



Specific Learning Disabilities: Revisiting the theories, research and rehabilitation in the current perspective

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ABSTRACT

Specific learning disabilities or difficulties are one of the most prevalent group of neurodevelopmental disorders, affects the children and adults. The persons with specific learning difficulties exhibit deficits in perceiving and processing information from their environment efficiently and accurately, there by facing difficulties in academic arena. The current review article is taken up mainly because the existing data base on SLD, especially in India is found to be limited and with lots of variation, inbuilt in it. Also the theories which act as the guiding frameworks in the field of SLD are decades old and there is felt need to revisit and challenge certain concepts in view of the latest research in the field. This review article had discussed the existing body of knowledge on prevalence, causative factors, comorbidity, assessment, differential diagnosis and the predominant theories in the field of Specific learning disabilities. The article further attempts to critically analyse and identify the knowledge gaps and bottle necks in the relevant areas. The article further made efforts to provide suitable recommendations in the identified areas in view of the latest developments in the field, there by attempting to strengthen the existing schools of thoughts, models of assessment and intervention in the field of specific learning disabilities.

Key words - Specific learning disabilities, neuro developmental disorders, theories, prevalence, differential diagnosis, comorbidity

INTRODUCTION

Specific learning disabilities or difficulties are one of the most prevalent group of neurodevelopmental disorders that affect primarily the children and continues during adulthood also. (DSM 5) Persons with specific learning difficulties exhibit specific deficits in perceiving and processing information from their environment efficiently and accurately. They are forced to make intense efforts to achieve one or more academic areas, such as reading, mathematics, or writing, despite adequate intelligence and educational opportunity (American Psychiatric Association, 2013; Hallahan, Pullen, & Ward, 2013). The Diagnostic and Statistical Manual of Mental Disorders 5th ed. (DSM-V) (American Psychiatric Association, 2013) enlists the main problems in learning and academic skills that might be manifested as difficulties in at least one of the following: word reading, reading comprehension, spelling, written expression, mastering number sense, number facts, or calculation, and mathematical reasoning.

RATIONALE

The review article is found essential mainly because the existing data base on SLD, especially in India is found to be limited and with lots of variation. Also the theories which act as the guiding frameworks in the field of SLD are decades old and few of the concepts are worth revisiting and challenging in view of the latest research. The primary objective of this review article is to discuss the existing body of knowledge on

prevalence, causative factors, comorbidity, assessment, differential diagnosis and the predominant theories in the field of Specific learning disabilities. The second objective is to critically analyse and identify the knowledge gaps and bottle necks in the above identified areas. The third objective is to make an attempt to provide suitable recommendations in the relevant areas in view of the latest developments in the field and strengthen the existing models of assessment and intervention in the field of specific learning disabilities.

PREVALENCE :

As per the DSM V, specific learning disability can be classified as reading disorder (dyslexia), disorder of written expression (dysgraphia) and disorder of calculation (dyscalculia). Among Children with Specific learning disabilities, world wide, about 3- 6% of children are diagnosed with specific reading disability with neurobiological origin, or developmental dyslexia (Hulme&Snowling, 2009; Vellutino, Fletcher, Snowling& Scanlon, 2004). In India, the prevalence studies on SLD using standardised and exclusive screening tool as well as studies on the determinants of SLD are sparse. The existing limited prevalence literature also reports a large variance in results, ranging from 5-15%. Long time back, Rutter and Yule (1975) had stated that the prevalence rate of SLD varies from country to country and even within different locations of the same country. Chan (2008) reported a difference in statistical figure of prevalence, i.e. 1% and 10%, in two different studies in China. Recently, the results of two studies in India follow the same trend. A recent Indian study, based on a North Indian population in India, showed a prevalence rate of 1.58% of children with learning disability (Arun, Chavan, Bhargava, Sharma &Kaur, 2013) where as another study on South Indian population indicated a prevalence rate of 15.17% for dyslexia with further specification of 12.5%, 11.2% and 10.5% for dysgraphia, dyslexia and dyscalculia respectively Mogasale, Patil, Patil & Mogasale (2012). In the school population, 8%–15% and 6% of children of SLD had difficulties in written expression and mathematical difficulties respectively. Although, some studies have shown that there is no significant gender difference in reading disability, several others have shown that SLD is more common in boys. The prevalence of SLD was found to be higher in lower classes, when compared to higher. It was also found that low maternal education, very low birth weight, low 5-minute APGAR score, and other obstetric issues are also found to be the high risk factors for learning disability. Such huge variation in the results partly threatens the measurement processes and tools used for Indian population. The difference in the statistical figures on prevalence of SLD has been addressed by a number of authors in this field. This demonstrates the need for more systematic culture/region specific research using standardized diagnostic and functional assessment tools, applicable to our needs and context. This will help to generate a more realistic and reliable data base on Specific Learning Disabilities, its prevalence, causative & risk factors which will also help in developing effective early identification, intervention models.

