes, but is due to their inability to form a 'perceptual anchor' in tasks that depend on a small set of repeated stimuli. The objective of the study was to compare the prediction made by the perceptual anchor theory that deficits in rapid naming should be present in only small sets of repeated items rather than the larger sets of unrepeated items. The findings of the study were contrary to the predictions made by the theory which clearly revealed that deficits were present in both small and large sets of items with the latter set displaying larger deficits.(Di Filippo, et al (2008))

There is a variation in the structural and functional basis of dyslexia depending on the type of language an individual is exposed to. For example the individuals with dyslexia who are exposed to alphabetic-languages such as English, show an abnormality in the volumetric gray matter present in the posterior brain systems which are found to be normal in the individuals who are exposed to non-alphabetic languages such as Chinese (Siok, W. T et.,al (2008).

Neurobiological studies using postmortem brain specimens and various imaging techniques such as magnetic resonance imaging (MRI), functional brain imaging, and electrophysiology reveal that the impaired and non-impaired readers differ in the temporo-parieto-occipital regions of the brain.

The functions of the posterior brain systems in the left hemisphere were improper in adults with dyslexia in fMRI studies Shaywitz, S. E., & Shaywitz, B. A. (2007).

Heikki Lyytinen* et al (2004), found the neuronal markers of dyslexia from the review of brain imaging studies, which revealed that the neuronal basis of language problems associated with difficulties in reading are due to auditory processes involved in speech perception. Event-related potentials (ERPs) was found to be effective in not only finding out if the child is at risk of dyslexia or not at an early age itself with the help of brain responses (ERPs) to speech sounds but also in predicting the development of languageand acquisition of reading skills in the later period.

The neurobiology of reading disability suggests that the asymmetrical differences in the planum temporal play a significant role in the functions. Also a strong relationship is seen between the planar asymmetry, hand preference, and general verbal skills. Eckert, M. A., & Leonard, C. M. (2000).

Neurobiological studies have focused on measuring the size and asymmetry of temporal lobe auditory structures as reading disability (RD) is considered a disorder of language, rather than vision. Leftward asymmetry of the planum temporale in the superior bank of the sylvian fissure, posterior to primary auditory cortex is well documented in the anatomical correlates of the language dominance in the left hemisphere.

In a study conducted on 21 dyslexic and 29 control students using magnetic resonance images Duara, R., et al (1991) found asymmetrical brain structures among dyslexics with the right side being larger in the frontal half of the horizontal brain section and the left side being larger in the occipital polar segment which is in the posterior part of the brain. The midposterior segment that corresponds to the angular gyrus was found to be asymmetrical with the right side being larger and the splenium in the corpus callosum was also found to be larger among the dyslexics than their counterparts. This suggests that anatomical differences exist in in the dyslexics. A gender difference was also seen among them with a larger splenium in the females than in males.

Maguire, E. A (1999) examined brain activations associated with the components of story processing. The anterior and ventral parts of the medial parietal/posterior cingulate cortex were found to be activated while hearing unusual stories, the medial parietal cortex (precuneus) and left prefrontal cortex activations were observed during story repetition and the medial ventral

orbitofrontal cortex and left temporal pole activations were found to be associated for the general aspects of comprehension.

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Children with dyslexia often show an impairment in auditory timing perception in which temporal grouping plays a vital role. Eveline Geiser et.,al (2014) investigated the effect of the impaired

temporal processing on the organizational structure of speech which is referred to as prosody, that affects the interpretation of the syntax and the comprehension in children with dyslexia. The researchers conducted this study on two groups of children, one with dyslexia and the other without dyslexia of age 6-8 years. The children's efficiency of sentence processing for temporary syntactic ambiguities was examined for their prosodic facilitation and the results showed that the temporal processing or the prosodic phrase boundaries usage for speech processing is not impaired in children with dyslexia.

In a study, the remedial effect of a training involving a nonverbal auditory-visual matching task on reading skills in developmental dyslexia was examined by Törmänen, M. R. K. & Takala, M. (2009). The sample for the study consisted of 41 children between the ages of 7 and 12. The pretest/post-test design was used and the training sessions of 15 minutes each was conducted twice weekly for a period of eight weeks. The results showed that the children scored better on the reading tests which included reading nonsense words and they also improved their speed in reading during the training period. It was concluded that it is the perceptual difficulties from which the reading difficulties partly emerge.

Ramus, F., et al (2003), conducted a multiple case study to evaluate the three theories of developmental dyslexia such as(i) the phonological theory, (ii) the magnocellular (auditory and visual) theory and (iii) the cerebellar theory among the adults. A battery of psychometric, phonological, auditory, visual and cerebellar tests were administered on the two groups of 16 adults each with one group of adults having dyslexia and the other group without dyslexia. It was found from the phonological subtest of the battery that all the 16 adults with dyslexia lacked the phonological component,whereas the other subtests of the battery such as auditory, visual and cerebellar tests showed deficits in their respective areas with varying number of adults in each category. The results supported the phonological theory by indicating that the deficit in phonological component is adequate enough to cause literacy impairment.

The causal relationships between pre-reading phonological awareness (PA) and reading success in first and third grades was explored by Kozminsky, L., & Kozminsky, E. (1995). These first and third grade children completed their kindergarten classes in the same school where they were pre-

trained with phonological awareness for a period of eight months. The effectiveness of the training was assessed three times with one being assessed during the training, the second time being assessed at the end of kindergarten and then at the end of the first grade. Reading comprehension was assessed at the end of the first and third grades. It was found that the initial phoneme isolation and sound deletion tasks of phonological awareness were the high predictors of success in reading acquisition in first-grade children.

Children with dyslexia have difficulties in fluent word recognition and spelling, which ultimately results in problems related to reading and comprehension. These difficulties are attributed to the deficit in the phonological component of language which not only impedes the vocabulary and knowledge development, but also affects their educational and vocational achievement to an extent that the disorder remains a life long condition even after intensive remediation . Richard Boada, Erik G. Willcutt, and Bruce F. Pennington (2012).

Nelson, J. M (2012), explored the relationship between phonological processing abilities and basic reading among 116 kindergarten and first grade children. Phonological awareness and rapid automatized naming were found to be inconsistent with word reading though rapid automatized naming is not much used practically.

Morris et al., 1998 attempted to identify the subtypes of reading disability in 232 children using cluster analysis which produced 7 subtypes of dyslexia. Out of these 7 subtypes, two displayed a deficit in language skills and the 4 subtypes displayed a relative variations in verbal short-term memory and rapid serial naming and a deficit in phonological awareness. The remaining one subtype was found to have a deficit in verbal and nonverbal measures associated with the processing rate of oral reading. It was concluded that children with dyslexia have deficit in phonological awareness.

Environmental causes

SES is lower for children with RD

Erik G. Willcutt and Bruce F. Pennington conducted a study on the four factors such as age, socioeconomic status (SES), IQ, and academic achievement among boys and girls with and without RD. The results indicated that the four groups did not differ with respect to age. The SES of the family and scores in the general cognitive ability and academic achievement were also lower for the children with RD than their counterparts.

The early stimulation required for childhood development is less likely to be received by the socially disadvantaged children and are hence especially at risk. Educational levels of the parents and the child's overall intellectual capabilities are the other causal factors of dyslexia. Morrison, J. (2017).

ADHD

RD and ADHD association and gender difference

Willcutt EG , Pennington BF (2000) conducted a comparative study to assess the relationship between ADHD and RD among the twins with and without reading disabilities. The sample of the study was 867 out of which 494 twins(223 girls, 271 boys) werewith reading disabilities and 373 were without reading disabilities (189 girls, 184 boys). They classified the symptoms of ADHD into teo types such as inattention and hyperactivity-impulsivity (H/I)based on DSM-III and DSM-IV critreria. Results indicated that individuals with RD were more likely than individuals without RD to meet criteria for ADHD and that the association between RD and ADHD was stronger for symptoms of inattention than for symptoms of H/I. it was found from the study that the criteria of ADHD were more likely to be met by the individuals having reading disabilities than the individuals without reading disabilities. A strong relationship between RD and the inattention type of ADHD was seen both in boys and girls whereas the relationship between RD and hyperactivity-impulsivity (H/I) type of ADHD is seen only in boys which is supportive in explaining the gender difference with the ratio being four boys to one girl.

Gender Difference

In a comparative study conducted among the children with and without RD it was seen that the criteria for DSM-III ADD / WO was met by the children of both the genders having dyslexia than the children of the same gender without dyslexia. The children with RD were compared with their same gender counterparts on two dimensions of ADD such as inattention and hyperactivity/impulsivity, in which both the boys and girls with RD scored more on the inattention type of ADD than their respective counterparts. In the second dimension, namely hyperactivity/impulsivity, the boys with RD showed a significant difference than the boys without RD whereas, there was no significant difference between the girls of the two groups.

Comorbidity between Rd and ADHD

RD and ADHD

Novita, S. (2016). Attempted to compare the relationship between dyslexia and its secondary symptoms such as high anxiety and low self-esteem among children with and without dyslexia. The sample for the study constituted of 124 school children of age ranging from eight to eleven years whose IQ and the reading and writing ability were also measured. The results showed that issues related to anxiety and self-esteem exist in children with dyslexia in a particular domain but not in general.

Sumner et al (2014), attempted to differentiate the developing children with the dyslexic children based on their spelling ability and found that the writing task is restricted due to their spelling ability.

Vieira, S.,et al (2013) compared the space representation among children with and without dyslexia by carrying out two tasks such as line bisection task and circle centering task. In the line bisection task, rightward bias was seen in central and right sided locations and leftward bias was seen for the left sided locations among the children with dyslexia, whereas no bias was observed among the other group of children. The groups also differed on the grounds of processing in the context of space, wherein the children with dyslexia exhibited an asymmetrical processing with more inclination towards the left side, whereas the children without dyslexia showed a clear symmetry in the processing. It was concluded from the findings that the two groups differed in their behavior based on the task.

The comorbidity between reading disability (RD, or dyslexia) and Attention Deficit Hyperactivity Disorder (ADHD), is attributed to both cognitive and genetic risk factors (McGrath et al., 2011; Willcutt et al., 2010).

McGrath, L. M et al (2011) examined a multiple cognitive deficit model of reading disability (RD), attention-deficit/hyperactivity disorder (ADHD), and their comorbidity. phonological awareness and response inhibition were involved in the model as a unique predictor of RD and ADHD respectively. The processing speed, naming speed, and verbal working memory were found to be potential shared cognitive deficits. It was concluded that the processing speed was the important factor for the phenotypic co-occurrence between reading and inattention.

There is a frequent co-occurrence of complex disorders such as ADHD and RD in childhood with the etiology being unrevealed. Willcutt et al., (2010) conducted a study to find the causes of RD, ADHD, and related disorders on 457twin pairs. Two groups with and without RD and ADHD were compared to find the causes for the association between any cognitive weaknesses and the disorders. It was found from the phenotypic analysis that both RD and ADHD are caused not by a single primary cognitive deficit, but multiple cognitive deficits. A deficit in cognitive factors such as phonemic awareness, verbal reasoning, and working memory was associated with RD and genetic factors were found to be associated with ADHD. The twin analysis revealed that the processing speed was the only cognitive factor that was commonly found in both RD and ADHD, thereby attributing it to the genetic influences.

Writing or copying is a complicated task for children with dyslexia as it requires both reading and writing tasks to coordinate sequentially which is rather thought to operate independently. Martlew (1992) examined the process of writing using a digitizing writing tablet among four groups of children who were categorized based on whether they were dyslexic, or were eight or ten year olds, or were in their typical developmental stage. The speed of eight year old children was quite slower than the ten year olds, whereas the children with dyslexia were found to commit more errors than the developing children which showed that children with dyslexia struggle with the process of spelling.

Dyscalculia

A deficit in the ability to generate and use a mental number line and in spatial orientation was observed in the individuals who have got injured in their right parietal cortex. (Zorzi et al. (2002) A deficit in spatial working memory task was seen in children with dyscalculia with the cause behind it being unclear such that it is caused either due to a deficit in executive function or inability to represent information in visuospatial systems. McLean, J. F., & Hitch, G. J. (1999).

Neurodevelopmental Changes During Mental Arithmetics

Robin L. Peterson et al (2016) examined the unique and shared influences of multiple-cognitive predictors on word reading, math ability, and attention on a sample of 636 twins of age ranging from 8-16 years. The results indicated that the overlap between both reading and attention as well as math and attention was due to processing speed, while the overlap between reading and math was due to verbal comprehension. The difference in the variation of the predictors between the younger and older children was quite less.

Dyscalculia, a specific Learning Disorder with impairment in mathematics is a part of a larger nonverbal learning disability in which the individuals have difficulty in the number sense and the representation of numbers. They have difficulty in understanding the mathematical concepts and performing mathematical operations such as counting, recognizing symbols, learning multiplication tables, performing operations as simple as addition. It is estimated that about 5% of school children are affected with dyscalculia and is most likely to have an influence on adult functioning.

Landerl, K., & Moll, K. (2010). tested the preponderance and gender differences of specific learning disorders and their comorbidities in 293 elementary school children who were selected on the basis of presence of atleast one learning disorder. The data was collected from the parents through survey method. The comorbidity of arithmetic and reading disorder was found to be less mediated than the comorbidity of arithmetic and spelling disorder. With respect to isolated conditions, gender differences were found such as arithmetic disorders in girls and spelling disorder in boys while comorbid conditions were found to be stable in both the genders.

Capano, L.,et al (2008), assessed the predominance of dyscalculia compared to reading disorders and the influence of other factors such as age, sex and the subtype of ADHD on 476 children with ADHD. Intelligence, academic attainment, and language abilities of the children were assessed using standardized tools and semi structured interviews from teachers and parents. The sample was divided into four groups based on the presence of co-existing learning disorders such as ADHD + RD, ADHD + dyscalculia, ADHD +dyscalculia + RD, and ADHD only. IQ, academic achievement and language abilities were found to be lower for ADHD children with either dyscalculia or reading disorder than in children with ADHD only. Deficits in receptive and expressive language were clearly observed in children who had all the three conditions such as ADHD, dyscalculia, and RD. Dyscalculia was found to be prevalent in children with ADHD and was also frequently found to be associated with RD.

