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Research Paper

Impact of Attention Deficit and Hyperactivity Disorder (ADHD) on Behavior and Cognitive Profile in Children with Specific Learning Disability (SLD)

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ABSTRACT

Background: Attention deficit and hyperactivity disorder (ADHD). is the most commonly co-occurring condition with Specific learning disability (SLD). ADHD and SLD has specific cognitive deficiencies and behaviour challenges. Understanding the differences and potential overlap between them can guide targeted intervention. Purpose of the study is to examine the difference in behaviour and cognitive profile in children diagnosed with SLD and children diagnosed SLD with comorbid ADHD. **Method:** Sample consisted of 32 children in the age group between 8 to 12 years diagnosed with SLD only (Group 1) and SLD with Comorbid ADHD (Group 2). Behaviour profile were compared using scores on Child behaviour checklist completed by parents for Group 1 and Group 2. Difference in behaviour problems between two groups were assessed using Mann Whitney U test. Cognitive profile was compared using WISC IV index score, General Ability Index (GAI), Cognitive proficiency Index (CPI) for Group 1 and Group 2, a t test was used. **Results:** Children diagnosed with SLD and comorbid ADHD show significantly higher behaviour problems than children diagnosed with SLD only, U= 30.50, p<.001. Overall, Children with SLD were found to have significant strength in GAI and weakness in CPI, however no significant difference in cognitive profile was observed between the Groups. **Conclusion:** The findings suggest that co-occurrence of ADHD in children with specific learning disability can exacerbate behaviour issues in children with specific learning disability. ADHD does not significantly affect the cognitive profiles in children with SLD.

Keywords: *Attention deficit and hyperactivity disorder (ADHD), Specific learning disability (SLD), Comorbid, behaviour, Cognitive Profile*

ADHD is defined by impairing levels of inattention, disorganization, and/ or hyperactivity-Impulsivity. Whereas specific learning disability is characterized by persistent and impairing difficulties with learning foundational academic skills in reading, writing, and/ or with Math. (American Psychiatric Association, 2013).

Attention Deficit and Hyperactivity Disorder (ADHD) and specific learning disabilities overlap in a way that both are Neurodevelopmental disorders that commonly cooccur.

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(American Psychiatric Association, 2013). They are believed to be genetically inherited (ADRA2A gene) and have similar underlying genetic etiology (Chromosome 6b). (Couto et al., 2009; Stevenson et al., 2005; Willcut et al., 2002)

ADHD occurs in about 5% of children and the prevalence of SLD among school-going children is around 5 to 15%. (American Psychiatric Association, 2013). Studies have suggested a strong association between SLD and ADHD. Horbach et al. (2019) longitudinal study found that 33% of children with SLD were affected by ADHD.

Behaviour problems in children with SLD and ADHD

58% of children with SLD have psychiatric comorbidity. They have behavior problems like Anxiety, depression, aggression, conduct, and Oppositional defiance disorder. (Horbach et al., 2019; Margeri et al., 2013). Studies have shown that 70% of children with ADHD at least have one additional diagnosis. ADHD is also often associated with aggression, conduct disorder, depression, anxiety, and low self-esteem. Children with SLD and ADHD both experience peer rejection. (American Psychiatric Association, 2013, Larson K et al., 2011)

Cognitive Profile in Children with SLD and ADHD

Researchers have suggested a multiple cognitive deficit model for understanding "complex" neurodevelopmental disorders. It is hypothesized that the interactive effect of multiple genetic and environmental factors leads to weakness in multiple neurocognitive domains (Pennington et al., 2012; McGrath et al., 2011). Weschler's Intelligence Scale for Children IV index scores can used to analyse cognitive profiles in children. (Hale et al.,2008; Kaufman et al., 2006). A cognitive profile can be used to understand underlying strengths and weaknesses associated with academic underachievement in SLD. (Compton et al., 2012).