COMORBIDITIES:

The most common co-morbid conditions of reading difficulties are Specific Language Impairment (SLI) (Brookman, McDonald, McDonald, & Bishop, 2013). Both dyslexia and SLI showed almost similar profiles in terms of working memory and intelligence coefficient (Alloway, Tewelde, Skipper, & Hajar, 2017). Great co-occurrence has also been reported with Attention Deficit and Hyperactivity Disorder (ADHD), particularly inattention (Kaplan, Dewey, Crawford, & Wilson, 2001; Martin, Levy, Pieka, & Hay, 2006). The overlap among SLI, ADHD and LD, including dyslexia, has been reported between 10% to over 50% of cases (Bental & Tirosh, 2007; Dykman & Ackerman, 1991; McArthur, Hogben, Edwards, Heath, & Mengler, 2000; Semrud-Clikeman et al., 1992; Snowling, 2012; Willcutt & Pennington, 2000). Some researchers have also analysed reading difficulties in relation to developmental coordination disorders (also known as dyspraxia) and estimated an overlap of 35% to 50% of cases (Kirby, Sugden, Beveridge, Edwards, and Edwards 2008). Reading problems may coexist with handwriting problems. Also associations between more than one diagnosis have been recognised. Research has shown a high prevalence of reading disorders, ADHD and motor issues (Kooistra, Crawford, Dewey, Cantell, & Kaplan, 2005), thereby necessitating a very careful approach in diagnosing of SLD. This further highlights the need for developing highly sensitive tools in Indian context, for proper differential diagnosis as well.

EVALUATION OF SPECIFIC LEARNING DIFFICULTIES

The assessments of learning difficulties/disabilities is linked with the heterogeneity of their conceptualization, which can very well be observed in the diversity of the assessment tools available nowadays (Fletcher et al., 2014; Swanson et al., 2013). Also there are different criterias to diagnose specific learning disability, which varies from country to country, region to region. As per the Gazette of India notification, Department of Empowerment of Persons with Disabilities, MSJ&E had issued the guidelines for evaluation as well as procedure for certification of Specific Learning Disability (SLD). In the guidelines, NIMHANS Index of Specific Learning Disability' has been suggested as the only diagnostic tool for the assessment of Specific Learning Disability. 'NIMHANS Index of Specific Learning Disability', popularly known as 'NIMHANS SLD Battery (NSB)', is used by a significant number of psychologists across India and in a few neighbouring countries as well.

THEORIES OF SPECIFIC LEARNING DISABILITIES AND DYSLEXIA

Various theories had been proposed on the etiological and causative factors of Specific learning disabilities and dyslexia since 1990s. The current literature review was conducted with the objective of enhancing the understanding of SLD, the most challenging but often overlooked and missed out disability in India, its causative factors and its varied manifestations. The review also attempted to describe the salient features of these prominent theories of SLD, do a critically analyse of their Pros and Cons in the present context. The findings of this review will be helpful in developing the effective early identification and intervention models for Children with SLD.