Rivera, S. M., et al (2005) evaluated the neurodevelopmental changes in children aged 8-19 years while performing mental arithmetics. Greater activation in the left parietal cortex, along the supramarginal gyrus and adjoining anterior intra-parietal sulcus as well as the left lateral occipital temporal cortex was seen among the older subjects, whereas the prefrontal cortex, including the dorsolateral and ventrolateral prefrontal cortex and the anterior cingulate cortex was found to be activated among the younger subjects. There was no alteration in the density of gray matter, among the older subjects which clearly indicates functional maturation with age. The parts of the cortex that are shown to be activated in the younger children suggests that working memory and attentional resources are required relatively more to achieve similar levels of mental arithmetic performance.

Hanich et al. (2001) examined the mathematical cognition of 210 2nd grade children. They divided them into four groups in different combinations based on their achievement in mathematics and reading. Children who had difficulty in mathematics but not in reading surpassed the group of children with difficulty in both mathematics as well as reading in the tasks of problem solving and combination of arithmetic problems. Children having difficulty in both the areas were found to be inferior than the children having mathematical difficulty only in the areas that involved language but not in other areas which required visuospatial processing, automaticity and numerical magnitudes.

Dehaene et al., 1999 showed evidently that human capacity depend on both linguistic competence and visuo-spatial representations for mathematical intuition. Language dependence was examined between exact arithmetic and approximate arithmetic problems and was found that acquiring exact arithmetic is dependent on language and relies on the networks involved in word-association processes whereas the approximate arithmetic is not dependent on language and involves the bilateral areas of the parietal lobes involved in visuo-spatial processing.

DYSPRAXIA

The cognitive strengths of the individuals with dyspraxia may outweigh their physical weaknesses (Geschwind 1982). Their verbal intelligence is very higher than their performance IQ and hence they have a strong vocabulary which serves as an aid for some individuals to become highly literate despite of their slow auditory and visual processing rates. Gubbay, S. S. (1975)

Developmental coordination disorder is a neurologically based disorder that is characterized by difficulty in motor coordination and in performing daily activities that require motor skills. (Cermack, et al., 2002)

A dysfunction in the mirror neuron system which is also known as fronto-parietal circuit is also linked with the impairments associated with DCD. (Werner et al.,2012)

According to the National Institute of neurological Disorders and Stroke 2005, dyspraxia occurs when the messages are not efficiently passed from the brain to the body due to underdeveloped neurons. The neural pathways are not formed properly, which helps in performing tasks.

The study conducted by Gillberg (1999) was supported by Dewey D, (2002) et.al., who also found half of the children with DCD suffering with the symptoms of ADHD. Attention deficit symptoms of ADHD, reading and writing disorders are generally found to be associated with DCD.

Perceptual problems and symptoms of DCD are commonly seen in ADHD, regardless of the associated existence of learning disability. Raggio DJ (1999) ., Pitcher TM, Piek JP, Hay DA (2003)

Studies have shown the co- existence of ADHD and DCD with dyslexia. Dyslexia or the reading disorder is seen associated with ADHD and DCD. Empirical evidence have shown 50-80% of

those diagnosed with both ADHD and DCD and 25-40% of children with only ADHD to be having reading disorders. Kadesjö B (2000).

Dyslexia and Dysgraphia

The time taken to copy sentences is more in children with dyslexia than the children of their age Søvik, N., & Arntzen, O. (1986). And a variety of spelling deficits are also seen . A large number of spelling deficits is also seen in children with dyslexia which clearly shows that they are poor spellers. Afonso, O., Suárez-Coalla, P., & Cuetos, F. (2015).

Children of age 5-8 years write slowly and focus on reproducing the letters as written by the teacher. This process of reproducing the letters elaborate the sensory-motor maps for each letter which becomes stable by practice. (Halsband & Lange, 2006).

Interrelation of Comorbidity

Mayes and coll. insisted that learning and attention problems are severe in children with deficits in reading, math, or spelling along with ADHD when compared to those who have only one of the deficits. Mayes, S. D.,et.al (2000)

Need for Early Intervention

In an attempt to evaluate the effectiveness of the intervention on the phonological skills and the effect of academic improvement on the behavioral and social skills, Lane, K. L., et al (2007) conducted a study on 24 students of first-grade. Out of 24 participants, 18 were boys and 6 were girls whose reading skills were poor and had emotional and behavioral disorders. It was found that the group which received the intervention improved significantly in the phonemic skills with moderate improvement in word attack skills but the behavioral and social skills did not show any difference. Gender difference was also not observed.

Academic underachievement is associated with ADHD in childhood and delinquency in adulthood. Intervention is essential in the early stage itself because of the learning problems and behavioral problems that appear in the early childhood and the negative course that emerges due to the comorbid conditions associated. Hinshaw, S. P. (1992).

Remedies for Academic Performance

The behavior of the children can be improved and the symptoms of dyslexia can be reduced with the help of supplements that are rich in omega-3 fatty acids.

Physical exercise helps in not only attaining a good health, but also in improving the academic performance.

A range of neurodevelopmental disorders such as developmental dyslexia, ADD and ASDs involves the use of substrates such as Omega-3-fatty acids, which are unsaturated and are necessary for neural development and function.

In a report submitted by Donnelly, J. E. et al (2009), on Physical Activity Across the Curriculum (PAAC) approach, a significant improvement was seen in the academic performance of the elementary children. (California Dept of Ed, 2001)

Physical activity and Academic Performance

Donnelly, J. E. et al (2009), conducted a study for three years using Physical Activity Across the Curriculum (PAAC) approach which was a cluster randomized, controlled trial. 26 elementary schools received the physically active academic lessons, as part of the PAAC approach for 90 min/week that ranged from moderate to vigorous levels. The findings showed significant changes in the academic achievement scores.

Carlson, S. A et al (2008), conducted a longitudinal study on kindergarten children through fifth grade to explore the relationship between academic performance and the time spent on physical activities. An item response theory scale was used to assess the academic performance, especially in mathematics and reading and the time spent in physical activities was obtained from the respective teachers. There was a gender difference in the benefits attained in the academic performance by the involvement in physical activities. Girls showed a significant difference from boys in the academic benefits attained by involving more in the physical education.

Effectiveness of Phonological Awareness in Reading Achievement

Treutlein, A., et al (2008) attempted to examine the phonological awareness training effects on the reading achievement of children for which an experimental and control group of 107 participants each was taken. The phonological awareness training was given to the experimental group and was later compared with the control group to evaluate its effectiveness. It was found from the study that girls were benefitted from the training sooner than the boys and that that the preschool training in phonological awareness facilitates reading acquisition.

Chapter-III

Methodology

Introduction

Research is defined as a systematic search for pertinent information on a specific topic. It is the search for knowledge through objective and systematic method of finding solution to a problem. The description, explanation and justification of various methods of conducting research is called as research methodology. This chapter presents a clear description of research design, variables, tools, sample of the study, method of data collection and the statistics that will be used to analyze the data.

Aim

To identify students with Dyslexia and comorbid conditions like ADHD, dyscalculia, dysgraphia and dyspraxia using standardized tests. An intervention of using the Multisensory Techniques and

Objectives

1. Identify the nature and origin of dyslexia and comorbid conditions associated with it.
2. Designing a model by using the multisensory techniques and Brain Gym exercises.
3. Remedial Intervention to improve learning skills and social skills of children with dyslexia.

Variables

The study focuses on the conditions such as ADHD, Dyscalculia, Dygraphia, and Dyspraxia that are found to co-occur with Dyslexia.

The academic akills and social skills of each comorbid condition associated with Dyslexia are the dependent variables. The independent variable is the intervention model.

The descriptive variables are as follows:

- Age : ranging from 8-14

- Gender : Male / Female
- Class : 3-5 / 6-8
- Type of school: Government School / Private School / Special School
- Parent's qualification :
  Mother and Father : illiterate / School / UG / PG / Above PG
- Parent's occupation:
  Mother : Home maker / Self-employed / Private / Government
  Father : Self-employed / Private / Government

Hypotheses

Hypotheses of the present study are,

- Experimental group and Control group of children with dyslexia would significantly differ in pre-test on comorbidity ADHD, Academic skill and social skills.
- Intervention model would be effective in reducing the symptoms of comorbid condition- ADHD, poor social skills and enhancing the Academic skills among children with dyslexia.
- The scores of the Control group of children with dyslexia would significantly differ between the pre-test and post-test in comorbidity - ADHD, Academic skills and social skills.
- Experimental group and Control group of children with dyslexia would significantly differ in post-test in comorbidity- ADHD, Academic skill- reading and social skills.
- Experimental group and Control group of children with dyslexia would significantly differ in pre-test on comorbidity Dyscalculia, Academic skill- reading and social skills.
- Intervention model would be effective in enhancing comorbid condition of Dyscalculia, Academic skill and social skills among children with dyslexia.
- Control group of children with dyslexia would be significantly differ between pre-test and post-test in comorbidity Dyscalculia, Academic skill and social skills.
- Experimental group and Control group of children with dyslexia would be significantly differ in post-test on comorbidity Dyscalculia, Academic skill and social skills.
- Experimental group and Control group of children with dyslexia would be significantly differ in pre-test on comorbidity Dysgraphia, Academic skill and social skills.

- Intervention model would be effective in enhancing comorbid condition of Dysgraphia, Academic skill and social skills among children with dyslexia.
- Control group of children with dyslexia would be significantly differ between pre-test and post-test in comorbidity Dysgraphia, Academic skill and social skills.
- Experimental group and Control group of children with dyslexia would be significantly differ in post-test on comorbidity Dysgraphia, Academic skill and social skills.
- Experimental group and Control group of children with dyslexia would be significantly differ in pre-test on comorbidity Dyspraxia, Academic skill and social skills.
- Intervention model would be effective in enhancing comorbid condition of Dyspraxia, Academic skill and social skills among children with dyslexia.
- Control group of children with dyslexia would be significantly differ between pre-test and post-test in comorbidity Dyspraxia, Academic skill and social skills.
- Experimental group and Control group of children with dyslexia would be significantly differ in post-test on comorbidity Dyspraxia, Academic skill and social skills.
- Academic skill would be related to social skills of children with dyslexia
- Academic skill would influence social skills of children with dyslexia

Research Method

The research adopted a qualitative, quantitative and Quasi- experimental method of study. In qualitative method semi structured interviews was conducted among dyslexic children and their parents, teachers, and friends to understand the nature and sources of the problem. This qualitative method of research will help to understand dyslexia deeply in different aspects such as genetics, environment and other factors. This study was conducted in two phases : Phase - I and Phase -II

Phase-I

The Phase-I consisted of an identification of comorbidity factors associated with Dyslexia such as Dyscalculia, Dysgraphia, ADHD, and Dyspraxia by using standardized tools. For this purpose survey and interview methods were adopted.

Phase-II

Phase -II consisted of three parts:

- Pre-test
- Developing an Intervention Model and
- Post-test

Pre –Test Phase

In the Pre- test phase the academic performance and social skills of dyslexic children were assessed using standardized psychological tools. It was supported by interviews conducted on both Parents and Teachers.

Model Development Phase

Based on the performance of children and their requirements, Intervention Model was developed to enhance both the academic and social aspects.

In Intervention Model Cognitive therapy, Behaviour therapy, Counselling&Guidance, Brain Gymexercises, and strategies specific to each comorbidity were given. This developed intervention model was implemented for 43 children with dyslexia with the comorbidities for a period of 6 months.

Post-Test

After implementation of Intervention model, the academic performance and social skills were assessed again by conducting post-test to find the difference from pre-test. Based on the post test scores effectiveness of the developed Intervention Model was assessed.

Research Design

The research choose Descriptive and Diagnostic Design in this study

Tools Used

The data was collected through survey method using the following standardized tools.

1. DST-J: (Dyslexia Screening Test – Junior and Senior)
2. Wide Range Achievement Test –IV (WRAT-IV) by Gary S.Wilkinson, PhD and Gary J. Robertson, PhD to assess the reading level of children.
3. ADHDT2 (Attention – Deficit/ Hyperactivity Disorder Test second edition by James E. Gilliam)
4. VLDC (Verbal Learning Disability Checklist-by Vishal Sood) for assessing Dyscalculia and Dysgraphia.

5. NVLDC (Non-Verbal Learning Disabilities Checklist- by Vishal Sood) for assessing socio-emotional disabilities.
6. Developmental Coordination Disorder Questionnaire (DCDQ) by B.N. Wilson, for assessing Dyspraxia.

In addition to these tools, the personal data sheet (Appendix-1) was also given.

Description of the Tools

1. DST-J consists of the following subtests

This tool consists of 12 subtests and is used for children with age group of 6.6 to 11.5 years. Rapid Naming, Bead Threading, One Minute Reading, Postural Stability, Phonemic Segmentation, Rhyme, Two Minute Spelling, Backwards Digit Span, Nonsense Passage Reading, One Minute Writing, Verbal Fluency, semantic fluency and Vocabulary. The test-retest reliability of this tool is 0.90. The tool has face and construct validity.

2. DST-S consists of the following subtests

This tool also consists of 12 subtests and is used for the children of age ranging from 11.6 to 16.5 years. Rapid Naming, Bead Threading, One Minute Reading, Postural Stability, Phonemic Segmentation, spoonerisms, Two Minute Spelling, Backwards Digit Span, Nonsense Passage Reading, One Minute Writing, Verbal Fluency, Rhyme, and Vocabulary. The test-retest reliability of this tool is 0.95 and the inter-rater reliability is 0.98. Face and construct validity is well established.

3.WRAT-IV

WRAT-IV stands for Wide Range Achievement Test –IV (WRAT-IV) by Gary S.Wilkinson, PhD and Gary J. Robertson, PhD to assess the reading level of children. WRAT-IV measures the basic academic skills of word reading, sentence comprehension, spelling, and math computation. For the children with dyslexia, academic skills are affected because of the basic academic skills – reading, which is the basis for the other aspects of academics such as writing and comprehension, the reading subtest was only used to assess the reading level of children. The internal consistency reliability coefficient of the tool is 0.98 and has both internal and external validity.

4. ADHDT2: (Attention – Deficit/ Hyperactivity Disorder Test second edition by James E. Gilliam)

ADHDT2 (Attention – Deficit/ Hyperactivity Disorder Test second edition by James E. Gilliam) was used to assess the attention deficits and hyperactivity of the children with dyslexia. This questionnaire was given to the teachers who rated the child's activities. The cronbach's alpha of the tool was 96, test-retest reliability was 84 and interrater reliability was 90 which shows that the ADHDT2 has a high degree of reliability. The tool has adequate content-description validity, face validity, criterion-prediction validity, and construct-identification validity.

