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Thoughtfulness and Executive Functions of Children with Attention Deficit Hyperactivity Disorder with Learning Disabilities

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ABSTRACT
Children with attention-deficit/hyperactivity disorder (ADHD) can benefit from working memory training programs and that children with reading disorders have a positive response to executive functions training programs, there are still very few studies that have compared the deficits of executive functions in children with ADHD and children with learning disabilities. A total of 26 healthy children were included in the control group. These children were matched with cases in terms of gender, age, intelligence, and education. In order to pick them, relatives of patients who were receiving care in the Paediatrics department of the same hospital were looked through. Participants were considered for inclusion if they were consecutively diagnosed with attention-deficit/hyperactivity disorder (ADHD), met the inclusion and exclusion criteria, and were attending the outpatient facility of the Departments of Psychiatry and Neurology. There was a statistically significant difference in the Trail Making Test A scores between the patients and the comparator group (Mann Whitney U= 16.00, p=0.04), the research demonstrated that children with attention-deficit/hyperactivity disorder (ADHD) had a lower level of attention. It was also observed that there was a significant difference in the scores on the Trail Making Test B (Mann Whitney U = 15.00, p = 0.03). In order to have a deeper understanding of the cognitive impairment that is associated with ADHD, studies with bigger samples are required.

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Key Words
Attention-deficit, hyperactivity disorder, ADHD

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INTRODUCTION

A multicenter community-based Indian investigation that was carried out in a thorough manner found that the prevalence of the condition among children was 1.6%[1]. Although a few studies conducted in India have concentrated on the clinical profile and comorbidities of attention-deficit/ hyperactivity disorder (ADHD), there is still a lack of evidence from India about the neuropsychological foundation of the disorder[2,3].

It is necessary to conduct neuropsychological examinations in order to determine the degree to which certain brain processes, such as attention, memory, and executive skills, have been impaired. According to the findings of several studies, deficiencies in executive function may be the primary pathology that is responsible for the symptoms of attention deficit hyperactivity disorder (ADHD)[4,5]. However, a few studies have found that there are no significant changes with regard to this domain between individuals with ADHD and controls[6,7]. The lack of consistency among studies may be attributed to methodological limitations, such as the inclusion of children who suffer from comorbid autism spectrum disorders, obsessive compulsive disorders (OCD), oppositional defiant disorder (ODD), or conduct disorder (CD), all of which are associated with executive dysfunctions in and of themselves[8,9].

Cognitive abnormalities, in particular impairments in attention and executive processes, are assumed to be a fundamental component of attention-deficit/hyperactivity disorder (ADHD) (Barkley, 1997) and are believed to play a significant role in the challenging adaption process associated with ADHD[10]. Psychiatric comorbidity associated with attention-deficit/hyperactivity disorder (ADHD) has been found to be unrelated to these dysfunctions[10]. According to the guidelines established by the Indian Psychiatry Society, learning difficulty is a mild form of the condition in which the child has only mild difficulty in specific areas such as reading or writing, and on standardized testing the child's achievements may not be significantly below the expected level. On the other hand, learning disability (LD) is characterized by the child having substantial difficulty, which is evident on standardized testing, and the difficulty can be overcome to a significant extent through remedial education. According to these recommendations, a child is considered to have a learning disability if they have a considerable amount of difficulties in specific areas that are shown on standardized tests of achievement, and even if they receive acceptable therapy efforts, there may not be any significant change. A spectrum of increasing severity, ranging from learning difficulties to handicap, is a better way to describe the situation[11]. Research has presented multiple signs that some learning difficulties are connected with working memory problems. Additional evidence suggests that these children also exhibit deficiencies in central executive functioning. Specific learning disabilities are associated with working memory impairments. Despite this, there are a relatively small number of papers that discuss the deficiencies of the visual-spatial working memory that are associated with children who have reading challenges. In addition, there are empirical findings available for all three domains of working memory that pertain to children who have specific learning difficulties in the area of mathematics. Given the circumstances, it appears that the central executive is particularly compromised[12]. EF may have an effect on reading development beginning in preschool and continuing through the school years, according to the data that has been examined up until this point. In particular, prereading skills are related to inhibition and cognitive flexibility; word-reading proficiency is related to working memory, inhibition, shifting, updating, and attentional control; and reading comprehension is associated, at the very least, with planning, working memory, and inhibition. It is encouraging to see that these data highlight to the significant role that EF plays in the process of reading acquisition[13]. Recent studies have suggested that executive function skills, which include the ability to monitor and manipulate information in the mind (working memory), to suppress distracting information and unwanted responses (inhibition), and to think in a flexible manner (shifting), play an important part in the development of mathematical proficiency[14].