In the year 1999, Frith proposed a framework that helps to organise the predominant theories of Specific learning disabilities and dyslexia among into three domains : behavioural, cognitive and biological. The theories are compatible with one another in some points but also differ in certain aspects, since they try to explain the symptoms from different viewpoints that do not confine the phenomenon to just one level.

Phonological deficit theory

The psycholinguistic-based theories, developed in the early 1970s attempts to explore the relation between speech and reading development, and lead to the beginning of later research which focussed on phonology and its processing (Liberman, 1971; Liberman, Shankweiler, Fischer, & Carter, 1974).

The phonological deficit theory, one of the most studied (Stanovich, 1988), theory posits that reading and spelling difficulties result from impairments in the ability to identify or manipulate the component sounds in speech, which is otherwise known as phonological awareness. Phonological awareness is a relevant metalinguistic skill concerning knowledge about the sounds that make up words. Failures in phonological awareness lead to poor association of printed representations with the correct speech elements. Studies across different languages also demonstrated that children with developmental dyslexia have difficulties in basic phonological tasks such as manipulation of speech sounds (Goswami et al., 2010; Kim & Davis, 2004; Share & Levin, 1999; Heinz Wimmer, 1996; Ziegler & Goswami, 2005). Paulesu et al., (2001) also reported phonological connection with reading impairments as demonstrated by dyslexic children in Italian, French, and English .

The phonological theory has received support from researchers who have pointed a clear link between phonological deficits and the subsequent reading problems (Melby-Lervåg et al., 2012; Ramus et al., 2003; Vellutino et al., 2004) as the main explanation for reading difficulties in dyslexia. For example, Hayward et al. (2017) studied the common phonological awareness errors in first grade children and the results indicated that those children with poor reading performance were more prone to exhibit errors such as insertion and omission of letters, phonemic segmentation and substitution.

However, this theory had failed to explain the other symptoms associated with reading disorders such as poor motor skills, slow processing speed, a lack of automatization, problem in executive functions, maths difficulties, auditory processing deficit, and visual problems that may be manifested along with the reading problems (Dionne-Dostie et al., 2015; Fostick & Revah, 2018; Kruger, Kruger, Hugo, & Campbell, 2001; Nicolson & Fawcett, 1990; Stein, 2012; Viana, Razuk, de Freitas, & Barela, 2013).

AUTOMATIZATION DEFICIT HYPOTHESIS

The Automatization Deficit Hypothesis (Nicolson & Fawcett, 1990; Nicolson et al., 2010) claims that dyslexics may have difficulties performing any task that requires the automatization of skills. Nicolson and Fawcett (1990) observed the performance of dyslexic children in a dual-task – a task of motor balance and a second task that involved the distraction of conscious attention. The results indicated that the dyslexic sample had to put up an effortful performance in reading and writing also, the dyslexic sample was more prone to error, and more easily disrupted than a typically developed group. Further in a study in 1994 by Fawcett & Nicolson, (1994) the reaction time of the dyslexic children was measured in three different tasks - simple reaction, selective choice reaction, and lexical decision and it was found that in the last two tasks the dyslexic group had comparatively longer reaction times with a control group chronological age and reading age matched. Another study (Moores, Nicolson, & Fawcett, 2003) also confirmed a general impairment to automatized skills in adolescents and young adults. Later, Bucci, Bui-Quoc, and Gerard, (2013), who studied the postural control of dyslexic children while solving a cognitive task, reported worse performance in the dyslexic group than the control group, supporting the hypothesis of a deficit in the automatic integration of visual input and postural control. Orban, Lungu, & Doyon (2008) reviewed studies that linked automaticity with an impairment in motor sequence learning. Orban et al concluded that the deficit represents a mixture of implicit and explicit processing and found that all of the studies reviewed revealed a motor sequence learning impairment in dyslexics. Bucci et al. (2013) and Nicolson et al. (2010) showed that dyslexics need to consciously lead their attention to compensate even in routine tasks that should be done without having to think or concentrate consciously. Problems in skill automatization are attributable to impairments in cerebellar function, and automaticity is the final product of procedural learning (Fawcett & Nicolson, 2008; Nicolson & Fawcett, 2011).