5.VLDC stands for Verbal Learning Disability Checklist developed by Vishal Sood. This checklist is for the age group of 8 years to 15years and includes subtests related to verbal learning disabilities such as dyslexia, dysgraphia, dyscalculia and speech and language comprehension disabilities. This tool was used to assess the occurrence of Dysgraphia and Dyscalculia in children with dyslexia. The Dysgraphia subtest consists of 9 items and dyscalculia consists of 10 items. The test-retest reliability was 0.89 (teacher's rating) and 0.94 (parent's rating) and the inter-rater reliability of the tool was 0.81. The tool had adequate content, predictive, item validity. The inter-rater reliability coefficient of 0.81 is itself evident of both internal consistency and intrinsic validity of verbal learning disability checklist (VLDC).

6.NVLDC stands for Non-Verbal Learning Disability Checklist developed by Vishal Sood for the age group of 8-15 years and includes subtests related to Non-verbal learning disabilities such as auditory and visual perception disabilities, fine motor skills disabilities, ADHD, and socio-emotional disabilities. This checklist was used to assess the social skills of the children with dyslexia and other comorbidities, which consisted of 18 items. The reliability index 'r' of the tool was 0.76 and had adequate content and predictive validity.

7. DCDQ- stands for Developmental Coordination Disorder Questionnaire (DCDQ) by B.N. Wilson . It is an appropriate clinical screening tool for DCD in children aged 5-15 years. It consists of 15 items. The Cronbach's alpha coefficient of 0.89 shows that the tool has a high internal consistency and test-retest reliability of the tool is 0.94 (Tseng et al., 2010) . the tool has construct and concurrent validity.

Sample And Sampling

Sample

The sample for this study comprised of 8-14 year old children with dyslexia and the comorbidities associated with it such as ADHD, dyscalculia, dysgraphia and dyspraxia. Of the 170 total sample 82 children were taken for the intervention as they had only one co-occuring condition along with dyslexia. Rest of the 88 samples were found to have more than one comorbidity and were hence not included for intervention. Because intervention model was developed for single conditions with dyslexia and the effectiveness of the model would have got biased if the whole sample had been considered. Although the remaining sample of 94 children were not included for the intervention purpose, it showed that dyslexia does not necessarily co-occur with just one comorbidity but may occur with more than one comorbidities or with combinations of other conditions.

Sample Size

1. 170 children Boys: Girls =3:1
2. Age group 8-14 years

Sampling Method

The sampling method adopted in this study was purposive or non-probability sampling which involves purposive selection of particular units of the universe for constituting a sample which represent the universe. When population elements are selected for inclusion in the sample based on the ease of access, it can be called convenience sampling.

Method of data collection:

The investigator collected the data from 3 private schools, 1 Government school and 1 special school. The children were initially screened for Dyslexia and were then examined on the other aspects through the questionnaires related to the comorbidities. ADHD, dyscalculia, dysgraphia, dyspraxia and socio-emotional disabilities questionnaires were given to the teachers to rate the extent of their student's performance in respective areas. Confidentiality of their responses was assured. The collected data were scored as per the respective scoring keys.

Data Processing

The data collected were tabulated and analyzed using appropriate statistical tools such as Statistical analysis Mean, Standard Deviation, Mann- whitney U test, wilcoxon Signed Rank Test, MANOVA, Kruskal Wallis test, Pearson Product Moment Correlation, and Regression.

Correlation

Pearson's correlation coefficient is the covariance of the two variables divided by the product of their standard deviations. The form of the definition involves a "product moment", that is, the mean (the first moment about the origin) of the product of the mean-adjusted random variables; hence the modifier product-moment in the name. Product-moment correlation was used to find the relationship between variable.

Regression

Influence of independent variable on the dependent variables was assessed using regression.

Wilcoxon signed rank test

The Wilcoxon signed-rank test is a non-parametric statistical hypothesis test used to compare two related samples, matched samples, or repeated measurements on a single sample to assess whether their population mean ranks differ (i.e. it is a paired difference test). It can be used as an alternative to the paired Student's t-test, t-test for matched pairs, or the t-test for dependent samples when the population cannot be assumed to be normally distributed. A Wilcoxon signed-rank test is a nonparametric test that can be used to determine whether two dependent samples were selected from populations having the same distribution.

Mann-whitney U test

In statistics, the Mann–Whitney U test is a nonparametric test of the null hypothesis that it is equally likely that a randomly selected value from one sample will be less than or greater than a randomly selected value from a second sample.Unlike the t-test it does not require the assumption of normal distributions. It is nearly as efficient as the t-test on normal distributions. This test can be used to determine whether two independent samples were selected from populations having the

same distribution; a similar nonparametric test used on dependent samples is the Wilcoxon signed-rank test.

INTERVENTION MODEL - DEVELOPMENT AND IMPLEMENTATION

Introduction

Through the screening test of dyslexia and other comorbidities, the needs of the children were identified depending on which the intervention model was developed for the improvement of their academic and social skills, which were one of the three objectives of this research. This developed intervention model was implemented for a period of six months from November 2017 to April 2018 on a group of 43 children with dyslexia having different comorbid conditions such as ADHD, dyscalculia, dyspraxia, and dygraphia.

The data from 170 students were collected from different types of schools such as Government school, special school and private schools through the screening test which was the part of phase-I. Out of this 170 sample, 82 children were found to have one dominant comorbidity along with dyslexia and were taken for the intervention purpose with 43 children for experimental group and 39 for control group. The remaining 88 children had more than one comorbidity and hence were not taken for intervention purpose.The children who belonged to the private schools were taken for the experiment as their locations were near to one another which aided the investigator to conduct the 60 sessions of the intervention in each of the three different schools with ease.

The experimental group was divided into three groups A,B,C based on their comorbidities such as ADHD, dyscalculia, dysgraphia and dyspraxia respectively with age ranging from 8-14 years. The group ‘A’ had 21 students altogether from three different schools with only ADHD as a comorbidity. The second group ‘B’ of dyscalculia consisted of 11students and the third group ‘C’of 8 students consisted of both the students with dysgraphia and students with dyspraxia. All the three schools had three groups each and corresponding strategies were given to the respective groups.

The 40 participants for the experimental group were selected based on few criteria as the following:

1. Children with dyslexia having only one dominant comorbidity (one of the four comorbidities of dyslexia included in the study).

2. Availability of the sample that was easy to reach.

The 60 sessions were divided into 12 sessions per month for 5 consecutive months. These 12 sessions were divided into three sessions twice a week for each school with two sessions on the first day and one session on the second day. The duration of each session was one to one and half hours. The sessions were conducted separately for all the three groups A,B,and C.

> Intervention was given to 40 students who belonged to three different schools, who were classified into three different groups based on their comorbidities in each of the three schools. So the sessions were scheduled in such a way that every school had three sessions for two consecutive days per week rounding up to 8 days of 12 sessions per month.

The above schedule of two days was repeated every week, which rounded up the figure to 8 days of 12 sessions per month. The 12 sessions were divided into 3 sessions per week, which were carried out in two days with two sessions on first day and the third session on the second day. The sessions focused on improving academic skills and social skills and reducing the comorbidity conditions.

The model consists of strategies to improve two main aspects of dyslexic children with comorbidities - academic skills and social skills

The present study focuses on children with dyslexia and the co-occuring conditions whose symptoms vary from one another. Finding pure dyslexic children is difficult as they are always found with one or the other comorbid conditions. Hence the intervention development was focused on a holistic aspect that covers strategies for the comorbid conditions such as ADHD, dyscalculia, dyspraxia, and dysgraphia, which can help individuals with these different conditions to utilize the specific strategies required.

The main objective behind developing this intervention model is to improve the academic skills and social skills of the children with dyslexia and its associated comorbid conditions. The children with dyslexia struggle mainly with reading, writing and spelling. Strategies for academics were

given commonly to all the 40 participants of the experimental group along with the brain gym exercises for their respective conditions and were compared with the 36 students who were considered as belonging to a control group.

Keeping the symptoms of their respective comorbidities in mind, some strategies were used.

Strategies for Academics

Reading, writing and spelling are the necessary skills one must have in order to understand the concept and express it during exams to achieve success in academics. Of these, the most important one is reading, which is acquired only when one has attained the knowledge of phonics. Phonics helps in decoding the words by spelling out their respective sounds. And when the individuals learn to spell, they easily cope up with writing as well.

The academic part of the model includes strategies for reading, writing, and spelling as the children with dyslexia are impaired in reading.

Reading

The children were first screened for their reading disability using DST- Junior and senior and AT-IV.

The Strategies for Reading

1. Phonemic awareness.
2. Sight words
3. ROR (Repeated oral Reading)
4. Paired reading.

Based on the grade values obtained through WRAT-IV they were classified into groups and were given the strategies according to the intervention schedule.

Brain Gym Exercises

1.Belly breathing

2. Brain buttons

3. cross-crawl

Activities

Simple to complex fun-filled reading activities were given after teaching sight words. The students were divided into three groups based on their comorbidities and were named as A, B, C. the gr

Children with dyslexia having ADHD- Group A

Children with dyslexia having dyscalculia- Group B

Children with dyslexia having dysgraphia and Children with dyslexia having dyspraxia are together grouped as Group-C

Hand and finger exercises for Dysgraphia- by Dr. Phyllis:

1. Hand Press
2. Shoulder rolls
3. Chicken wings
4. Superman hands
5. Scoop
6. Wind shield wipers
7. Finger stretches
8. Finger tapping
9. All fingers tapping
10. Hand twist
11. Hand Press

These exercises are designed by Dr. Phyllis to help the fine motor and gross motor skills so that the handwriting becomes smoother and legible. A whole set of exercises especially to make sure your hands and your pen is working beautifully. These exercises would stimulate the muscles and the connections between the body and the brain so that the writing becomes easier. Mild background music is also helpful as children love music.

1. HAND PRESS

The students are asked to join their hands close together and press them close to their heart and are asked to think about their desire regarding their writing. They are asked to press the hands in such a way that their desires or intentions are pressed right into their heart.

2. SHOULDER ROLLS

The children are asked to loosen their shoulders that have the big muscles and start rolling their shoulders forward and backward for 60 seconds. Then the same is asked to perform with one shoulder at a time alternating with the other. The procedure is continued with the shoulders moving forward and backward and vice versa for few seconds in the beginning with the time increasing eventually. They are reminded of having a smile on their face all the time.

3. CHICKEN WINGS

This exercise proceeds from the shoulders down to the elbows, pretending to cluck like a chicken by bringing the elbows together in, with both the elbows touching each other and the elbows must be at the height of the shoulders when drawn out which looks like chicken wings, when repeated with elbows in and out, in and out, stimulating the shoulder girdle. This procedure can be done slowly in the beginning and alternated with a faster pace i.e the students are asked to do fast a few times then slow down and again faster and so on. They are then asked to shake their shoulders and hands and relax for a while. This exercise activates the brain and helps in not only writing, but also putting the thoughts on to paper.

4. SUPERMAN HANDS

The arms are stretched forward straight to the shoulders like superman and the hands are brought straight up and back to neutral and up again and back to neutral. This activates the muscles of the forearm near the elbow. It's important to keep the elbows straight. They are reminded of having a smile on their face. They are then asked to shake their shoulders and hands and relax for a while.

Initially, it would pain, but slowly by practice, it strengthens the muscles involved in holding the pen or pencil.

5. SCOOP

This is the opposite of superman hands in which hands are laid out straight with elbows also straight and the hands arescooped or clawed down and drawn back to neutral.This is repeated initially 10 times and is slowly increased. They are then asked to shake their shoulders and hands and relax for a while.

6. WIND SHIELD WIPERS

The arms are again laid out straight as in the previous exercise with the hands straight up and are waved sideways back and forth like a wind shield. Sometimes, the fingers are holded close together and sometimes apart with the elbows straight all the time. They are then asked to shake their shoulders and hands and relax for a while.

7. FINGER STRETCHES

The arms are laid out straight with hands upwards. The fingers are then stretched apart and brought close together and the same is repeated several times. . They are then asked to shake their shoulders and hands and relax for a while.

8. FINGER TAPPING

The arms are laid out straight with the palms facing upwards and the thumbs and small fingers are tapped with one another for several times.

9. ALL FINGERS TAP

This exercise is same as the previous one with variation being tapping of all the fingers with the thumb one by one. The finger tips are pressed a little. This can be repeated in same direction or otherwise. The same procedure of tapping fingers is then repeated with the palms facing downwards. So, this activity of tapping fingers with palms facing up and down can be repeated alternatively.

Pressing of the finger tips activates the brain and connects the right muscles to the right parts.

10. HAND TWIST

The arms are stretched with the palms facing each other. The hands are then turned downwards with the palms facing outwards and the thumbs are stretched perpendicular to the palms. Now the hands are brought back to the initial position with the palms facing upwards and the small finger standing upright. So the thumbs are pushed down and lifted up with the small finger. This exercise is begun slowly and the speed is increased gradually.

11. HAND PRESS

Hand press is the same first exercise which we began with. Here, we join our hands together placing them near the heart and press them with the thoughts in the mind that negatives are being squashed.