Studies have shown that children with Specific learning disabilities perform poorly on working memory and processing speed tasks. (Benenenti et al.,2010, Shanahan et al., 2006). Children with ADHD perform poorly on executive functioning tasks (Willcut et al 2005), working memory tasks (Kasper et al 2012, Martinussen et al., 2005), and processing speed (Shanahan et al., 2006).

Evidence also suggests that working memory problems are exacerbated in children with both ADHD and LD, compared to children with only one of these disorders (Parke et al., 2020). The presence of comorbid ADHD often complicates the intervention plan and requires a multidisciplinary measure.

We conducted the present study to know whether the presence of comorbid ADHD has any significant influence on the cognitive function and behavior of children with SLD.

METHODOLOGY

The purpose of the study is to examine the difference in behavior and cognitive profile in children diagnosed with SLD only and SLD with comorbid ADHD.

Method: Data of 32 children diagnosed with Specific learning disability without ADHD (n= 14; Males 8 Female=6; Mean Age= 9.86; SD= 1.14) and SLD with comorbid ADHD (n= 18; Male= 16, Female= 2; Mean Age=10.15; SD=1.26) in the age group of 8 to 12 years and meeting the inclusion and exclusion criteria was collected for analysis through

convenience sampling from the three year (2020-2023) database of children referred for developmental assessment by Paediatric neurologist at the Rehabilitation centre in Mumbai. Children referred for developmental assessment typically underwent standardized assessment tests for intelligence, learning, behavior, presence of ADHD, and Autism spectrum disorder.

Diagnosing children with Specific learning disabilities:
Children was diagnosed Using a standardized battery of intelligence (WISC IV INDIA) and achievement tests (Woodcock-Johnson III or Wide Range Achievement Test – IV and NIMHANS index for learning disability) by a team of clinical psychologists. Basic criteria used for diagnosis of SLD were Children with a General Ability Index score at or above 85 on WISV IV and having significant lag in academic achievement along with other qualitative measures (parent report, school performance, work sample).

Behavior problems and the presence of ADHD were assessed using CBCL/ 6-18 and Parent rating on Conners-3 Rating Scale (symptom level information from the Conners-3)
Information about course, age of onset, differential diagnosis, level of impairment and pervasiveness is taken in to account.

Inclusion criteria

- Children in the age group 8 to 12 years
- Studying in English medium School
- Primarily diagnosed with Specific Learning Disability with or without Comorbid ADHD

Exclusion criteria

- Previous history of psychiatric illness
- Children with major chronic medical conditions
- Children diagnosed with Autism or neurological disorder

Consent for data accessibility was obtained from the institutional authorities and parent-informed consent for use of data was taken at the time of initial interview.

Materials
CHILD BEHAVIOUR CHECKLIST (CBCL /6-18): It covers a broad range of symptoms used for evaluating behaviour problems in children between the ages 6 and 18 years. It is completed by Parent and problem items are rated as 0= Not true, 1=Somewhat true or sometimes true and 2=Very true or often true, based on the preceding 6 months. CBCL analysis is based on DSM-oriented and Syndrome scales. The test-retest reliability of the CBCL item was 0.93. Internal consistency for empirically based problem scales ranged from .78 to .97 and DSM oriented scale ranged from .72 to .91. (Achenbach & Rescoria, 2001)

WECHSLER'S INTELLIGENCE SCALE FOR CHILDREN-IV (INDIAN ADAPTATION): (WISC IV^{INDIA}) is used for assessing the cognitive ability of children aged 6 years 0 months to 16 years 11 months. It yields Full-scale IQ, four primary indices: Verbal comprehension index (VCI), Perceptual reasoning index (PRI), Working Memory index (WMI), Processing speed index (PSI) and Two additional indexes: General Ability Index (GAI), and Cognitive proficiency index (CPI) (Raiford et al., 2008; Saklofske et al.,

2006). The average split-half reliability coefficient ranged from .70 to .90 indicating good reliability. (Joseph & Mao, 2012).