Critics of the automatization theory, such as Raberger and Wimmer (2003), examined the relation between reading disability and ADHD with a balancing task and the results showed poor balancing only in the ADHD group and poor rapid naming only in the reading disabled group. Based on these results, Raberger and Wimmer argued that the automatization difficulties previously found by Nicolson and Fawcett, (1990) may have been biased by comorbidities within the sample.

THE DOUBLE-DEFICIT THEORY

A number of scholars defend the notion that dyslexics' difficulties are not exclusively or mainly associated with a deficit in phonological processing (Lovett, Steinbach, & Frijters, 2000; Wimmer, Mayringer, & Landerl, 2000; Wolf & Bowers, 2000). This led to the double-deficit theory, which is an extension of the dominant phonological deficit theory. The proponents of this theory Wolf & Bowers, (2000). argued that dyslexics people may have either phonological problems or processing speed problems independently. The double-deficit theory recognizes the role of phonological processing skills for reading development, as well as a deficit in rapid serial/automatized naming (RAN), which is an equally important skill for reading development. A Systematic Review and Meta-Analysis of Cognitive Skills Deficits among Chinese Children with Developmental Dyslexia: By Li X, Hu M, Liang H (2022) showed that the rapid automatized naming deficits are the core deficit of developmental dyslexia among Chinese children, with a pooled percentage of 44%. This is followed by orthographic knowledge deficits (43%), phonological awareness deficits (41%), morphological awareness deficits (40%), visual and motor skills deficits (33%), and short-term memory and working memory deficits (25%).

Although the DDH hypothesis has expanded the understanding of dyslexia, including disorders in automaticity, processing speed and fluency as well as phonology, Pennington, Cardoso-Martins, Green, and Lefly, (2001) argued that the phonological theory was able to give a comparatively broader explanation to the deficits that characterised dyslexia, including naming speed. Other studies (Nelson, 2015; Schatschneider et al., 2002; Vukovic & Siegel, 2006; Heinz Wimmer, Mayringer, Landerl, & Landerl, 2000) that reported evidence for an independent rapid naming deficit in dyslexia also lacked clarity, thus making the DDH weak in predicting the dyslexia symptoms.

THE MAGNOCELLULAR DEFICIT THEORY

The magnocellular deficit theory, developed by Stein (2001a) proposed that most reading problems have a primary sensorimotor cause. The visual magnocellular system, which is involved in the synchronization of visual information during the reading process (Stein, 2001a, 2001b) is impaired in dyslexia. This impairment affects motion sensitivity binocular fixation, and is considered responsible for timing visual events when reading leaving oral and non-verbal reasoning skills intact (Stein, 2018). Stein, (2001a) also proposed that dyslexic people have different brains, which affects their reading, writing and spelling skills, but extends to their coordination, laterality and sequence ability. Post-mortem studies on the brains of dyslexic people have also shown disorders in the magnocellular layers of the lateral geniculate nucleus and smaller magno-cells compared with controls, which may abnormally reduce their motion (Galaburda & Livingstone, 1993). The magnocellular visual processing is responsible for giving a response to fast changes in the visual system (Skottun, 2000) and failures in the magnocellular system functionings may cause an inadequate response to visual input, for example the appearance that letters move around and cross over each other when individuals attempt to read written texts (Stein, 2001a).

Dysfunction in the magnocellular system would also include deficit in visual, auditory, and tactile systems (Stein, 2014; Stein & Walsh, 1997). As cerebellum (Stein 2001a) is the main structure of the magnocellular system which is responsible for generation of responses to rapidly changing stimuli, impairments in this system may result in temporal processing deficits in both visual and auditory modalities (Livingstone, Rosen, Drislane, & Galaburda, 1991).