Activities Schedule

Month	Week	Sessions	Strategies (common for all comorbidities.)	Activities for comorbidities		
				Group-'A' ADHD	Group-'B' Dyscalculia	Group-'C' Graphia and Praxia
1st	1	1	Self- intro- rapport building-(10), Reading skill (25), Brain Gym (B.G) (10), Activity- (15) **[60 M]**	Sit straight for 30 sec-break-30 sec calm	Writing numbers on a sheet .	Writing alphabets on ruled sheet. Hand exercises-(3) Hand press, shoulder rolls, chicken wings.
		2	Phonetics (vowels and vowel sounds)- (30), (B.G)(10), Activity- (20) **[60 M]**			
		3	Phonetics- long vowels-(30), Social skills-good-bad jar (20) (B.G)(10), Activity (20) [**1:20 M]**			
		4	Phonetics –long vowels- 20, activity- tell the words that get long vowel sounds-10,	sit straight for 30 sec-break-30 sec calm.	Arranging numbers in order,	Board writing, tracing the

	2		(B.G)- 10, Comorbidity activity- 20 **[60 M]**	.	Activity-big and small numbers Good and the Evil Game	alphabets on board 'a' to 'e' Hand ex 1-3
		5	Spell and write words with long vowels- 30, (B.G)-10, comorb activity- 20 **[60 M]**			
		6	Basic sight words– 20, (B.G)- 10, comorbidity activity- 10, good-bad jar- 10, **[60 M]**			
	3	7	Phonetics – short vowels-20, (B.G)- 10, Activity- words with short vowels-20, comorbidity activity- 10 [**60 M]**	Pause-break-pause game.	'See-say' game.	1.Tracing the alphabets on the sheet. 'a' to 'e' 2.Hand exercises-(1 to 4) 3. Bead threading.
		8	Phonetics – short vowels-30, (B.G)-10, comorbidity activity- 20 [**60 M]**			
		9	Basic sight words-30, Recalling of the phonetics rules-10, (B.G)-10, comorbidity activity- 10 [**60 M]**			
	4	10	(B.G), all the activities of 1st three weeks (9 sessions are repeated.	Rehearsing the activities of the first three week sessions in the last week of the month.		
		11				
		12				
	5	13	Phonetics- consonant sounds-20, (B.G)-10, Activity-small C-V-C words -15, comorbidity	1.Stand and run (2 minutes),	Marble counting,	1.Board writing, air writing,

2nd			activity- 15 [**60 M]**	2. Marble solitaire game.	estimation of figures.	2.Hand exercisces- 1 to 5. 3. Tracing on the sheet .
		14	Pronounce &write (P-W)-20 (B.G)-10, sight words-20, comorbidity activities-10 [**60 M]**			
		15	Phonetics- consonant sounds -20, (B.G)-10 , comorb activities-20, button jar-10 [**60 M]**			
	6	16	Phonetics- consonant sounds Sight words-20, (B.G)-10, comorb activities-30 [**60 M]**	Bead threading Marble solitaire game.	estimation of figures - activity	Tracing ‘f’ to ‘j’; Hand exercises 1-5 Bead threading
		17	Basic Sight words-number names -20, (B.G)-10, comorbidity activities- 30 [**60 M]**			
		18	Sight words- spell and read 30, (B.G) - 10, button jar-10, comorbidity activities- 30 **[1:20M]**			
	7	19	Phonetics- blends-30,(B.G)-10, finding blend words- 20 [**60 M]**	Thermocolcolor ball separating activity	Number line. Number line activity	Writing on ruled sheet ‘a’ to ‘j’. Buttoning activity for dyspraxia. Hand ex 1-5
		20	Sight words with blends-20, (B.G)-10, comorb activities-30. [**60 M]**			

		21	Spell and write-(dictation-5 words)-10, (B.G)-10, good buttons-10, comorbidity activities-30			
	8	22 23 24	The activities of 2nd month (session no 13 to 21) were rehearsed.	Phonetics- consonant sound, blends and sight words. Making new words with consonants and vowels given to them.		
3rd	9	25	Phonetics- ending blends-20, (B.G) -10, P-W -20, comorbidity activities- 30 **[1:20 M]**	Activity- 1. ATC, 2. Run-Run stand in numbers.	1. Tables of '2'- 'Handy two'method. 2. Number line Activity	Tracing 'k' to 'o', Kneading the clay and making shapes. Hand ex 1-7
		26	Finding ending blend words-20, (B.G)-10, comorbidity activities- 20, button jar- 10 **[60 M]**			
		27	P-W ending blends -20, Reading -10, (B.G)-10, talk one good thing about your friend- (SS)-20 **[60 M]**			
	10	28	Phonetics- Beginning diagraphs-30, (B.G)-10, comorbidity activities- 20. **[60 M]**	Memory game, Memorising technique.	Circles of table '2-activity',	Tracing 'P' to 't', pressing smiley ball, scissors activity. Hand ex 1-7.
		29	Beginning diagraphs-Sight words-20, (B.G)-10, comorbidity activities- 30, **[60 M]**			
		30	Sight words- spell and write-20 (B.G)-10, button jar -10,			

			comorbidity activities- 20. **[60 M]**			
	11	31	Finding diagraph words-20, Reading-15, (B.G)-10, comorbidity activities- 15. **[60 M]**	Run the ground, Naming ball game. Phonemic segmentati-on	Tables of '2', Even odd numbers using number line 1's come out game	Run the ground, tracing on sheet from 'k' to 't', hand exercises. Naming ball game.
		32	Basic sight words- about colors-20, (B.G)-10, comorbidity activities-30 **[60 M]**			
		33	P-W diagraphs-15, reading -15, (B.G)-10, button jar-helping others-20 **[60 M]**			
	12	34	The activities of 3rd month (session no 25 to 33) were rehearsed.	Reading flashing words, blends, diagraphs. .		
		35				
		36				
4th	13	37	Phonetics- Ending diagraphs- 30, (B.G)-10, comorbidity activities-20 **[60 M]**	Substitute the word with the letter said. (change the initial)	Counting large quantities, Table '5' game	Writing without tracing 'a' to 't'; Hand exercises, Buttoning activity.
		38	Finding words with ending diagraphs-20, (B.G)-10, comorbidity activities-30. **[60 M]**			
		39	Finding and placing blends and diagraph words -20, (B.G)-10, button jar-10, share your good memories-20. **[60 M]**			

	14	40	Paired reading -20, (B.G)-10, comorbidity activities -30. **[60 M]**	opposite act (sit-stand, up-down) game Rapid naming of the pictures	Teaching 'Time' using '5' tables. Shop-keeper game	Opposite act, tracing sheet 'u' to 'z', Hand exercises. Ball pressing activity.
		41	Finding the dictated word (words from paired reading)30, (B.G)-10, comorbidity activities- 20 **[60 M]**			
		42	Paired reading- sight words with blends -20, (B.G)-10, comorbidity activities-10 **[60 M]**			
	15	43	Paired reading- sight words with diagraphs -20, (B.G)-10, comorbidity activities-30 **[60 M]**	Marble solitaire game. Thermocol balls Phonemic segmentation	Place value Activity – placing no.cards in the respective places	Writing on sheet without tracing- 'a' to 'z', Syringe writing. Hand exercises.
		44	'Exchange test' (in pairs)-25, (B.G)-10, button jar- 10, comorbidity activities-15 **[60 M]**			
		45	Reading - sentences with diagraphs- 20, (B.G)-10, Finding words and P-W-20, button jar-10. **[60 M]**			
	16	46	The activities of 4th month (session no 37 to 45) were rehearsed.	Placing words with blends, diagraphs, C-V-C in respective cateogories.		
		47				
		48				
	17	49	Paired reading- sentences with known words 20, (B.G)-10, comorbidity	Quick- quick game, arranging	Place value activities - Ones and tens	Cutting shapes using scissors.

			activities-30 **[60 M]**	home related accessories like small sofa set, kitchen vessels. Etc.		ADHD activities, Hand exercises.
		50	Reading non-sense words-10, Paired reading -10, (B.G)-10, comorbidity activities-30 **[60 M]**			
		51	R-O-R-20, (B.G)-10, comorbidity activities-20, button jar-(wait for turn)-10. **[60 M]**			
	18	52	Reading sight words- about animals - 15, (B.G)-10, Spell and write-15, comorbidity activities- 20.	Water measuring game, Thermocol ball separation.	Place value -ones, tens, hundreds. Time reahearsing .	Writing with time, Ribbon tying, Hand exercises, zig-zag running.
		53	Paired reading-20, (B.G)-10, Read the word and find the picture-20, comorbidity activities-10.			
		54	Rehearsing sight words-blends and diagraphs-20,P-W-sight words20, (B.G)-10, button jar- Praising others-10.			
	19	55	Sight words blends-20, Reading sentences with blends -20, (B.G)-10, comorbidity activities-10.	Balloon hitting, jumping	Odd- even circle game.	Balloon hitting, ADHD activities, Hand
		56	Sight words with diagraphs-20, reading sentences with			

			diagraphs -30, (B.G)-10, comorbidity activities-20.	opposite (in and out)	Shop-keeper game.	exercises, writing words on sheet.
		57	Self-reading – choose picture and write - 20, (B.G)-10, writing words of the picture shown-20, Accepting mistakes, button jar-10			
	20	58	The activities of 5th month (session no 49 to 57) were rehearsed	Reading non-sense words.		
		59				
		60				

Brain Gym Exercises- (B.G):

ACADEMICS	Reading	1. Belly breathing 2. Brain buttons 3. cross-crawl
	Spelling and writing	Figure 8s 2. cross-crawl 3.Belly breathing 4. Brain buttons
COMORBIDITIES	ADHD	1. Thinking cap 2. Brain buttons 3. Cross crawl
	Dyscalculia	1.Thinking cap 2. Calf-pump 3.Elephant
	Graphia and praxia	Figure 8 S and other hand exercises.

All the sessions were same for all the three groups- A,B,C with difference in the comorbidity activities (i.e)., all the three A's had same comorbidity activities, the 'B'groups had their respective comorbidity activities, and 'C' groups had same comorbidity activities. Each session was conducted separately for all the three groups for an hour or more with three sessions in two days per week.

1st session in the forenoon with one hour for each group –

9.00am to 10.00 am –ADHD
10.05 am to 11.05 am- dyscalculia
11.15 am to 12. 15 pm – dysgraphia and dyspraxia

2nd session in the afternoon for all the three groups.
1.00 pm-2.00pm
2.05 pm-3.05 pm
3.15pm -4. 15 pm
These two sessions were conducted on the first day and the third session was conducted in the forenoon of the next day. The afternoon session of the second day was used for evaluating the performance of each child. Based on the researcher's observation in the three sessions related materials were given to their regular teachers to practice the same in their remedial classes on the remaining three days of the week.
This was repeated throughout the intervention period for 5 months.

SESSION: 1 TO 6

In the first session, children were asked to introduce themselves and the researcher was successful in building rapport with them.

Reading:

The students were asked to read a paragraph from their grade book to check their level of reading and to know the point to start for every child in the group. In the next session vowels and their

sounds were taught for 30 minutes, long vowels which give the sounds of the letters itself, basic sight words such as a, an, the, they, them, and, to etc., and activities such as telling words that have long vowel sounds, spell and write words with long vowel sounds.

1. Vowels and their sounds
2. Long vowels, activity: telling words with long vowel sounds.
3. Spell and write words with long vowel sounds.
4. Basic sight words such as a, an, the, they, them, and, to etc.

Brain Gym: (B.G): (10 minutes/session)

The brain gym exercises were conducted for ten minutes.

Activity: 15 minutes

Group –A: (ADHD)

Children with ADHD were asked to sit straight on their chairs with hands folded for 30 seconds and were given a break for 30 seconds and were again asked to resume the same posture for 1 minute and were let free for a minute. Gradually the sitting time was increased to 3 minutes with the break time constantly being 30 seconds. It was difficult for the children in the beginning, but they enjoyed once they were told that they will be rewarded if they follow the instructions.

Group –B: (Dyscalculia)

1. Children were asked to write numbers from 0-100 on a sheet of paper.
2. Arranging numbers in order
3. Activity-big and small numbers (Good and the Evil Game)

   Good and the Evil Game:

   The game is to teach the children chanting, the difference between large and small, increasing and decreasing.

   Two dice are given and 100 squares are made on a cardboard. The child is asked to throw the dice and look at the number they have arrived at and move their coins. These 100

squares are all not uniform. Some have instructions on it which brings them down sometimes. This is to teach them the difference in small and big numbers.

Group –C: (Dysgraphia and Dyspraxia)

1. Writing alphabets on ruled sheet.
2. Hand exercises-(1-3): Hand press, shoulder rolls, chicken wings.
3. Board writing
4. Tracing the alphabets on board-'a' to 'e'
5. Hand exercises: 1-3

Social skills

Good-button jar

All the students were allotted a color in the beginning itself and were handed a packet of color buttons and were asked to bring them to the classes. They were told that whatever good they do would not go unnoticed and will be rewarded for the same any time later.Everysmall act such as helping friends, behaving well in the class, giving chance to others, sharing things etc would be counted and the children who behaves well and listens to the instructions will be applauded and their color buttons would be dropped in the good-button jar. The one whose color buttons are dropped more in the jar would be rewarded. Every good act of the students was appreciated which motivated the other students also. And if the students' behavior was found to be inappropriate, they were counseled separately and were motivated to do the good.This was done in every third session. An activity for the social skills was conducted at the end of every 12th session which was at the end of a month

Social skills (Good-Bad Jar)

Children are allotted colors and every small good and appropriate behaviour of every child is noticed by the investigator and whenever it is noticed the investigator asks the color of the child to remind everyone of its importance and puts the color button into the jar in front of everyone. This motivates the other children to behave properly and be a good child to win the same next time.

Session 7- 12

Reading

1. Short vowels
2. Activity: words with short vowels
3. Basic sight words
4. Rehearsing long and short vowel sounds and their usage.

Brain Gym: (B.G): (10 minutes/session)

The brain gym exercises were conducted for ten minutes.

Comorbidity Activities

Group –A: (ADHD)

Pause-break-pause game

See the sand clock and watch it until the whole sand drops down- break –pause. This position of sitting still is referred to as the 'pause' and then a break of few seconds is referred to as 'break' which is again continued with the pause. This helps the ADHD children to focus attention and at the same time to sit still at a place.

Group –B: (Dyscalculia)

'See-say' game:

The investigator arranges the plastic toy numbers as two digit numbers. The children are asked to tell the names of the numbers as whole. For eg. If the investigator presents the number as '63' the child has to name it as 'sixty-three'. This is to check the knowledge of the child about the numbers.

Group –C: (Dysgraphia and Dyspraxia)

Board writing

The child is asked to write the first five English small alphabets ‘a’ to ‘e’ on the board with the chalk. Then the investigator writes the 5 alphabets of moderate size on the board at a height that is reached by the child with ease. The child is asked to trace the figure until the child traces it correctly.

1. Tracing the alphabets on the sheet-‘a’ to ‘e’
2.Handexercises. -(1 to 4) superman hands exercises was added as 4^{th} exercise to the previous three exercises such as Hand press, shoulder rolls, chicken wings.
3. Bead threading.
4. Dyspraxia: same as ADHD (Pause-break-pause)

SOCIAL SKILLS- ACTIVITY

The students were given different pictures and were asked to describe the pictures by pointing out the good and bad out of it. They were told to tell the moral of the story.

WEEK 4: REHEARSAL OF ALL THE ACTIVITIES DONE SO FAR
SESSION-13 to 18

Academics: - Reading

1. Consonant sounds
2. Finding C-V-C words.
3. Pronounce &write (P-W)
4. Consonant sounds Sight words
5. Basic Sight words-number names
6. Sight words- spell and read

C-V-C

Consonant –Vowel- Consonants.

Children are asked to find CVC words from newspaper cuttings. This helps them recognize the consonants and vowels visually.

Brain Gym: (B.G): (10 minutes/session)

The brain gym exercises were conducted for ten minutes.

