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EXECUTIVE FUNCTIONING IN CHILDREN WITH NON-VERBAL LEARNING DISABILITY

[1]Shweta Kansal, [2]Dr.Thiyam Kiran Singh, [3]Dr. Nidhi Malhotra

***ABSTRACT**--Non Verbal learning disability (NVLD) is a disorder which is usually seen with significant discrepancies with regards to verbal skills and motor skills, visual spatial and social skills. This becomes a major concern as it leads to learning difficulties. Our objective of the research is to study executive functioning in children with non-verbal learning disability. A purposive sample of 45 children; 15 children with Non-verbal learning disability (NVLD) (as per Children's Nonverbal Learning Disabilities Scale), 15 children diagnosed with Attention deficit hyperactive disorder (ADHD) according to DSM-5 and 15 healthy children with a mean age of 9.53 years (SD=2.13), 10.27 years (SD=2.40) and 10.67 years (SD=2.13) were selected from outpatient services of Department of Psychiatry according to the inclusion and exclusion criteria. For the purpose of the study Vanderbilt ADHD Diagnostic Parents' Rating Scale, Children's Nonverbal Learning Disabilities (NVLD) Scale and NIMHANS neuropsychological battery for children particularly- verbal fluency (FAS), verbal N back task, visual N back task, visuo-spatial working memory, wisconsin card sorting test (WCST) and maze were used. The findings of the present study indicated that there were significant differences among the three groups with respect to error verbal N back 2 ($F=4.24$, $P<0.05$), error Visual N back 2 ($F=58.95$, $P<0.01$) and set shifting ($F=13.02$, $P<0.01$) which indicates all three groups have significant difference statistically in terms of executive functioning. From the study it can be concluded that as compared to healthy group, children with NVLD and ADHD performed poor on the tasks of verbal as well as visual working memory and between ADHD and NVLD group children with ADHD performed better than children with NVLD. Study also showed that children with ADHD and healthy control performed better than children with NVLD on the task of cognitive set-shifting.*

***Key Words--** Executive Functioning, Non Verbal Learning Disability, Neuropsychology, ADHD.*

I. INTRODUCTION

Nonverbal learning disability (NVLD) was first described by Johnson and Myklebust.[1] Individuals diagnosed with NVLD primarily have difficulties in visual-spatial functioning. Although the etiology of these difficulties is not clear, they are assumed to be pervasive and associated with the right hemisphere and lead to secondary deficits in mathematics and social skills. [2] Currently, NVLD is not included in DSM-5 and ICD-10. Individuals with NVLD have delayed language development and problems with semantics, prosody and

[1] M.phil (Clinical Psychologist), Department of Psychiatry, Ex- trainee at Government Medical College & Hospital,Chandigarh. shwetadrc@gmail.com

[2] Associate Professor (Clinical Psychology), Department of Psychiatry, Government Medical College & Hospital, Chandigarh. I/C, Clinical Psychology Services,Assoc. Professor (Clinical Psychology), Department of Psychiatry, 5- Level, D- Block, GMCH , Sector-32, Chandigarh, Mobile No: 9888622772, thiyamkiransingh@gmail.com

[3]Assistant Professor (Psychiatry), Department of Psychiatry, Government Medical College & Hospital, Chandigarh. malhotra.nidhi05@gmail.com

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pragmatics.[2] They find difficulty in interpretation of visual social cues, such as body language, gestures, facial expressions, understanding of tone of voice, mood, emotional cues, comprehension of information not immediately contained in words, such as nuances, humour, sarcasm, metaphors, imagery, the pragmatics of language, particularly social language, knowing what another party knows or needs to know what to say when, when and how to initiate and maintain conversations, when and how to terminate communication and so on.[1,3] In addition, deficits are frequently found in the areas of functioning like general organizational abilities; most specifically, in the ability to break down a complex task into its component parts and to work through the steps in order to complete the task. They have difficulties with part-whole relationships, mastery of nonverbal mathematical concepts such as time, space, quantity, visual array, ability to grasp and manipulate spatial relationships in one, two and three-dimensions, understanding of the position of self in space, orientation, directionality, visual pattern recognition and memory, visual-motor integration and fine motor control.[1,3]

As per research, there is overlapping of symptoms of NVLD with autism spectrum disorder,[4] specific learning disability,[1] and children with ADHD.[5]. ADHD and NVLD both impact social skills and learning. They share common symptoms such as poor social skills, academic difficulties, inattentiveness, over focusing on certain tasks, excessive talking and speaking without thinking about it first. Many kids thought to have NVLD appear to boast large vocabularies, outstanding memory and auditory retention and average-to-superior intellect – and they're also often misdiagnosed with ADHD (Attention Deficit Hyperactivity Disorder). Thus, for diagnostic clarification, research shows that it is important to differentiate on the basis of the neuropsychological profile of children.

II. MATERIALS AND METHODS

Ethical statement:

The thesis Ethics Committee of institution has approved the study related protocol. Written informed consents were obtained from all the participants as well as from parents prior to the interviews. They were explained the purpose of the study properly in their vernacular language like English, Hindi or Punjabi. It was emphasized that participation in the study is voluntary and they can withdraw from the study at any time if they are not willing to continue.