Though the magnocellular deficit framework has considerable power in explanatory terms and does have much in common with Nicolson and Fawcett's procedural learning deficit framework, it is very much more specific, arguing that all the problems arise only from magnocellular processing difficulties rather than differences in neural plasticity etc. The adequacy of the magnocellular theory as complete explanation for reading difficulties has been challenged due to the lack of evidence about other cognitive processes that are related to the magnocellular function such as spatial orientation.

AUDITORY PROCESSING DEFICIT THEORY

Perceptual strength and weaknesses in different sensory modalities have been found during assessments of dyslexic children. Focusing on one of these modalities, Tallal, (1980) tested the relation between auditory temporal perception and reading disabilities and proposed that the children's deficit was linked with the perception of auditory stimuli that arrived rapidly and sequentially, and that this perceptual deficit may be a characteristic of people with dyslexia. This deficit in the basic auditory level would affect the integration of rapid sensory information, which would lead to an incorrect analysis of speech, and thus phonological issues (Tallal, 1980; Tallal, Miller, & Fitch, 1993). The postulates of this theory made the phonological impairment as a secondary issue to a more basic auditory deficit in children with SLD. Similarly Hari and Kiesila, (1996) observed deficit in the processing of rapid sound sequences in dyslexic adults, Stefanics et al., (2011) reported impaired auditory neural processing in children with dyslexia that reflected a general auditory impairment. Fostick and Revah, (2018) also supported the view that dyslexia is of a multi-deficit and remarked the relevance of an auditory temporal processing deficit in its manifestation.

The detractors of auditory processing deficit theory argued that the auditory perception may vary between different languages associated with orthography consistency, which would be a challenge to the explicative power of this theory (Goswami, 2014). In addition, other studies (Breier, Fletcher, Foorman, Klass, & Gray, 2003; Landerl & Willburger, 2010; Share, Jorm, Maclean, & Matthews, 2002) have also reported unclear relationship between temporal auditory processing and the phonological deficit of persons with reading difficulties.

To summarise, among all these theories, within a cognitive level, the phonological theory had received the maximum support as the main cause of reading difficulties, including developmental dyslexia, since many decades. A study by Bart Boets 1, Jan Wouters, Astrid van Wieringen, Pol Ghesquière (2007) investigated whether the core bottleneck of literacy-impairment should be at the phonological level or at a more basic sensory level. Phonological ability, speech perception and low-level auditory processing were investigated in a group of 5-year-old pre-school

children with dyslexia high-family risk, compared to a group of low-risk control children. Based on family risk status and first grade literacy achievement children were categorized into groups and pre-school data were retrospectively reanalyzed. At the end of grade 1, Children with high family risk and literacy-impairment, presented significant pre-school deficits in phonological awareness, rapid automatized naming, speech-in-noise perception and frequency modulation detection. The coexisting presence of these deficits, even before receiving any formal reading instructions, might suggest a causal relation with problematic literacy development. However, a closer inspection of the individual data indicates that the core of the literacy problem is situated at higher-order phonological processing. The study concluded that though auditory and speech perception problems are relatively over-represented in literacy-impaired subjects and might possibly be aggravating the phonological and literacy difficulties, it is improbable that they are at the basis of these problems.

However, strong evidence for the outlier symptoms are also emerging in the motor, procedural, and sensory fields since last (Dionne-Dostie et al., 2015; Fostick & Revah, 2018; Kruger, Kruger, Hugo, & Campbell, 2001; Nicolson & Fawcett, 1990; Stein, 2012; Viana, Razuk, de Freitas, & Barela, 2013). Even the very early reports of Orton in 1925 (cited in Henry, 1998) recognized the importance of the motor skills for literacy. The magnocellular (Stein, 2001) and auditory processing deficit theories (Tallal, 1980) focus their analysis on the sensory issues that underlie the reading difficulties, but they need a broader outlook in terms of understanding the multifariousness of their manifestation. However, neurobiological evidences suggest that phonological deficit may co-occur with sensorimotor issues (Ramus, 2004). A review by Gerd Schulte-Körne 1, Jennifer Bruder (2010) provided an overview of research findings in the last two decades on motion related and contrast sensitivity visual evoked potentials and on auditory event related potentials to basic tone and speech sound processing in dyslexia. These results are mainly important for the magnocellular deficit hypothesis, the temporal processing deficit hypothesis and the phonological deficit hypothesis. Evidence of altered visual evoked potentials to rapidly moving stimuli presented at low contrasts extended support for magnocellular deficits in dyslexia.