Comorbidity Activities

Group –A: (ADHD)

1. Stand and run (2 minutes)
   Children with ADHD were asked to run at the same place, (i.e) stand and run for 30 seconds initially, followed by couple of minutes' break, then again they were asked to run for 1 minute and the break period being the same.
   Slowly, the duration of running is increased and the break duration is decreased.
2. Marble-solitaire game is a game with round plastic or wooded board with 33 pegs in them and 32 marbles. These pegs are arranged with the marbles except the centre peg and the child has to make the moves such a way that the entire board is emptied and the central peg is left with the marble.This game is played individually and increases the child's attention power. The children do not reach the goal of single marble but the least number of marbles that are left in their entire number of trials is considered to be their improvement. Their planning ability is increased with every trial.

Group –B: (Dyscalculia)

- Marble-counting, estimation of figures.
  The children with dyscalculia were asked to count the marbles. The counting started initially as one, two, three and so on.
  Then they were given a handful of marbles and asked to estimate the number of marbles just by looking at it.
  Activity
  An activity from Brian Butterworth and Dorian Yeo was used to teach the students with dyscalculia to estimate and count.The marbles are arranged in tens and the children are asked to count the marbles as one, two, three and arrange them in tens.

They are arranged in a line with a clear gap between every tenth marble.Then a number is told and the students are asked to point out the number on the marble line. Then the students are asked to count the marbles in tens such as ten, twenty, thirty, forty and so on. Once the children become familiar with the tens counting, a number is told at random and students are asked to point out the correct number on the marble line without counting from the beginning as one, two etc. their answers are recorded. Similarly, by pointing to the track of marble the students are asked to estimate what number it is. In this way they learn to estimate and count numbers.

Group –C: (Dysgraphia and Dyspraxia)

1.Board writing- 'f' to 'j'

2.Handexercisces- 1 to 5.-the 5^{th} exercise named as Scoop by Dr.Phyllis was introduced and all the exercises were given from 1^{st} to 5^{th}.

3. Tracing on the sheet- 'f' to 'j'

Social skills

Good-button jar

By session 18, most of the children were curious of getting good buttons and corrected themselves when they were wrong or mischievous. Children with ADHD were disorganised and the activities for them were conducted accordingly.

Session 19 to 24

Academics: - Reading

1. Phonetics- blends
2. Finding blend words
3. Sight words with blends
4. Spell and write-(dictation-5 words)

Brain Gym: (B.G): (10 minutes/session)

The brain gym exercises were conducted for ten minutes.

Comorbidity Activities

Group –A: (ADHD)

1. Bead threading

   A string and number of big beads were given and the students were asked to fill the string with maximum number of beads in 30 seconds using their preferred hand. The number of beads put by each child was noted and was compared with his next trials. The aim of the activity was to increase the number of beads in the same amount of time.

2. Statue game

   Students are asked to stand and one will be the instructor who would turn and stand and count till three while the other students standing away from this child would head towards him. After counting till three, the instructing child will turn back and say statue and the students moving towards will stand as such without moving. If the moving children reach the instructor before his counting gets over, they tap the instructor's back and come off. And if unable to reach before the instructor gives the command as 'statue', the moving children are supposed to stand still in the same pose. The instructor is allowed to make others laugh by doing funny things but without touching them. The one, who moves off on watching or hearing the funny acts of the instructor or is unable to stay as a statue will be the loser and will act as the next instructor. This game helps children to be attentive and stay at a place for a while. Repetition of this game / activity would help children to some extent.

3. Thermocol color balls separating activity

   A tray of small sized color thermocol balls were given to the children and were asked to separate these balls in their respective colored bowls. This helped them to concentrate more on specific colors. This activity was used to increase their attention.

Group –B: (Dyscalculia)

Number line

Children were first shown a number line with tens highlighted on it, which is then broken into 5 and multiples of 5 are shown at the middle of the tens.this gives the children with dyscalculia some idea about number structures.they are then given plastic transparent rulers with a white sheet pasted beneath it for clear visibility and are asked to mark the 'tens' on itsuch as 10, 20, 30, and so on. They were then asked to mark the 'fives' such as 5, 15, 20, 25 and so on.They were then given numbers other than fives and tens such as 19, 07, 24, 13 etc. and were asked to mark it on the number line. The students were practiced with this concept until they attained complete understanding about it

Group –C: (Dysgraphia and Dyspraxia)

1. Writing on ruled sheet 'a' to 'j'.
2. Buttoning activity for praxia.
   The two middle pieces of shirt which has buttons and the holes were given to the children with dyspraxia to improve their fine motor skills such as buttoning. It is one of the activities of daily living commonly referred as ADL, which these children find difficult.
3. Hand exercises 1-5

Social skills:

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WEEK 8: (sessions 22-24) REHEARSING EVERYTHING

Making new words with consonants and vowels given to them

SESSIONS 25 to 30

Academics: - Reading

1. Phonetics- ending blends

2. Finding ending blend words
3. P-W ending blends
4. Phonetics- Beginning diagraphs
5. Beginning diagraphs-Sight words
6. Sight words- spell and write

Brain Gym: (B.G): (10 minutes/session)

The brain gym exercises were conducted for ten minutes.

Comorbidity Activities

Group –A: (ADHD)

1. Activity- ATC: (Run-run stand in two's, single, half, two and half.)Activity- ATC(Act to Commands):

   Children are asked to be attentive and listen to the commands given, remember them and act accordingly. The commands were to make a circle and run until they were told to stop. While stopping they had to be attentive to the commands that followed immediately such as stand in two's- where every child had to fold his/her hands at the abdomen representing themselves as two with the trunk part above the folded hands as 'one' and below the folded hands as 'two'. If they were asked to stop as 'single' they had to stand straight with the arms beside the body as in attention position in 'march-past'.If they were asked to stand as half they had to sit with the kneels down on the floor representing themselves as 'half'. If they were given the command of standing as 'two and half', they had to keep their right hand at their abdomen symbolising two halves of their body and their left hand had to be stretched out straight to the shoulders straight to the body symbolising the half part. These commands of standing in twos, single, half and two and half varied and were not given in the same order always.

   This activity kept the children with ADHD attentive and keeping the symbols of half, single, two, two and half in mind was difficult as their working memory was put into work which is usually weak for ADHD children. Their hyperactivity was

put into use by running and attention deficit was focused by making them listen to the commands given.

2. Memory Game:

   Children with ADHD, Dyspraxia have a weak working memory. This activity would help them to be attentive and motivate them to concentrate for a brief period. The children are shown a number of things like stationary items, and other small things of children's interest in a tray for a minute. They are instructed to look at all the things and write them on a paper in any order. This activity helps them to concentrate or focus their attention for a minute, which if continued would help them in improving their working memory.

Group –B: (Dyscalculia)

1. Number line activity

   In the earlier activity of number line children were taught about the places of numbers as where do they fall. The understanding of the children about the concept of number line was assessed by asking a range of structured-questions such as what is the next tenth number after '24'?. If the child had understood the concept, he would answer it as '38' and if not, he will be taught the concept again concretely by counting from the number '24'as one, two, three and so on on the number line.

2. 2 Tables- 'Handy two'method:

   The researcher developed a new method of learning multiplication tables of two with the hands and hence named it as 'Handy two method'. In this method,the dorsal part of the left hand fingers above the knuckles which are visible when a fist is made, were numbered consecutively as 2,4,6, 8 and 10starting from the little finger and the inside of the same fingers were numbered as1, 2, 3, 4, 5starting from the little finger respectively. Thechildren were asked to consider their right handthumb as 2 andcall the thumb as '2'throughout the activity. The child was told to look at the thumb and say '2'and first hit the little finger and say the number written on it '1' which becomes 'two ones'and say 'are' while closing the same finger and say '2' while looking at the number on the closed finger. When continuously done, it becomes 'two ones are two' and similarly the same procedure is

followed with the other fingers. This handy two method helped the children to learn the multiplication tables of two

Even – odd numbers

The same handy two method was used to learn the even and odd numbers with slight variation in it. The inside numbers which were numbered as 1, 2, 3, 4, 5 were numbered with odd numbers as 1, 3, 5, 7, and 9.

while looking to the open finger simultaneously and then turn the thumb towards left by saying ‘2’ and simultaneously closing the little finger of the left hand which would show ‘2’. Then again the right thumb was brought back to previous position’up’ by saying ‘3’ while simultaneously looking at the tip of the next finger written as ‘3’andthen turning the right thumb towards left saying the next number’4’ while closing the second finger which is numbered as ‘4’.

Activity: ‘Circles of two tables’

Materials used

This activity involved 5 sets of two pieces of chart each (one rectangular and the other squared in each set). So there were ten chart pieces in total, with five cut in rectangles of 14x7 cm with each piece having two circles drawn on it and five pieces cut in squre with one circle drawn on it. These circles were numbered at the bottom consecutively as 1-2, 3 - 4 and so on. The two circles on the first piece were numbered as 1 and 2 respectively, the second rectangular piece of chartwith two circles was numbered as 3 and 4 respectively. Likewise the other three rectangular pieces were also numbered accordingly. Five squared chart pieces were taken and a single circle was drawn on each of the 5 square pieces and were numbered one through 5.

Description of the activity

The children were given the 5 sets of cards and were asked to arrange them in two rows with the square pieces numbered as as 1, 2, 3, 4, 5 on the top consecutivelyand rectangular pieces numbered in pairs as 1-2, 3-4, 5-6, 7-8, 9-10 in the second row such that each set is arranged as a ‘therefore’ mark. So, there were one square card on the top placed at the centre of the rectangular card at the bottom. Children were asked to write number ‘2’at the bottom left corner of each rectangular card having circles 1 and 2 and were asked to draw a line from there with free handto the top square

card having a circle numbered as 1 without touching the circle numbered as ‘1’ in the bottom row and were simultaneously asked to pronounce ‘two ones are’, and were then instructed to draw the line from the squared card at the top to the bottom circle of the rectangular piece with the circle numbered as 2 while pronouncing it as ‘two’ simultaneously. The same procedure was repeated with other sets of cards by drawing a line from the cornered number ‘2’ to the top card with no.2 by simultaneously saying ‘two two’s are’, without touching the left circle of the second rectangular card numbered as ‘3’ and drawing a line from the top square card to the right circle down on the rectangular card saying ‘are 4’. So this activity makes them tell the tables of two while visualizing as well as doing it kinesthetically as ‘two one’s are two’, ‘two two’s are four’, two three’s are six and so on.

This activity was repeated several times until the researcher was sure that the child had learnt the table theoroughly and the same was taught to their regular teachers to teach practice them with the same throughout the week.

Group –C: (Dysgraphia and Dyspraxia)

1. Tracing ‘k’ to ‘o’.
2. Kneading the clay and making shapes.

   The children were given the wheat-flour and were asked to knead the flour tightly and make different shapes out of it.

3. Tracing ‘p’ to ‘t’
4. Pressing smiley ball

   The children were asked to make a circle and the researcher throwed the sponge ball toone of the children who was then asked to press it tightly and throw back to the researcher. Then it was thrown to other children in the same way and were asked to do the same as the first child did. This helped their fingers to work and catching the ball is one of the gross motor skills which are weak in these children.
5. Scissors activity

   The children were given scissors and newspapers. They were asked to cut the images along the borderline. This helped in improving their fine motor skills.

6. Hand exercises.(1-7).Windshield Wipers and finger stretches were added to the previous exercises.

Social skills

Good-button jar

SESSION 31 to 36

Academics: - Reading

1. Finding diagraph words
2. Reading
3. Basic sight words- colors
4. P-W diagraphs

Brain Gym: (B.G): (10 minutes/session)

The brain gym exercises were conducted for ten minutes.

Comorbidity Activities

Group –A: (ADHD)

1. Run the ground

The children were made to run the ground two times which reduced their high energy a little and were allowed to relax for few minutes.

2. Phonemic segmentation:

The children were then given an activity of phonemic segmentation. They were told a word which they processed auditorily and were asked to tell the first or the last sound of the word, for example, the word ‘boat’ was given and the students were asked to tell the first sound of the word and the child had to say the sound of the letter ‘b’ and not the name of the letter ‘b’. Similarly few words were asked to be pronounced without the first sound- eg say the word ‘snail’ without the sound ‘s’. They were not given the clue as letter ‘s’ but rather they were told the sound. Children who found difficult were given the clue as “tellthe word ‘snail’ without the letter ‘s’ number of words one by one

3. Naming ball game

This activity was again to focus the attention deficit and hyperactivity of the ADHD children. The students were asked to form a circle and the researcher was also a part of the circle. The instructions were given such that the researcher would call the name of any child and throw the ball towards him/her. The child had to be attentive to the names being called and whoever receives the ball would call some other perso'sname in the circle immediately and throw the ball towards that person. It was also told that the ball should go on without any break until the researcher told to stop.

This activity helped in bringing the attention of the children to focus.

Group –B: (Dyscalculia)

1. Tables of 2 (refer the earlier session)
2. Even and odd numbers using a number line

   The numbers were written consecutively on the number line and two different colored markers were used to show the even and odd numbers. This was taught to them to get an idea of what even and odd numbers are.
3. 1's come out game:

   The children were made to stand in a line facing the researcher and were given cards with each card having a number on it. The cards were numbered in order starting from 1 through 10depending on the number of children and were asked to hold the card and also remember their respective numbers. They were then told that the researcher would call a number and the person with that number would step out of the line. The researcher called out the even numbers and the students standing at the even numbered positions stepped out who were now positioned between the odd numbered students at their back. These even numbered children who stepped out were asked to turn and face the odd numbered line of children. Now the two sets of children syood face to face and the researcher now told them to tell their numbers aloud one by one in an order starting from number '1'.The children followed the instructions and started telling their numberswhich sounded alternatively from two lines. They were then told that the starting number '1' is an odd number and the next number '2' is an even number, and the next number '3' is an odd number and the next

number ‘4’ is an even number. Therefore even and odd numbers alternate each other. Then the students with odd numbers alone were asked to tell their numbers one by one quickly and loudly. The same was instructed to the even numbered children. This was practised for several minutes for the students to get familiar with the even and odd numbers.

Group –C: (Dysgraphia and Dyspraxia)

1. Run the ground,
2. Tracing on sheet from ‘k’ to ‘t’,
3. Naming ball
4. Hand exercises 1-9 (Finger tapping and All fingers tapping by Dr.Phyllis was added to the previous exercises.