PARENT RATING ON CONNERS 3:

Conners 3rd Edition (Conners 3TM) provides a structured means of considering ADHD as a diagnosis. It is used for assessment of children and adolescents between 6 and 18 years of age. It has strong link to the DSM-IV-TR. Conners 3 test retest reliability range from .70 to .98 and internal consistency coefficients range from .77 to .97. Inter-rater reliability ranges from .52 to .94. (Conners K, 2008)

RESULTS

Statistical Analysis:

Statistical analysis was performed in SPSS version 29.0. The difference in behavior problems between the two groups was assessed using the Mann-Whitney U test. The cognitive profile was compared using the WISC IV index score, General Ability Index (GAI), and Cognitive Proficiency Index (CPI) for Group 1 and Group 2, a t-test was used.

Findings:

Table 1 shows socio-demographic information. Out of the total number of children (n=32), 14 (43.75%) children had comorbid ADHD and 18 (56.25%) of children were diagnosed with SLD only.

Table 1: Sociodemographic information of study group

Socio-Demographic Variables	**Study Group (N=32)**
Age in Years Mean (SD)	9.98 (1.27)
Education Mean (SD)	4.41 (1.86)
Gender (Boys: Girls)	24: 8
Children with SLD only Total Number (Percentage)	18 (56.25%)
Children with SLD and ADHD Total Number (Percentage)	14 (43.75%)

In Table 2, the Mean composite score on various index on WISC IV is listed. Two groups were compared using a t-test and it was found that the groups did not differ significantly in their cognitive profile as assessed by index scores on WISC IVINDIA.

Table 2: Comparison of cognitive profile on WISC IV between the groups

WISC IV INDEX	**Overall N=32**		**SLD with ADHD n=14**		**SLD only n=18**		**t-test**	**df**	**P value**
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**			
Verbal Comprehension (VCI)	102.06	14.21	101.36	14.40	105.39	15.21	.761	30	.45
Perceptual reasoning (PRI)	107.44	12.43	109.00	13.37	105.00	13.03	-.852	30	.401
Working Memory (WMI)	95.03	14.48	95.79	15.70	93.67	14.71	-.392	30	.698

WISC IV INDEX	Overall N=32		SLD with ADHD n=14		SLD only n=18		t-test	df	P value
	Mean	SD	Mean	SD	Mean	SD			
Processing speed (PSI)	94.25	12.53	97.00	13.12	93.44	15.28	-.694	30	.493
Full scale IQ (FSIQ)	101.25	12.24	102.93	13.86	100.50	14.54	-.478	30	.636
General Ability (GAI)	105.88	13.14	105.93	14.29	105.83	12.61	-.020	30	.986
Cognitive Proficiency (CPI)	94.00	15.38	97.00	12.20	91.67	17.46	-.972	30	.336

In Table 3, the behavior profile is compared between two groups using CBCL/6-18 syndrome scales, externalizing and internalizing scales, and total problem behavior score. The analysis is done using the Whitney U test. Results found that internalizing behaviour problems were significantly greater for children with SLD and ADHD than the SLD-only group, U= 59.0, p<.001. There was no difference in Externalizing behaviour problems between children with SLD and ADHD and in SLD-only group, U= 77.0, p= .065.