SENSORY PROCESSING AND SPECIFIC LEARNING DISABILITIES

According to the magnocellular deficit theory, developed by Stein (2001a) most reading problems have a primary sensorimotor cause and dysfunction in the magnocellular system would also include deficit in visual, auditory, and tactile systems (Stein, 2014; Stein & Walsh, 1997).

Sensory processing abilities have been vividly studied in the spectrum of neurodevelopmental conditions. Approaches from the field of the sensory integration, sensory processing, and multi-sensory functioning have provided relevant insights for the understanding of neurodevelopmental conditions (Miller, Nielsen, Schoen, & Brett-Green, 2009; Schaaf et al., 2015; Wallace & Stevenson, 2014). The estimated rate of sensory issues within neurodevelopmental disorders has ranged from about 40% to almost 90%, which is significantly higher than in the 'neuro-typical' population with an estimation of about 5% to 10% (Ahn et al., 2004; Fox et al., 2014; Talay-Ongan & Wood, 2000). A review of Dunn et al., (2016) showed that children with neurodevelopmental disorders process sensory inputs differently from their peers with no conditions, which suggested that sensory processing is associated with cognitive processes and brain activity. However among the population of neuro developmental disorders, majority of the recent sensory processing studies are focussed on ASD and ADHD. Only few investigations had demonstrated the potential role of sensory processing as part of the characteristics of LD (Dove & Dunn, 2008; Dunn, 2014; Keller, 2001; Kruger et al., 2001; Padankatti, 2005). Dove and Dunn (2008) compared the sensory processing profile of students with and without specific learning difficulties and ADHD. The results indicated that sensory profile of high frequency of behaviours in response to sensations in students with specific learning difficulties that may create more difficulties (Dove & Dunn, 2008). Dunn (2014) reported significant differences in the sensory profile of children with and without LD, characterized by the challenging processing of auditory, visual, and movement systems and a sensory profile that differed from the norms. Padankatti, (2005) examined the sensory profile of children with and without learning disabilities and demonstrated that children with LD

differed of the typical group regarding their sensory profile, especially in the sensory systems of movement, touch, and body position. Kruger et al. (2001) conducted a phylogenetic study on children with learning difficulties. The results of Kruger et al. showed an interrelation between auditory, visual, somato-sensory, motor and language skills, implying that is not possible to observe learning difficulties without the presence of sensory involvement. This finding highlights the close association between cognitive skills and sensory processing and their mutual influence for the acquiring of learning goals. Finally, poor handwriting, a common behavioural manifestation in learning difficulties (Fawcett & Nicolson, 1999; Nicolson et al., 2001) is associated with an inadequate sensory integration process, and so demonstrates an additional link between SLD and sensory issues (Keller, 2001).

Researchers also have proposed that children with reading problems have difficulties linking verbal labels to the corresponding visual stimuli, which affects the establishment of appropriate associations between a word and its spelling (Blau et al., 2010; Wimmer et al., 2000; Windfuhr & Snowling, 2001). Similarly, the integration of auditory and visual sensory inputs has been noted as more relevant for the development of cognitive skills such as reading (Chen, Zhang, Ai, Xie, & Meng, 2016; Francisco, Jesse, Groen, & McQueen, 2017; Froyen, Van Atteveldt, Bonte, & Blomert, 2008; Froyen, Willems, & Blomert, 2011; Kronschnabel, Brem, Maurer, & Brandeis, 2014; Nash et al., 2017).