Social skills

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WEEK 12: REHEARSING EVERYTHING

Reading flashing words, blends, diagraphs.

SESSION 37 to 42

Academics: - Reading

1. Phonetics- Ending diagraphs
2. Finding words with ending diagraphs
3. Finding and placing blends and diagraph words- Activity.
   A paragraph of many blend words and diagraph words were given to each child and were asked to mark them with two different colored pens to differentiate them and were asked to write them on the same sheet of the passage in the respective columns.
4. Paired reading
5. Finding the dictated word (words from paired reading)
6. Paired reading- sentences with bends.

Brain Gym: (B.G): (10 minutes/session)

The brain gym exercises were conducted for ten minutes.

Comorbidity Activities

Group –A: (ADHD)

1. Substitute the word with the letter (change the initial)
   Students were given words individually and were asked to change the first letter of that wordwith the letter given by the researcher and pronounce them.
2. Opposite act (sit-stand, up-down) game
   In this activity, the children were asked to act opposite to the instructions given. Four instructions such as sit, stand, up and down were given in which the children were supposed to 'stand' if they were told to 'sit' and vice versa. Similarly they were asked to bend down with both the hands touching their feet instructed as 'up' and were asked to raise their hands up straight when instructed as 'down'. They had to act opposite to the commands given- 'sit' for 'stand' and 'stand' for 'sit'. Similarly 'up' for 'down' and 'down' for 'up'.
   This activity involves one to be very attentive and act quickly to the commands and hence useful for children with ADHD.
3. Rapid naming of the pictures:
   The children were shown a sheet of pictures without their names on it. They were asked to name the pictures rapidly by looking at it. This helped children to explore and improve their vocabulary.

Group –B: (Dyscalculia)

1. Counting large quantities
2. Table '5' game
3. Teaching 'Time' using '5' tables.

Group –C: (Dysgraphia and Dyspraxia)

1. Writing without tracing 'a' to 't';

2. Hand exercises1-11 (Hand twist and hand press were also added to the previous exercises and with this the graphia are learnt.)
3. Ball pressing.
4. Buttoning
5. Opposite act
6. Tracing sheet ‘u’ to ‘z’,.

Social skills:

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SESSION 43 to 48

Academics: - Reading

1. Paired reading- sight words with diagraphs
2. Exchange test’(in pairs):
   Children were made to sit in pairs and were given passages and were asked to find the words with diagraphs and were asked to exchange and correct the sheets.
3. Reading sentenceswith diagraphs
4. Finding words and P-W.

Brain Gym: (B.G): (10 minutes/session)

The brain gym exercises were conducted for ten minutes.

Comorbidity Activities

Group –A: (ADHD)

1. Marble solitaire game.
2. Thermocol balls separating activity.
3. Phonemic segmentation.
   All the three activities are mentioned in the earlier sessions

Group –B: (Dyscalculia)

1. Shop-keeper game
2. Place value
3. Activity – placing no.cards in the respective places:

   Children were given cards with one digit, two digits and three digits numbers written on it. The class room was divided into three areas named as ones, tens and hundreds.They were then asked to place the cards in the respective places based on the number of digits on the card the children possessed. One digit cards were to be placed in ones area, two digit number cards were to be placed in tens area and three digits number cards were to be placed in hundred area. This helped the children to understand the place value in the number system.

Group –C: (Dysgraphia and Dyspraxia)

1. Writing on sheet without tracing ‘a’ to ‘z’
2. Syringe writing :

   Materials required: Needleless syringe and a bowl of water.

   Children were given a needleless syringe and were asked to fill the syringe with water and use it as a material to write on sand, or cemented floor where the writing would be visible. They were taught to fill the syringe and write which involved both the hands. Children who dislike to write also enjoyed the activity and were willing to write more.
3. Hand exercises (1-11)

Social skills

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WEEK 16: REHEARSING EVERYTHING

Placing words with blends, diagraphs,cvc in the respective cateogories.

SESSION 49 to 54

Academics: - Reading

1. Paired reading- sentences with known words

2. Reading non-sense words
3. R-O-R
4. Reading sight words – animals
5. Spell and write (P-W)
6. Paired reading- read the word and find the picture.
7. Rehearsing sightwords – blends and diagraphs.
8. P- W- sight words.

Brain Gym: (B.G): (10 minutes/session)

The brain gym exercises were conducted for ten minutes.

Comorbidity Activities

Group –A: (ADHD)

1. Water measuring game:

   Materials required:

   Jar of water, measuring cap(30 ml), empty jar

   In this activity, a jar of water along with a measuring cap was given to the children. They were instructed to fill the measuring cap and fill the empty jar which also had marks of measurement. The one who filled the empty jar with maximum amount of water was rewarded. The aim of this activity was to control the hyperactivity and at the same time focus on the task of filling the jar to the maximum.

2. Thermocol ball separation
3. Lap-clap game:

   This was a game to be performed together by the group. The children were made to sit on the floor making a circle. They were instructed to first clap twice on their lap which is called as lap-clap and then clap with both the hands which is called as hand clap. They were instructed to say‘quick-quick’ during lap clap and remain silent during hand clap. Every lap-clap was alternated with hand clap and were asked to say the following in order at the lap-claps which are: ‘quick-quick’, ‘what’s name’, ‘category’s’ name’ (categories such as animals, fruits, vegetables, colors, names, vehicles etc) and the category’s name was followed by the items that fell in that category. For example,the first child who starts

the game would begin with “quick-quick” at the first lap-clap and the second child would say “what’s name” at the second lap-clap and the third child would say any category’s name, for instance, “colors name” at the third lap-clap and the next child would say “blue color”, followed by other colors by other children at consecutive lap-claps and the child who does not get the corresponding category item immediately would say “please change” at his lap-clap which would be then switched on to “quick-quick” again by the next child and the same procedure is followed by different categories as mentioned above and anything apart from that which would be of children’s interest.

4. Arranging home related accessories like small sofa set, kitchen vessels. Etc
   Materials required: Toy accessories like small sofa set, kitchen vessels, small furnitures, color chalk pieces.
   Children were assigned an area in the classroom and were given chalk pieces to divide their assigned areas into living room, kitchen, bedroom etc based on the structure of their own house. These accessories were given to the children in a tray and were asked to arrange them in the respective places divided b y them. This activity was given to improve their organising skills which is one of the social skills as well.

Group –B: (Dyscalculia)

1. Place value- ones, tens, hundreds.
2. Place value activities- Ones, tens, hundreds.
3. Time rehearsing.

Group –C: (Dysgraphia and Dyspraxia)

1. Scissors cutting shapes- Newspapers
2. ADHD activities
3. Hand exercises (1-11)
4. Writing with time
   The children were given words and were asked to write them in the stipulated time using sand clock.
5. Ribbon tying

Materials required: a rectangular card board with holes punched at both the ends and a cotton ribbon.

A single ribbon was put on a rectangular card board piece by punching a hole at the two ends of the card and a knot was put on the top side of the card so as to keep it stable while performing the activity. The students were given this ribbon card and were asked to tie the ribbon making simple knots one after another. This is another fine motor skills which the children with dyspraxia lack in.

6. Zig -Zag running

Two children perform this activity simultaneously by competing with one another. Two tracks of balls are placed in a line and two children perform at the same time by running between the balls in a zig-zag fashion and coming back the same way to their starting position. The group that has more children can be divided into two groups and a competition between them can be conducted which not only helps them in improving gross motor skills but also increasing team spirit.

Social skills

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SESSION 55 to 60

Academics: - Reading

1. Sight words blends- Reading sentences with blends
2. Sight words with diagraphs- reading sentences with diagraphs.
3. Self-reading – choose picture and write
4. Writing words of the picture shown.

Brain Gym: (B.G): (10 minutes/session)

The brain gym exercises were conducted for ten minutes.

Comorbidity Activities

Group –A: (ADHD)

1. Balloon hitting

   In this activity the child hits a balloon, lets it fly and does not allow it to fall down. The time duration is initially set and noted and a reinforcement is given if the duration is reached or exceeded.

   Then in the next level, two balloons are given in which the child has to increase the speed and hit the balloons one by one such that neither of the two falls down. This helps the children to concentrate both physically and mentally and they also enjoy performing this activity.

2. Jumping opposite ('IN' and 'OUT')

   Two circles were made with one inside the other, with enough gap between them such that a child could stand within the circle without touching it's boundary. They were asked to stand within the outer circle and jump the opposite side of the command given. For example, if they were told to jump 'in' they had to do the opposite by jumping outside the circle and vice versa.

   This activity helped them to be attentive as they had to perform opposite to the command and jumping reduced their hyperactivity by losing energy.

Group –B: (Dyscalculia)

1. Odd- even circle game:

   This game was same like the jumping opposite activity with variation being the name of the circles such as odd-even. The two circles were made one inside the other and the outer circle was named as odd with numbers 1, 3, 5, 7, 9 written all over the circle whereas the inner circle was named as even with numbers such as 2, 4, 6, 8, 10 written in all over the inner circle. The students were asked to act according to the numbers told at a given time. They had already learnt the even-odd concept through numberline activity mentioned in the earlier sessions. Once they were familiar with the numbers that come under each category, they were gradually told only the names of the circles such as 'odd' or 'even'

and the numbers in it were erased. This activity was helpful in teaching children the concept of odd-even.

2. Shop-keeper game

Materials required: Plastic coins.

Tokens of paper with some numbers written on it can be used as currency in this game to teach children buying and selling. The researcher used plastic coins to teach the monetary concepts to the students with dyscalculia. The students were grouped in pairs and each pair had to perform as a buyer and seller. The researcher handed a whole sum of amount to the buyer and asked him to buy a list of things from the seller. The number of things on the list was gradually increased from two to 7 things. The price of each thing was set by the researcher and a list of it was handed to both the buyer and the seller. The buyer had to give the whole amount to the seller and calculate the amount to be received back and the seller also had to calculate the balance to be given. This helps in teaching subtraction and monetary skills

Group –C: (Dysgraphia and Dyspraxia)

1. Balloon hitting.
2. ADHD activities.
3. Writing words on sheet.
4. Hand exercises.

Social skills:

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WEEK 20: REHEARSING EVERYTHING

DYSGRAPHIA

- Board writing

The children with dysgraphia were asked to

The child is asked to write the next five English alphabets ‘f’ to ‘j’ on the board with the chalk. Then the investigator writes the 5 alphabets of moderate size on the board at a height that is reached by the child with ease. The child is asked to trace the figure until the child traces it correctly.

DYSPRAXIA: ADHD activity of ‘stand and run’ was followed, but with little more relaxation.

- Hand and finger exercises

  Memory Game

  Children with ADHD, Dyspraxia have a weak working memory. This activity would help them to be attentive and motivate them to concentrate for a brief period. The children are shown a number of things like stationary items, and other small things of children’s interest in a tray for a minute. They are instructed to look at all the things and write them on a paper in any order. This activity helps them to concentrate or focus their attention for a minute, which if continued would help them in improving their working memory.

Chapter-IV

Results and Discussion

Table:1 Descriptive Statistics

Demographic variables	Demographic variables in detail	Frequency	Percent
Group	Experimental	43	52.4
	control	39	47.6
School	Government	29	35.4
	Private	23	28.0
	Special	30	36.6
Gender	Male	60	73.2
	Female	22	26.8
Age	7.5-11.5	61	74.4
	11.6-14	21	25.6
Class(Grade)	3-5	59	72.0
	6-8	23	28.0
Mother's Educational qualification	School	21	25.6
	UG	43	52.4
	PG and above	18	22
Mother's Occupation	Home-maker	45	54.9
	Self-employed	17	20.7
	Private	18	22.0
	Government	2	2.4
Father's Educational qualification	School	3	3.7
	UG	29	35.4
	PG and above	50	61.0
Father's Occupation	Business	38	46. 3
	Private	39	47.6
	Government	5	6.1
Family history	Yes	32	39.0
	No	50	61.0

The demographic variables involved in the study were the following:

1. Group – Experimental group and control group
   The experimental group was comprised of 52.4% , whereas the control group consisted of 47.6%
2. School – Government school, Private school, and special school
   The children with dyslexia having co-morbidity were taken from three different types of schools such as Government school, Private school, and special school. The percentage of children from these schools were 35.4, 28.0, and 36.6 respectively.
3. Gender- Male and female

   With regard to gender, the male children comprised of 73.2 % whereas the female children were relatively lower forming only 26.8 % .

4. Age group- 7.5 to 11.5 and 11.6 to 14
   The children ranging from age 7.5 to 11.5 were 74.4 % whereas the children of the age group 11.6 to 14 were 25.6 %.
5. Grade or class – 3-5 and 6-8
   The percentage of children studying in grades 3-5 was 72% whereas the children studying in grades 6 to 8 formed only 28%.
6. Educational qualification of Mother- School, UG, PG and above
   The educational qualification of the mothers of children with dyslexia were taken into account as they were the ones who looked after their children at home. The mothers who had done schooling formed 25.6%, whereas Under graduated Mothers were of 52.4% and Mothers who had educational qualification above PG level were of 22%.
7. Occupation of Mother – Home-maker, Self-employed, Private job, and Government job.
   The occupation of Mothers were also included as a demographic variable in the study as that determined the time they were able to spend on their children. 54.9% of the mothers were home-makers, whereas 20.7 % of mothers were self-employed. Also, 22% of the mothers were working in private sectors and 2.4% of the mothers were working in a Public sector.

8. Educational qualification of Father- School, UG, PG and above

   The educational qualification of Fathers were also considered in the study to assess any kind of influence on their children by their guidance. The fathers who had done their schooling alone and did not take up any further studies were of 3.7%. 35.4% of the fathers were under graduated and majority of the fathers who had done their post graduation were of 61%

9. Occupation of Father – Business, Private job, and Government job.

   The father's occupation was also considered in the study as the economic status of the family which could influence a child's performance was dependent on the occupation of the fathers. Fathers who were running a business were 46.3%, whereas those who were working in a private sector formed 47.6% and the remaining 6% were working in a Public sector.

10. Family History

    As shown by various research studies that dyslexia and its comorbidities are hereditary in nature to some extent, the family history of these children were also considered. If even one of the parents or any family member reported to be having any history of learning disability, it was taken into account. The family history of 39% of children were reported to be having some kind of learning disability.