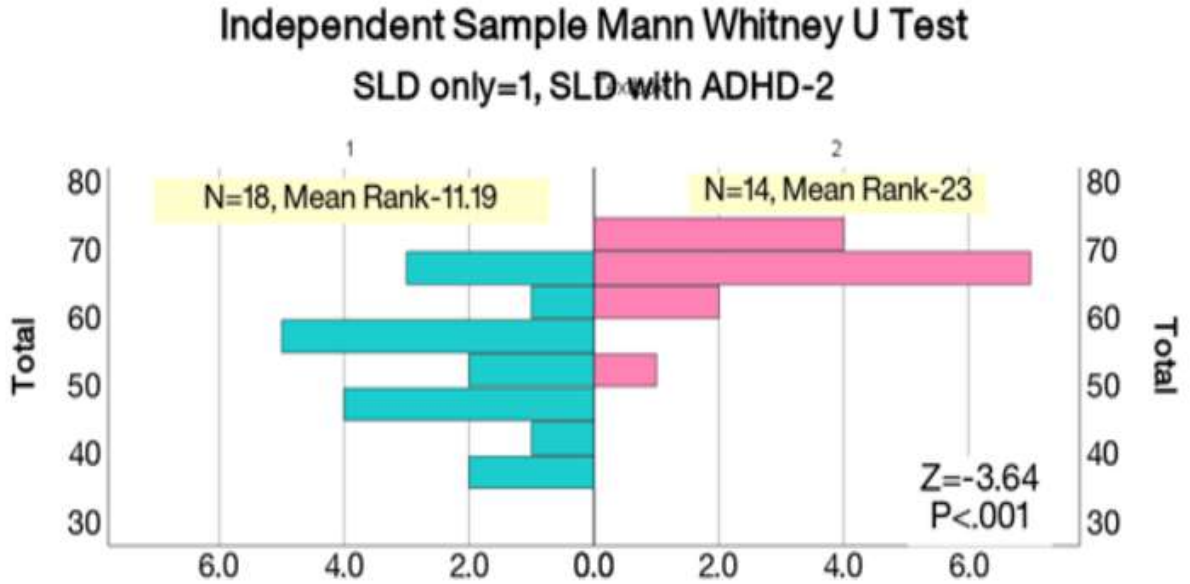
Table 3: Comparison of syndrome scales, Internalizing, Externalizing, and Total problem behaviour score on CBCL/6-18 between the groups

CBCL	SLD with ADHD n=14	SLD only n=18	Mann-Whitney U	P value
Anxious	22.46	11.8	42.50	<.001**
Withdrawn	18.46	14.97	98.50	.301
Somatic Complaints	21.36	12.72	58.00	.009**
Social Problem	21.04	12.97	62.50	.014*
Thought Problem	20.96	13.03	63.50	.016*
Attention Problem	21.50	12.61	56.00	.007**
Rule breaking	19.64	14.06	82.00	.099
Aggressive	20.43	13.44	71.00	.036*
Internalizing	21.29	12.78	59.00	.010**
Externalizing	20.00	13.78	77.00	.065
Total Problem behavior	23.32	11.19	30.50	<.001**

**p ≤ .05, **p ≤ .01*

Children with SLD along with comorbid ADHD had significantly greater problems related to anxiety, somatic complaints, social problem, thought problems, attention, and aggression than children with SLD only (p<.05). No difference between groups was found on rule-breaking and withdrawn behaviour.

Figure 1: Graphic representation of results of independent Mann Whitney u test for Total Problem behavior score



A shown in fig1, Children diagnosed with SLD and comorbid ADHD show significantly higher behaviour problems than children diagnosed with SLD only, *U*= 30.50, p<.001.

DISCUSSION

The purpose of the study was to examine the impact of comorbid ADHD on cognitive and behavior profiles in children with SLD. In the present study, the prevalence of ADHD in children with SLD was found to be around 43.75. This supported by a Systematic review done by Khodier et al, 2020 of psychiatric comorbidity in children with SLD, the prevalence rate of ADHD with SLD was found be around 25.5 to 41.9%. In some of the Indian studies on the prevalence of ADHD with SLD, a study by Karanda et al. (2007) has showed ADHD as comorbidity among 20% of Children with SLD and Sharma et al. (2018) has found ADHD among 30% of children with SLD.

As per results of the study listed in Table 2, the General Ability Index score (m=105.88, sd=13.14) was significantly greater for the total study sample than the Population Mean (M=100, SD=15; p<.05) for WISC IV and Cognitive Proficiency Index (m=94.00, sd=15.38) was significantly lower than the Population Mean (M=100, SD=15; p<.05). Children with SLD with or without ADHD have better General Ability skills than general population and they are lower on cognitive proficiency. The cognitive proficiency index (CPI) represents a set of functions that involves proficiency in processing certain types of cognitive information. Scores on two tasks working memory and processing speed are summarized in to single index score on the Wechsler scale and are calculated as the Cognitive Proficiency index. Similarly, General Ability Index is computed using scores on the Verbal Comprehension and Perceptual Reasoning Index. (Devena et al., 2012; Raiford et al., 2008). The results are similar to the study by Poletti et al (2016). They investigated the intellectual profile on WISC IV of 172 children diagnosed with SLD and compared them with children in the control group. Children with SLD had higher General ability index scores than cognitive proficiency and the discrepancy was significant. Children performed poorly on similarities, Digit span, letter-number sequencing, and coding subtests.