Thus, most of the literature on SLD and sensory deficits, except Padankatti (2005) has focused primarily on studying auditory and visual processing. But Dunn's Model of Sensory Processing (Dunn, 1997b) which has been extensively used in research as an instrument to depict the sensory processing profile of children (Baker et al., 2008; Cheung & Siu, 2009; Dove & Dunn, 2008; Engel-Yeger & Dunn, 2011; Kern et al., 2007; Lowe et al., 2016; Padankatti, 2005; Taal et al., 2013; White, Mulligan, Merrill, & Wright, 2007), posits that all of the senses, that is the senses of touch, smell, taste, sight and sound, as well as physical movement and body awareness, are required to have a posed balanced response which will enable the appropriate functioning of brain mechanisms and adaptive responses. Also study by Liu S, Wang LC, Liu D (2019) examined whether temporal processing (TP) is associated with reading of a non-alphabetic script, that is, Chinese suggested that TP is vital for reading in children with dyslexia than in typically developing children, and the impact of TP in dyslexia require further examination.

Further since there is no consensus about the relevance as well as prevalence of sensory difficulties across the various sensory domains as well as within the variability of the LD manifestation, it may reflect on the other non-sensory developmental variables (Goswami, 2014). For example, Hulslander and colleagues (2004) assessed children and young adults with a range of reading ability, on the measures of IQ, reading, and sensory processing (frequency and amplitude modulation detection of auditory stimuli, and motion and form detection of visual stimuli). The results indicated the correlation between reading skills and sensory processing threshold, however when controlled by IQ the association was lost. These findings do suggest the possibility that sensory processing might have an effect on reading skills and evidence for such association might be not easily detected, thus necessitating incorporation of a new approach to test learning difficulties and their sensory characteristics.

Further, till day there has been very few studies aiming to connect sensory profile research to the underlying cognitive or cognitive neuroscience research, despite its perceived necessity in the field of children with Specific Learning disability. (SLD). One recent study (Metz et al., 2019) examined the validity of the Dunn's four quadrant model by analyzing the variation of the scores of the adolescent/adult version (Brown & Dunn, 2002) with external measures such as personality and brain stimulation. Though Metz et al. (2019) failed to find linkage between Dunn's hypothetical threshold measure and event-related potentials, there is a need to probe the relationship between Dunn's well-established clinically relevant behavioural tests and established literacy and cognitive measures. Also Metz et al. research was done with healthy adults, thus it is not known whether its interpretations of non linkage can extended to children or individuals with special needs.

Thus despite magno cellular theory supporting sensory processing deficits in SLD and research had shown some evidences for sensory-related behaviours and temporal processing as a relevant component in SLD, the influence of sensory issues on learning disorders has been challenged by a strong emphasis in phonological theories. Also the sensory processing deficits within the manifestation of learning difficulties are seem to vary in terms its expression and prevalence among different sensory domain as well as within the sub types of SLD and populations. Further there is limited evidence on the relationship among sensory processing, cognitive development and academic performances of Children with SLD. This demonstrates and necessities the need for in depth systematic research focusing on sensory processing deficits of SLD as well as its linkage with their functional performance. This will not only help in revisiting theories and postulates of SLD in the light of latest research evidence and also contribute for effective intervention planning in the field of SLD.

DISCUSSION AND RECOMMENDATIONS

Specific learning disabilities or difficulties, one of the most prevalent group of neurodevelopmental disorders, affects the children and adults. The persons with specific learning difficulties exhibit deficits in perceiving and processing information from their environment efficiently and accurately,there by facing difficulties in academic arena.