Table:2 Kruskal wallis test for demographic variables of experimental group in Academic and social skills

Dyslexia with comorbidities	Demographic variables	(N=42)	Mean rank	Chi-Square	Sig.
Academic	Govt. School	15	19.10	1.46	.48
	Private school	11	24.95		
	Special school	17	22.65		
Lack of social skills	Govt. School	15	20.27	.58	.74
	Private school	11	24.05		
	Special school	17	22.21		
Academic	Mother's qualification-school	11	24.00	.378	.82
	Mother's qualification-UG	20	21.25		
	Mother's qualification-PG	12	21.42		
Lack of social skills	Mother's qualification-school	11	19.73	.759	.68
	Mother's qualification-UG	20	23.68		
	Mother's qualification-PG	12	21.29		
Academic	Mother's occupation-home maker	30	21.80	.143	.93
	Mother's occupation - self employed	7	21.36		
	Mother's occupation - private	6	23.75		
Lack of social skills	Mother's occupation-home maker	30	23.17	.878	.64
	Mother's occupation - self employed	7	19.71		
	Mother's occupation - private	6	18.83		
Academic	Father's qualification-school	2	5.00	3.941	.13
	father's qualification-UG	15	23.53		
	Father's PG and above	26	22.42		
Lack of social skills	Father's occupation	2	37.50	4.583	.10
	father's occupation	15	18.23		
	Father's occupation	26	22.98		

The above table shows the difference in the academic skills and lack of social skills between the various demographic variables such as type of school, Mother's qualification, Mother's occupation, Father's qualification, and father's occupation. There is no significant difference in any of the above variables with respect to academic skills and lack of social skills. There is no

significant difference between the children of the different types of schools with respect to academic and social skills indicating that all are equal. There is no significant difference in the academic skills as well as the social skills of the children based on their mother's qualification and occupation. Similarly, the qualification and occupation of Fathers also does not show any significant difference in both academic skills and lack of social skills

TABLE: 3 Difference among demographic variables in Academic and social skills

(Mann Whitney U test)

Experimental group with all the comorbidities	Demographic variables	(N=43)	Mean rank	z-value	Sig.
Academic skill	Male	31	21.92	.068	.94
	Female	12	22.21		
Lack of social skills	Male	31	21.65	.299	.76
	Female	12	22.92		
Academic Skill	Class (3-5)	32	17.45	4.06	.00
	Class(6-8)	11	35.23		
Lack of social skills	Class (3-5)	32	25.63	3.23	.00
	Class(6-8)	11	11.45		
Academic skill	Family history-yes	16	25.00	1.209	.22
	Family history-no	27	20.22		
Lack of social skills	Family history-yes	16	22.72	.290	.77
	Family history-no	27	21.57		

The above table shows the difference between the various demographic variables such as gender, class/ grade, and family history with regard to academic skills and lack of social skills of the children belonging to the experimental group. Of these three demographic variables, the variable 'class' was found to have significant difference in both academic skills and lack of social skills. The difference between the lower and higher class children with respect to academic skills was significant at 0.01 level ($p<0.01$). The mean rank value shows that the academic skills of the children of lower classes (3-5) were significantly lower (17.45) than the higher class children (6-8) whose mean rank value was (35.23). Similarly, the difference in the social skills of the two classes were also significant at 0.01 level ($p<0.01$). The mean rank value in the case of social skills were found to be significantly higher among the children of lower classes (25.63) indicating poor social skills in them than the children of higher classes (11.45). The other demographic variables

such as gender and family history were not significantly different from each other in both academic and lack of social skills.

TABLE: 4 Comparison between experimental and control group before the intervention in comorbidity ADHD, Academic and social skill of children with dyslexia

Experimental group and Control group of children with dyslexia would be significantly differ in pre-test on comorbidity ADHD, Academic skill and social skills.

ADHD	ADHD	N	Mean Rank	z-value	Sig.
Comorbidity	Experimental group	21	21.12	.452	.65
	Control group	18	18.69		
Academic	Experimental group	21	19.24	.67	.50
	Control group	18	20.89		
Lack of social skills	Experimental group	21	21.07	.63	.52
	Control group	18	18.75		

The above table clearly shows that there is no significant difference between the experimental and control group before the intervention, indicating that both the groups are equal in the conditions of comorbidity- ADHD, academic skills and social skills.

TABLE: 5 Comparison between experimental and control group after the intervention in comorbidity ADHD, Academic and social skills

Experimental group and Control group of children with dyslexia would be significantly differ in pre-test on comorbidity ADHD, Academic skill and social skills

ADHD	ADHD	N	Mean Rank	z-value	Sig.
Comorbidity	Experimental group	21	16.17	2.18	.02
	Control group	18	24.47		
Academic	Experimental group	21	23.69	2.29	.02
	Control group	18	15.69		
Lack of social skills	Experimental group	21	16.81	1.98	.05
	Control group	18	23.72		

The values in the above table show that the values in all the three variables are significant at 0.05 level. The norms of ADHD and social skills tools are such that, decrease in scores indicate improvement in their respective aspects, whereas the academic scores are positive in nature wherein the higher scores indicate improvement. The mean rank value of ADHD in the experimental group (16.17) is lower than the mean rank value of ADHD in the control group (24.47) indicating that the symptoms of ADHD are reduced in the experimental group after intervention. Similarly, the mean rank value of the social skills (16.81) in the experimental group is lower than the mean rank value (23.72) in the control group indicating that the poor social skills are reduced in the experimental group after intervention. In the case of academic skills, the difference in the experimental and control group is also significant at 0.05 level with the mean rank value of the experimental group (23.69) being higher than the control group (15.69), indicating a significant improvement in the academic skills of the children belonging to the experimental group who were exposed to the intervention.

TABLE: 6 Wilcoxon signed rank test for experimental group after the intervention in comorbidity ADHD, Academic and social skill of children with dyslexia

Hypothesis : Intervention model would be effective in enhancing comorbid condition of ADHD, Academic skill and social skills among children with dyslexia

ADHD	ADHD	N	Mean	SD	z-value	Sig.
Comorbidity	Pre-test	21	14.24	2.09	4.11	.000
	Post-test	21	12.67	2.12		
Academic	Pre-test	21	28.76	6.37	4.05	.000
	Post-test	21	33.00	6.46		
Lack of social skills	Pre-test	21	45.76	5.84	4.04	.000
	Post-test	21	41.29	6.04		

From the above table- 3, which is about the experimental group of children with ADHD as comorbidity, it is clear that there is significant difference between the pre-test and post-test scores of all the three aspects such as comorbidity, academic and social skills. The mean value of the post-test in the case of comorbidity symptoms is found to be lower (12.67) than it's counter part

(14.24), indicating a reduction in the symptoms of ADHD in the former group that was exposed to intervention.

Similarly in the case of academic skills, the mean value of the post-test (33) is found to be higher than the pre-test (28.76), indicating a significant improvement in the academic skills of the children after intervention.

The mean value of the social skills also portray a significant difference between the scores of pre-test and post-test with the value of the post-test (41.29) being lower than the pre-test (45.76). This indicates that the social skills that were poor before intervention have reduced now.

TABLE: 7 Wilcoxon signed rank test for control group in comorbidity ADHD, Academic and social skill of children with dyslexia

Hypothesis : Control group of children with dyslexia would be significantly differ between pre-test and post-test in comorbidity ADHD, Academic skill and social skills

ADHD	ADHD	N	Mean	SD	z-value	Sig.
Comorbidity	Pre-test	18	13.72	1.96	1.81	.07
	Post-test	18	14.17	1.88		
Academic	Pre-test	18	29.22	6.44	1.39	.16
	Post-test	18	28.89	6.51		
Lack of social skills	Pre-test	18	44.67	5.44	1.72	.08
	Post-test	18	45.22	5.65		

The above table is about the difference between the pre-test and post-test scores of children belonging to the control group who were not exposed to intervention. The values from the above table show that neither of the three aspects such as comorbidity, academic skills, and social skills have significant difference between their respective pre-test and post-test scores, indicating that they are almost the same after post-test as they were during the pre-test. Thus the hypothesis stating that "Control group of children with dyslexia would be significantly differ between pre-test and post-test in comorbidity ADHD, Academic skill and social skills" is rejected based on available evidence.

Table:8 Dysgraphia - Control group pre-test, post-test comparison (Wilcoxon Signed Ranks Test)

- **Hypothesis :** Control group of children with dyslexia would be significantly differ between pre-test and post-test in comorbidity Dyscalculia, Academic skill and social skills.

Dysgraphia	Control group	N	Mean	SD	Z-value	Sig.
Comorbidity	Pre-test	6	27.20	1.30	.816	.41
	Post-test	6	27.80	2.58		
Academic	Pre-test	6	30.20	3.27	1.76	.07
	Post-test	6	27.60	3.50		
Lack of social skills	Pre-test	6	46.40	5.27	.00	1.00
	Post-test	6	46.60	4.15		

The scores in the above table shows that there is no significant difference in the pre-test and post-test scores of the control group which indicates that children of the control group who were not exposed to intervention did not improve and remained the same before and after the post-test

Table: 9 Dysgraphia -Experimental group pre-test, post-test comparison (Wilcoxon Signed Ranks Test)

Hypothesis : **"**Intervention model would be effective in enhancing comorbid condition of Dyscalculia, Academic skill and social skills among children with dyslexia.**"**

Dysgraphia	Experimental group	N	Mean	SD	Z-value	Sig.
Comorbidity	Pre-test	5	27.40	1.51	2.04	.041
	Post-test	5	24.60	1.14		
Academic	Pre-test	5	27.80	3.34	2.03	.042
	Post-test	5	32.60	2.60		
Lack of social skills	Pre-test	5	44.60	5.41	2.02	.043
	Post-test	5	38.20	4.71		

The above table shows the difference between the pre-test and post-test scores of the experimental group among children with dysgraphia with respect to comorbidity, academic and social skills. It is observed that there is a significant difference at 0.05 level in the scores of pre-test and post-test in all the three conditions.

In the case of comorbidity- dysgraphia, the mean value of the post-test (24.60) is found to be lower than the pre-test (27.40), which indicates that the symptoms of dysgraphia which were higher during the pre-test are reduced in the post test after intervention, there by proving the effectiveness of the intervention model.

The post-test value of the academic skills is found to be significantly higher (32.60) than the pre-test value (27.80) suggesting that there was significant improvement in the children with dysgraphia belonging to the experimental group have after intervention.

The difference in the scores of the social skills is also significant with the post-test score being lower (38.20) than the pre-test (44.60) suggesting that the deficit in social skills is reduced and the children have improved their social skills after intervention.

Table: 10 Mann- Whitney U test: Difference between Experimental group and control group in pre-test

Hypothesis : "Experimental group and Control group of children with dyslexia would significantly differ in pre-test on comorbidity Dysgraphia, Academic skill- reading and social skills.**"**

Dysgraphia	Experimental group	N	Mean Rank	Z-value	Sig.
Comorbidity	Experimental group	5	5.70	.219	.21
	Control group	5	5.30		
Academic	Experimental group	5	4.30	1.27	.20
	Control group	5	6.70		
Lack of social skills	Experimental group	5	5.00	.522	.60
	Control group	5	6.00		

All the three conditions such as comorbidity- dysgraphia, academic skills and social skills showed insignificant difference between the two groups in the pre-test suggesting that all the children were equal to some extent before the post-test.

Table:11 Mann- Whitney U test: Difference between Experimental group and control group in post-test

Hypothesis : "Experimental group and Control group of children with dyslexia would be significantly differ in post-test on comorbidity Dysgraphia, Academic skill and social skills**"**

Dysgraphia	Experimental group	N	Mean Rank	Z-value	Sig.
Comorbidity	Experimental group	5	3.40	2.22	.02
	Control group	5	7.60		
Academic	Experimental group	5	7.60	2.20	.02
	Control group	5	3.40		
Lack of social skills	Experimental group	5	3.10	2.522	.01
	Control group	5	7.90		

It is evident from the above table that there is significant difference in the post-test scores between the experimental and control group of children with dysgraphia at 0.05 level in the case of comorbidity and academics, and at 0.01 level in the case of social skills. The mean rank value of the experimental group is (3.40) which is significantly lower than the control group (7.60). Despite of the experimental group being worser than the control group, there was significant reduction in the symptoms of the comorbidity- dysgraphia than their counterparts, revealing the effectiveness of the intervention. Also, the academic scores are found to be higher in the experimental group (7.60) than the control group (3.40) displaying an improvement in the former group after intervention. And in the case of social skills, the mean rank value of the experimental group is lower (3.10) than the control group (7.90), suggesting that the poor social skills were reduced in the former case after intervention.

Table 12: Control group pre-test, post-test comparison (Wilcoxon Signed Ranks Test)

Hypothesis : "Control group of children with dyslexia would be significantly differ between pre-test and post-test in comorbidity Dyspraxia, Academic skill and social skills**"**

Dyspraxia	Control group	N	Mean	SD	Z-value	Sig.
Comorbidity	Pre-test	6	29.00	.89	1.34	.18
	Post-test	6	29.50	.54		
Academic	Pre-test	6	27.50	1.04	.966	.33
	Post-test	6	27.00	2.09		
Lack of social skills	Pre-test	6	42.83	2.48	.962	.33
	Post-test	6	42	1.41		

The children of the control group having dyspraxia as comorbidity along with dyslexia did not show any significant difference between the scores of their pre-test and post-test, which means that they remained the same without any significant change in their academic skills, social skills and co-morbidity conditions in both the pre-test and post-test.

Table: 13 Experimental group pre-test, post-test comparison (Wilcoxon Signed Ranks Test)

Hypothesis : **"**Intervention model would be effective in enhancing comorbid condition of Dyspraxia, Academic skill and social skills among children with dyslexia**"**

Dyspraxia	Experimental group	N	Mean	SD	Z-value	Sig.
Comorbidity	Pre-test	6	29.83	1.47	2.01	.04
	Post-test	6	33.83	1.72		
Academic	Pre-test	6	28.83	2.31	2.22	.02
	Post-test	6	33.50	2.73		
Lack of social skills	Pre-test	6	45.50	1.51	2.20	.02
	Post-test	6	38.50	1.04		

The children with dyspraxia as co-morbidity in the experimental group showed a significant difference between the pre-test and post-test scores with respect to the conditions of their comorbidity- dyspraxia, academic skills and social skills all at 0.05 level.

The mean value with respect to the comorbidity is higher in the post-test (33.83) than the pre-test (29.33), which means that the gross motor and fine motor activities that were difficult to perform earlier by these children are now improved after intervention.

Similarly, the scores in the post-test of the academic skills are also higher (33.50) than the pre-test (28.83) revealing that the children have improved in the academic skills after intervention.