One of the reasons for poor performance on proficiency tasks could be due to the presence of inattention. Studies have suggested that children with SLD have difficulty with attention even if they do not meet the diagnostic criteria for ADHD (Mayes et al.,2000). Earlier dated studies have found problems in figure-ground tasks and sustained and selective attention tasks in children with SLD. (Malhotra S et al., 2009; Richards et al.1990).

Results of our study can be partly attributed to the problem in executive function and implicit learning in children with SLD (Menghini et al., 2010). The evidence is also provided by neurobiological studies. Study by Weng et al. (2018) found decreased connectivity in the left superior frontal gyrus with default mode network in children with SLD as compared to typically developing children. According to the conclusion of a study by Boisgueheneus et al. (2006) lateral posterior portion of the left superior frontal gyrus is a key component of the neural network of working memory. Similarly, FMRI studies in ADHD children have found fronto striatal dysfunction that is part of executive function as a central pathophysiology to ADHD (Cherkasova & Hechtman., 2009).

In the present study, no significant difference was found in the cognitive profile between children with SLD and ADHD and with SLD-only group. The results are similar to the study by Becker et al., 2021. They compared the WISC V profile of children with ADHD and Specific Learning disorders and found no specific impairment in any of the cognitive domains.

The results highlight the potential overlap in cognitive functions of children with SLD and ADHD.

However, results of the behavior outcomes in the study found that children with SLD and ADHD group had more internalizing behavior problems. They were found to have more anxiety, somatic complaints, inattention, and aggressive behavior than their counterparts. Total problem behavior score was higher in this group. Around 40% of this group were in the clinical range for parent-reported behavior problems. Studies have shown that the cooccurrence of ADHD with SLD results in more behavior problems, greater attention problems, and poor learning outcomes (Smith & Adams, 2006; Mayes et al., 2000). We have similar results in the study.

One of the perspectives is that as studies have made attempts to understand the link between specific brain areas to cognitive deficits, attempts have been made to understand social cognition and its link to specific areas of the brain. Here social cognition is the way we interpret, analyse, remember, and use information about the social world. It is strongly influenced by emotions. Brain areas that can be involved are the prefrontal cortex, temporoparietal junction, insula, and amygdala. (Beaudoin & Beauchamp, 2020; Beauchamp & Anderson, 2010). Some of these areas are implicated in SLD and ADHD children. For example, studies have found overactivation of the anterior insula in children with SLD, and a deficit in the insula area is noted in ADHD. (Rubia K, 2018; Prasad et al., 2020; Richlan et al., 2010;). Over-activation of the insula is present in anxiety as involves anticipation of aversive events (Alvarez et al., 2015). Thus, increase in anxiety problems in children with SLD and with ADHD can be due to specific networks involved causing overactivation of this area than expected in children without comorbid ADHD.

The results of the study highlight the possibility of a separate neural network system for behavior, the influence of which may not be noted in general cognitive tasks.

CONCLUSION

The presence of ADHD in children with SLD shows greater behavior problems than in SLD alone. No significant difference in cognitive profiles was found with the presence of ADHD in children with SLD. The results suggested that the presence of ADHD in children with SLD differed with the SLD-only group significantly on internalizing problems (like anxiety, and somatic complaints).

Future Direction

The findings of the study necessitate a distinct diagnostic category for SLD with ADHD. Also, keeping in mind the integrative or systems biology, potential overlap between ADHD and LD, it would be of important to know whether the social cognitive component can be seen as a separate component in information processing from the general cognitive process. This can help in treatment planning and prognosis. Further researchers are required to validate the findings.

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Conflict of Interest

The author(s) declared no conflict of interest.

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