Laboratory tests were used in the majority of the studies that were conducted, despite the fact that it is common knowledge that rating scales and clinical reports of how a person manages everyday tasks are significantly more sensitive and valid diagnostic indicators than laboratory tests or performance-based tasks of EF. This is also due to the high comorbidity that exists between attention-deficit/hyperactivity disorder and learning disabilities. Neither of the illnesses was compared in any substantial trials, and the effects of the medicine on executive functions were not taken into consideration. In addition, despite the fact that children with attention-deficit/hyperactivity disorder (ADHD) can benefit from working memory training programs and that children with reading disorders have a positive response to executive functions training programs, there are still very few studies that have compared the deficits of executive functions in children with ADHD and children with learning disabilities.

MATERIALS AND METHODS

Participants were considered for inclusion if they were consecutively diagnosed with attention-deficit/hyperactivity disorder (ADHD), met

the inclusion and exclusion criteria and were attending the outpatient facility of the Departments of Psychiatry and Neurology at a tertiary care medical college hospital. A total of 26 healthy children were included in the control group. These children were matched with cases in terms of gender, age, intelligence, and education. In order to pick them, relatives of patients who were receiving care in the Paediatrics department of the same hospital were looked through. The inclusion of the children was determined by the following criteria: they were between the ages of 6 and 12 years old, they were drug naive, and they were right handed. The children who were excluded from the study were those who had been diagnosed with autism spectrum disorders, Tourette syndrome, obsessive-compulsive disorder, obsessive-compulsive disorder, CD, mood disorders, psychotic illness, substance use disorder, or mental impairment (Binet Kamat score below 70). Additionally, children who had a history of epilepsy or a head injury that resulted in loss of consciousness, as well as children who had a visual or auditory impairment that could be diagnosed or that they self-reported, were not allowed to participate. The parents gave their consent in writing after being fully informed. A decision was made by the Institutional Ethics Committee to approve the study.

For continuous data, the Mann Whitney U test was utilized, and for categorical variables, the Chi-square test was utilized. Comparisons were carried out across all of the groups.

RESULTS AND DISCUSSIONS

All of the participants in the study were male (n = 26). As far as age, number of years of education, or intelligence quotient were concerned, there was no discernible difference between the two groups. The fact that the control group had low Vanderbilt scores provided clinical evidence that they did not have attention-deficit/hyperactivity disorder (ADHD). A Mann Whitney U value of 0.00, with a $p>0.001$, Table 1.

Given that there was a statistically significant difference in the Trail Making Test A scores between the patients and the comparator group (Mann Whitney U = 16.00, p = 0.04) the research demonstrated that children with attention-deficit/hyperactivity disorder (ADHD) had a lower level of attention. It was also observed that there was a significant difference in the scores on the Trail Making Test B (Mann Whitney U = 15.00, p = 0.03) Table 2.

To circumvent the potentially confusing impact of attention-enhancing medicines, the evaluation was conducted on children who had no prior experience with drugs. Children who were right-handed were the only ones who participated in the study and the controls were matched with the cases in terms of age, gender, and level of schooling independently.

According to the findings of the study, children who have attention deficit hyperactivity disorder (ADHD) tend to have attention deficiencies, but they do not have executive dysfunction. The executive dysfunction theory of attention-deficit/hyperactivity disorder (ADHD) is still being disputed due to research findings that are inconsistent and contradictory. It was not observed that individuals with ADHD had any abnormalities in reaction inhibition or set shifting. We have found that our findings are consistent with the findings of a recent metaanalysis of response inhibition on the Stroop test as well as a few studies on set shifting in attention-deficit/hyperactivity disorder [15-16]. The finding, on the other hand, stands in contrast to a few other studies that have been conducted on the executive functioning of children who have ADHD. During the trial creating tests, we discovered a significant difference in the attention and psychomotor speed of children with ADHD compared to children who served as controls. This finding is consistent with the findings of prior studies[17].