Reliable and accurate statistics on the prevalence of SLD population in India is essential for obtaining adequate and fund which will help in promoting research and service activities. The prevalence rates of SLD, infact varies drastically from country to country as well region to region to region within the same country, due to various factors which was long back pointed out by Rutter and Yule (1975). In India also, the prevalence studies reported varied prevalence rates ranging from 5-15 % and there is only limited evidence available on the prevalence and determinants of SLD using standardized and exclusive screening tool as well on the determinants of SLD are sparse. This demonstrates an immediate need for focusing on the prevalence and causative factors of SLD. Also Department of Empowerment of Persons with Disabilities, Ministry of Social Justice & Empowerment vide its Gazette notification had declared NIMHANS SLD Battery as an official tool for diagnosis and certification of SLD in India.

Secondly early intervention is essential for remediating the deficits and strengthen their academic acumen. And for that there is a dire need to strengthen the existing system of screening, early identification, referral support, assessment, appropriate and differentiated diagnosis as well as effective intervention planning and implementation with the trained resources. The manifestation of Specific Learning disabilities over lap on many co-morbid conditions ranging from Speech Language Impairments, Attention Deficit Hyperactive Disorder(ADHD), Sensory Processing Dysfunction (SPD) and Developmental Coordination Disorder (DCD). Differential diagnosis play a vital role in any condition more so far SLD in view of its varied manifestations. This calls for developing more number of indigenous and highly sensitive screening, assessment tools, relevant to Indian conditions in the field of Specific Learning Disabilities.

Thirdly there are various predominant theories on the underlying deficits of SLD since decades and these theories act as a framework for SLD intervention planning. The postulates of these theories include deficits in phonology, auditory processing, automation, cerebellar dysfunctions, sensory issues and other magno cellular deficits. However in the case of specific reading disorder, also known as developmental dyslexia, phonological theory, the well established and leading theory (Lieberman, 1971; Liberman et al., 1974) that posits that reading and spelling difficulties result from impairments in the ability to identify or manipulate the component sounds in speech, called phonological awareness (Lieberman, 1971; Liberman et al., 1974),. However underlying cause of the phonological deficits still remain unclear. Also the longstanding theories that claim that ‘magnocellular’ sensory problems are significantly involved (Stein, 2019). is gaining momentum of late. Hence in the light of the latest research as well exponential works on bio-cellular and other areas of NDDs, there is a need to revisit these theories. This exercise will for sure help to plug in the possible loopholes in the intervention plans ,there by contributing for the welfare of SLD.

Fourthly, Sensory processing abilities have been widely studied in the spectrum of neurodevelopmental disorders and the estimated sensory issues in Neuro Developmental Disorders range from 40%-90%. As per the magnocellular deficit theory, most of the reading difficulties have a primary sensorimotor cause which includes deficit in visual, auditory, and tactile systems (Stein, 2014; Stein & Walsh, 1997). Though there are some evidence of sensory issues accompanying learning difficulties,they are very limited, restricted more to

Visual and auditory sensations. Also there is no agreement on the prevalence of sensory difficulties across the various sensory domains as well as within the varied types of the SLD. The scenario however become complex after the advent of new nomenclature –sensory processing disorders (SPDs) which has been accepted in the Diagnostic Classification of Mental Health and Developmental Disorders of Infancy and Early Childhood (DC:0-3R). Though it is not recognized as a disorder in the ICD-10 or the DSM-5, however there is debate over whether SPD should be a distinct diagnosis. Further there is limited evidence available on the relation between sensory processing and cognitive development of SLD. This demonstrates the need for more detailed studies to be conducted to understand the sensory processing deficits of Children with SLD and their relations to the cognitive development of children with academic difficulties.

CONCLUSION

The literature review concludes that there is a need for more systematic research in the field of Specific learning disabilities with diagnostic tools which are standardized in Indian context. The research should be more culture specific and region focused. The existing system of screening, early identification, referral support, assessment, appropriate, differentiated diagnosis and trained human resources needs to be strengthened for intervention planning and implementation. There is a need for an in depth exploration of the sensory processing and integration deficits in Children with SLD, across various sensory domains as well as among varied learning disorders. More research to be taken up to explore the relationship between sensory processing and cognitive development of children with special needs. There is also a need to revisit the postulates of existing prominent theories in the field of SLD to validate them in the present context and development.

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