The significant difference in the scores of the social skills with the post-test score being lower(38.50) than the pre-test (45.50) also shows that the social skills that were poor earlier have reduced after the intervention.

Table: 14 Mann- Whitney U test: Difference between Experimental group and control group in pre-test

Hypothesis : "Experimental group and Control group of children with dyslexia would be significantly differ in pre-test on comorbidity Dyspraxia, Academic skill and social skills**"**

Dyspraxia	Experimental group	N	Mean Rank	Z-value	Sig.
Comorbidity	Experimental group	6	7.50	.993	.39
	Control group	6	5.50		
Academic	Experimental group	6	7.50	.978	.39
	Control group	6	5.50		
Lack of social skills	Experimental group	6	8.42	1.86	.06
	Control group	6	4.58		

The pre-test scores of both the experimental and control group show no significant difference in any of the three aspects such as co-morbidity, academic skills and social skills. It means that both the groups were homogenous in all the three aspects before intervention.

Table: 15 Mann- Whitney U test: Difference between Experimental group and control group in post-test

Hypothesis : "Experimental group and Control group of children with dyslexia would be significantly differ in post-test on comorbidity Dyspraxia, Academic skill and social skills"

Dyspraxia	Experimental group	N	Mean Rank	Z-value	Sig.
Comorbidity	Experimental group	6	9.50	2.92	.003
	Control group	6	3.50		
Academic	Experimental group	6	9.50	2.91	.004
	Control group	6	3.50		
Lack of social skills	Experimental group	6	3.58	2.82	.005
	Control group	6	9.42		

When the children of both experimental and control group were compared after the intervention, there was a significant difference between them at 0.05 level. The mean rank value in the case of comorbidity shows that the children of the experimental group have scored significantly higher (9.50) than the control group (3.50) in the post-test displaying the effectiveness of the intervention model. Similarly, the mean rank value in the academic skills shows that the children of the experimental group who were given the intervention scored higher (9.50) than the control group (3.50) which was significant at 0.01 level ($p<0.01$). The difference in the mean rank value or scores of the social skills among the two groups show that the children of the experimental group have improved. The score of the experimental group is lower (3.58) than the control group (9.42) showing that the social skills that were poor during the pre-test have reduced after the intervention.

Table:16 Control group pre-test, post-test comparison (**Wilcoxon Signed Ranks Test)**

Hypothesis : "Control group of children with dyslexia would be significantly differ between pre-test and post-test in comorbidity Dyscalculia, Academic skill and social skills**"**

Dyscalculia		N	Mean	SD	Z-value	Sig.
Comorbidity	**Pre-test**	10	31.00	1.49	1.000	.317
	Post-test	10	30.80	1.22		
Academic	**Pre-test**	10	29.60	4.69	.730	.465
	Post-test	10	29.30	4.08		
Lack of social skills	**Pre-test**	10	44.10	6.65	.359	.719
	Post-test	10	44.40	6.00		

It is clear from the above table that there is no significant difference in the pre-test and post-test scores of the control group. But if the mean difference is taken into account, there is little difference in the scores of the two tests with improvement in the comorbidity-dyscalculia alone whereas the other two conditions such as academics and social skills showed a deteriorating condition.

Table: 17 Experimental group pre-test, post-test comparison (Wilcoxon Signed Ranks Test)

Hypothesis : **"**Intervention model would be effective in enhancing comorbid condition of Dyscalculia, Academic skill and social skills among children with dyslexia**"**

Dyscalculia	Experimental group	N	Mean	SD	Z-value	Sig.
Comorbidity	Pre-test	11	30.18	1.83	2.980	.003
	Post-test	11	28.00	1.94		
Academic	Pre-test	11	28.73	5.38	2.949	.003
	Post-test	11	33.73	4.83		
Lack of social skills	Pre-test	11	42.55	4.76	2.953	.003
	Post-test	11	39.82	5.21		

Difference between the pre-test and post-test scores of the experimental group of children with dyscalculia with respect to comorbidity, academic and social skills is shown in the table. It is observed that there is a significant difference in the scores of pre-test and post-test in all the three variables at 0.05 level. The mean value of the pre-test (30.18) is found to be higher than that of the post-test (28) in the case of comorbidity-dyscalculia which indicates that the difficulties of dyscalculia which were higher in the pre-test are reduced in the post test after intervention.

In the case of academic skills, the post-test value is significantly higher (33.73) than the pre-test value (28.73) suggesting that children with dyscalculia belonging to the experimental group have improved significantly after intervention. The difference in the scores of the social skills is also significant with the post-test score being lower (39.82) than the pre-test (42.55) suggesting that the deficit in social skills is reduced and the children have improved their social skills after intervention.

Table:18 Mann- Whitney U test: Difference between Experimental group and control group in pre-test

Hypothesis : "Experimental group and Control group of children with dyslexia would significantly differ in pre-test on comorbidity Dyscalculia, Academic skill- reading and social skills**"**

Dyscalculia	Experimental group	N	Mean Rank	Z-value	Sig.
Comorbidity	Experimental group	11	9.55	1.14	.252
	Control group	10	12.60		
Academic	Experimental group	11	10.18	.63	.52
	Control group	10	11.90		
Lack of social skills	Experimental group	11	10.05	.742	.45
	Control group	10	12.05		

There was no significant difference in any of the three conditions such as comorbidity-dyscalculia, academic skills and social skills in the pre-test of the experimental and control group. (to be included)

The difference in the symptoms of dyscalculia, between the experimental and control group was not significant in the pre-test. The mean value with respect to the comorbidity- dyscalculia obtained by the experimental group and control group after intervention was 28 and 30.80 respectively. The mean value of the experimental group was lower than the control group which indicates that the difficulties of dyscalculia were reduced in the former group after intervention.

The academic skills of the two groups varied significantly at 0.05 level. The mean value of the experimental group was (34.27) which was higher than the control group (29). This high mean value of the experimental group shows that there was a considerable improvement in the academic skills of children with dyscalculia after intervention.

The social skills between the two groups also differed significantly at 0.05 level. The mean value of the experimental group (39.82) was lower than the control group(43.90)which suggests that the children who had poor social skills improved after intervention.

Table:19 Mann- Whitney U test: Difference between Experimental group and control group in post-test

- **Hypothesis : "**Experimental group and Control group of children with dyslexia would be significantly differ in post-test on comorbidity Dysgraphia, Academic skill and social skills.**"**

Dyscalculia	**Experimental group**	**N**	**Mean Rank**	**Z-value**	**Sig.**
Comorbidity	Experimental group	11	7.18	2.99	.03
	Control group	10	15.20		
Academic	Experimental group	11	13.68	2.087	.03
	Control group	10	8.05		
Lack of social skills	Experimental group	11	8.32	2.083	.03
	Control group	10	13.95		

Above table shows difference in the dyscalculia (comorbidity), academic and social skills between the experimental and control group of children with dyscalculia as comorbidity after intervention.

The difference in the symptoms of dyscalculia between the experimental and control group was significant at 0.05 level. The mean rank value with respect to the comorbidity- dyscalculia obtained by the experimental group and control group after intervention was 7.18 and 15.20 respectively. The mean rank value of the experimental group was lower than the control group which indicates that the difficulties of dyscalculia were reduced in the experimental group after intervention.

The academic skills of the two groups varied significantly at 0.05 level. The mean rank value of the experimental group was (13.68) which was higher than the control group (8.05). This high mean rank value of the experimental group than the control group shows that there was a considerable improvement in the academic skills of children with dyscalculia after intervention.

The social skills between the two groups also differed significantly at 0.05 level. The mean value of the experimental group (8.32) was lower than the control group(13.95)which suggests that the poor social skills of the children reduced after intervention.

Table: Correlation for comorbidities associated with dyslexia on READING AND Lack of social skills

Hypothesis: Academic skill would be related to social skills of children with dyslexia

Comorbidities associated with dyslexia	reading	Lack of social skills
Reading	1	-.584**
Lack of social skills	-.584**	1

**. Correlation is significant at the 0.01 level (2-tailed).

From the above correlation table, it is observed that there is a negative correlation between reading and lack of social skills which is significant at 0.01 level. This negative correlation means that when the academic skills are improved, the deficit in social skills is reduced. The children with dyslexia having comorbidities lack social skills and are unable to score well on their academics as well. They are being ignored in their classrooms for either of the reasons such as poor performance in academics or poor social skills. When they perform well on academics, they may be appreciated

and encouraged which motivates them to get more praising words and maintain the same by behaving well with their peers and others there by reducing their poor social skills.

Table: 21 Regression

Hypothesis: Academic skill would influence social skills of children with dyslexia

Comorbidities associated with dyslexia	B	S.E	Beta	't'	R^2	F	Sig.
	60.79	3.02	.584	20.18	.341	41.39	.000

Dependent variable: Lack of social skills

Independent variable: Reading(Academic)

From the regression table mentioned above, it is clear that academic skills, especially reading has an influence of 34% (R square) on social skills.

Chapter-v

Summary and conclusion

Every child has the right to education, which is one of the fundamental rights of every citizen of India. One of the primary aims of our country is to attain 'Education for all' and the country is gradually progressing to achieve that goal. Though the number of children going to school has increased, there is an equal amount of increase in school dropouts as well, which could be due to several reasons. One such reason, which is of utmost importance is low levels of achievement in academics.

Impairment in reading or the so called 'Dyslexia', is one of the major causes of low levels of achievement which is often manifested by a number of associated or comorbid factors like ADHD, dyscalculia, dysgraphia, dyspraxia, etc. Dyslexia with these associated disorders hamper smooth learning and hence it is the need of the hour to find a holistic approach to train them to cope with their obstacles.

The aim of this research work is to help these children to overcome their obstacles gradually using various activities and strategies of the developed intervention model.

The findings of this study add to the growing body of research on dyslexia and the comorbidities associated with it. The children with a dominant comorbidity were categorized into groups such as ADHD, Dyscalculia, dysgraphia, and dyspraxia respectively. All these groups were compared on three aspects or variables such as their respective comorbidity, academic skill especially reading, and lack of social skills. The experimental groups and control groups were first assessed which was considered to be the pre-test. They were given the intervention for a period of five months which covered 60 sessions and the control groups were excluded from the intervention. After intervention, they were tested again to see the difference. Also, the difference between the two groups- experimental and control groups was also seen.

For easier understanding let us name the groups with different comorbidities such as ADHD, Dyscalculia, dysgraphia and dyspraxia as A, B, C, and D, with the experimental groups as 'A1' 'B1' 'C1' 'D1' and the control groups as 'A2' 'B2' 'C2' 'D2' respectively. The children with dyslexia having ADHD as comorbidity and belonging to the experimental group will be referred

to as ‘A1’ and the control group as ‘A2’. Similarly the children with dyscalculia as ‘B1’ and ‘B2’; dysgraphia as ‘C1’ and ‘C2’ and dyspraxia as ‘D1’ and ‘D2’.

A1 and A2:

The experimental group children with ADHD as comorbidity (A1) were found to be significantly different from their corresponding control group children (A2) at 0.05 level ($p<0.05$). The pre-test and post-test scores of the experimental group (A1) also differed significantly from each other with improvement in the post-test scores in all the three conditions. The academic skill- reading was improved, symptoms of ADHD and poor social skills were reduced after intervention.

B1 and B2:

The children of the experimental group (B1)and control group (B2)differed significantly from each other in all the three conditions such as academic skill-reading, comorbidity symptoms reduction and poor social skills’ reduction at 0.05 level ($p<0.05$). The pre-test and post-test scores of the experimental group (B1) also differed significantly at 0.05 level with the post-test scores showing positive improvement in all the three conditions mentioned above.

C1 and C2:

The experimental group and control group children (C1 and C2) differed significantly from each other with at 0.05 level with the C1 group showing improvement than the C2 group. The difference in the pre-test and post-test scores of the C1 group also differed significantly from each other at 0.05 level ($p<0.05$) with the post-test showing considerable improvement in all the three conditions.

D1 and D2:

The children of the two groups D1 and D2 also differed significantly ($p<0.05$) with D1 showing positive output when compared to D2. The pre-test and post-test scores also differed significantly with the latter showing improvement in all the three cases.

The academic skill- reading is negatively correlated (-0.584) with the deficit in social skills which is significant at 0.01 level ($p<0.01$). The negative correlation between the academic skill- reading and deficit in social skills indicate that the academic skill - reading is improved and the deficit in

social skills is reduced. The R square value of 0.341 shows that the influence of academic skill- reading on social skills is 34% which is significant at 0.05 level.

Conclusion:

It is concluded from the findings that there is a significant difference between all the experimental and control groups respectively. Also, there is a significant difference between the pre-test and post-test of every the experimental group- A1, B1, C1, D1**.{see if these green lines are ok instead of the 1st three lines of the following paragraph. Choose the suitable lines}.**

The significant difference between all the experimental groups with their respective control groups and the significant difference between the pre-test and post-test scores of all the experimental groups indicate that the intervention model, which is an independent variable of the study is effective. The academic skill- reading and deficit in social skills are negatively correlated with 34% of influence of the academic skill- reading on the social skills. It is concluded from the results that the holistic intervention model developed to improve the main academic skill- reading and the specific domains- ADHD, dyscalculia, dysgraphia and dyspraxia which co –occur along with the impairment in reading is effective in improving the comorbid conditions.

Limitations of the study

There are few limitations in the study which are as follows:

- The major limitation of the study is the sample size which was very less as it is a rare sample.
- The duration of the study was about two years which covered screening of the sample, development of intervention model, implementation and post-test, data analysis and report writing. So, it was difficult to attain a large sample.
- Permission from schools and Parent's consent was also a challenging task for the researcher.
- As the sample was scattered over different areas, it was difficult for the researcher to go around and conduct the intervention sessions regularly.

- Due to time constraints, the researcher employed a dual model of teaching wherein, the regular teachers played the researcher's role and continued implementing and practicing the strategies to the children.
- The duration of the intervention was for only 6 months due to time constraints.
- Among the academic skills, only reading was considered.

Suggestions for further study

- The sample size can be increased
- The duration of the intervention could be also increased for very effective results.
- Academic skills like comprehension can also be considered apart from reading.
- The intervention could be taken separately as a package and implemented on particular comorbidities.
- The intervention could be implemented on the sample of children with dyslexia without any comorbidities.
- Also, slow learners could be benefitted with the help of this intervention.
- The intervention could be given to children with different learning disabilities irrespective of their comorbidities.
- Parents and teachers can be trained with the intervention and be implemented on the children.
- This intervention can be combined with various other methods and be given to children.

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