During the Stroop test, it was discovered that children with attention-deficit/hyperactivity disorder (ADHD) had higher individual scores for naming the colors, words and color word. Stroop interference score is the most essential metric that determines cognitive flexibility but it is rarely evaluated in studies that focus on attention-deficit/hyperactivity disorder (ADHD)[18]. The interference score did not show any significant differences between the groups in our sample, as we were unable to discover any. A prior study also produced results that were comparable to those seen here[18]. According to the findings of our research, children with attention-deficit/hyperactivity disorder (ADHD) had considerably higher scores on the Stroop color and word tests. This indicates that their ability to name colors and read the names of color words required more time. Children who have reading difficulty and attention-deficit/hyperactivity disorder (ADHD) are more likely to have these deficiencies, even if they do not have interference score deficits[19]. Due to the fact that we did not eliminate children who also had reading disorders from our sample, it is possible that the difference in Stroop color and word score could also be the result of an undiagnosed reading disorder.

In the current study, it was shown that children with attention-deficit/hyperactivity disorder (ADHD) and children with a combined ADHD and learning disability (LD) group had considerable difficulties in regulating their emotions. This discovery may provide an explanation for the emotional liability symptom that is associated with ADHD. One study[20] found that at least eighty percent of adults who have attention-deficit/hyperactivity disorder (ADHD) report significant levels of emotional liability. These levels are frequently severe and cause impairments that go

Table 1: Distribution of sociodemographic and clinical variables

Variable	ADHD	Control	Mann whitney U	p-value
Age	9.63±3	9.51±3	35.00	0.90
Years of education	4.10±1.68	3.70±1.72	35.53	0.90
Intelligence (BKT)	109.52±13.51	110.60±13.16	34.52	0.83
Vanderbilt score	39.10±9.00	7.00 ± 1.64	0	<0.01

Table 2: Neuropsychological test scores

Variable	ADHD	Control	Mann whitney U	p-value
Trail making test (TMT) scores				
TMT A	12.31	7.35	16.0	0.05
TMT B	12.10	7.31	15.0	0.04
Stroop colour word interference test scores				
Stroop color	12.70	6.91	12.3	0.01
Stroop word	11.00	5.41	4.0	0.009
Stroop color word	10.52	5.83	7.0	0.04
Predicted color word	11.00	5.41	4.0	0.09
Interference	10.12	6.10	9.0	0.08
Wisconsin card sorting test (WCST) scores				
Total correct	9.60	10.41	33.4	0.75
% Errors	10.21	9.73	35.0	0.89
% Perseverative response	7.85	1.39	18.0	0.08
% Perseverative errors	8.91	11.21	27.4	0.38
% Non- perseverative errors	11.60	8.22	21.4	0.17
% Conceptual level response	10.41	9.3	33.0	0.76
Categories completed	10.20	9.73	35.0	0.89

beyond what can be accounted for by inattention, hyperactivity, or impulsivity. Additionally, it has been demonstrated that medication treatments for ADHD can improve symptoms of emotional liability. In addition, there was a strong relationship between emotion regulation and other psychiatric comorbidities, which was discovered to be a risk factor for emotion regulation executive dysfunction (odds ratio = 12, confidence interval 3-46). This provided an answer to Surman's query, which was whether or not emotion liability in adult ADHD is due to emotional liability. On the other hand, due to the restricted assessment of the comorbidity's role to emotional symptoms to this point, I was unable to provide an answer[21]. The findings of our research lead us to believe that the answer is yes. This is because the emotion regulation executive dysfunction decreased when children with additional mental comorbidities were excluded from the study. As a consequence, it was shown to affect just 37% of the ADHD only group and 30% of the combination group. It was found that the psychiatric comorbidity that had the most significant impact on this EF was disruptive behavior disorders, which included obsessive-compulsive disorder and conduct disorder. This was followed by mood and anxiety disorders, which affected 92% of them, then epilepsy, which affected 89% of them, and finally, those with a history of (nocturnal enuresis or language delay) affected 79% of them. Additionally, a number of studies came to the conclusion that major depressive disorder (MDD) is linked to executive dysfunction and the defective prefrontal ability that is connected with it. On the other hand, some investigations demonstrated that the status of executive function in anxiety disorders and in comorbid depression and anxiety situations is still unknown[22].

Our study has a number of significant limitations, the most significant of which are the small sample size, the fact that only boys were included in both groups, and the limits of employing measures like as TMT and WCST on a younger age group. Therefore, in order to validate these findings, larger investigations that are not constrained by such methodological constraints are required.

CONCLUSION

In this study, attention, naming colors and words, and psychomotor speed were found to be impaired in individuals with attention-deficit/hyperactivity disorder (ADHD). However, other executive functions, such as response inhibition and set shifting, were found to be unimpaired. In order to have a deeper understanding of the cognitive impairment that is associated with ADHD, studies with bigger samples are required.

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