Setting and Design:

The aim and objective of present research was to study executive functioning in children with non-verbal learning disability. The present study was carried out cross-sectional and comparative in nature.

Subjects:

A purposive sample of 45 children; 15 children with Non-verbal learning disability (NVLD) (as per Children's Nonverbal Learning Disabilities Scale), 15 children diagnosed with Attention deficit hyperactive disorder (ADHD) according to DSM-5 and 15 healthy children with a mean age of 9.53 years (SD=2.13), 10.27 years (SD=2.40) and 10.67 years (SD=2.13) were selected from outpatient services of Department of Psychiatry. Initially, a total of 52 children were selected for the study who were already diagnosed with ADHD in the Child

Guidance Clinic of the hospital and those who were referred for assessment of learning disability. For ADHD, a total of 16 children were administered, one dropped out (due to non-cooperation from the child in completion of the assessment). For NVLD, a total of 36 children were screened, out of which 15 met the criteria as per the NVLD scale and on those 15 children, neuropsychological battery was administered.

Inclusion criteria of children with Non-verbal learning disability: male/female aged 6 to 15 years, children with arithmetic and visuospatial difficulties, children going to school, able to understand English/Hindi/Punjabi. Exclusion criteria of children with Non-verbal learning disability: children who have co-morbid intellectual disability or any other psychiatric disorder, children with difficulty in reading or spelling, children with epilepsy or brain injury, children with impaired speech. Inclusion criteria of children with ADHD: Male/Female aged 6 to 15 years, children diagnosed with ADHD (as per DSM-5)[6], children going to school, able to understand English/Hindi/Punjabi. Exclusion criteria of children with ADHD: children who have co-morbid intellectual disability or any other psychiatric disorder, children with learning disability, children with epilepsy or brain injury, children with impaired speech. Inclusion criteria of healthy children: Male/Female aged 6 to 15 years, children with average intellectual functioning, children going to school, able to understand English/Hindi/Punjabi. Exclusion criteria of healthy children: children who have co-morbid intellectual disability or any other psychiatric disorder, children with learning disability, children with epilepsy or brain injury and children with impaired speech.

Measures used:

1. Vanderbilt ADHD Diagnostic Parents' Rating Scale[7] : This scale is meant for children of age group 6 to 12. It can also be used with other age groups. There are different forms which are available; separately for parents and teachers. Both forms screen for symptoms of ADHD and inattention. There were six counted behaviors with a score of 2 or 3 out of the nine questions for inattention or hyperactivity to meet DSM-5 criteria for ADHD. The scale has good internal consistency, factor structure, and concurrent validity for the assessment of ADHD.

2. Children's Nonverbal Learning Disabilities Scale[8] : This scale was developed by David B. Goldstein. This scale has a checklist of characteristics that may be indicative of a Nonverbal Learning Disability. A referral to a neuropsychologist or for a more in-depth evaluation of a Nonverbal Learning Disability is considered if the parent reports deficits "Sometimes" or "Often" on over half the items examining motor skills (at least 3 of the 4 items), visual-spatial skills (at least 4 of the 7 items), and interpersonal skills (at least 3 of the 4 items).

3. NIMHANS neuropsychological battery for children[9] : Neuropsychological assessment is done to identify adequacies and deficits of cognitive functions. It also aims to identify the brain function which is dysfunctional or damaged analyzing the neuropsychological profile of the patient. In this study, verbal fluency (FAS), verbal N back test, visual N back test, visuo-spatial working memory, wisconsin card sorting test (WCST) and maze were used.

Procedure:

A total sample consisted of 45 children; 15 children with Non-verbal learning disability, 15 children diagnosed with ADHD and 15 healthy children. They were selected from Outpatient services of the Department

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of Psychiatry of Govt. Medical College and Hospital, Chandigarh. Children in each group who fulfilled the inclusion and exclusion criteria were given consent form and explained the purpose of the study properly in their vernacular language like English, Hindi or Punjabi. It was emphasized that participation in the study is voluntary and they can withdraw from study any time if they are not willing to continue. This study took seven months starting from November 2017 to May end 2018. For children with non-verbal learning disability, children referred for SLD testing by treating psychiatrist were approached. Out of these children, those who faced difficulty in arithmetic and visuo-spatial tasks were identified and those with reading difficulty were excluded. Then, on these identified children, Children's Non-verbal learning disability scale was administered and those who scored more than the cut-off were chosen for the present study. Neuropsychology battery was administered on each child to assess executive functions. For the ADHD group, children diagnosed with ADHD as per DSM - 5 in Psychiatry OPD were approached. Vanderbilt ADHD Diagnostic Parents' Rating Scale and neuropsychological battery were administered on each subject. For a healthy group, siblings (having average intellectual functioning clinically without any specific learning disability as per the reports of parents or caregivers) coming with children were chosen and a neuropsychological battery was administered on each child.

III. DATA ANALYSIS

The whole sample was subjected to descriptive statistics such as mean, standard deviation, frequencies and percentage to identify the sample characteristics. ANOVA and Tukey Post-hoc tests were used to find out the significant differences among the three groups.

IV. RESULTS

Table 1: Socio-demographic characteristics of children and healthy control

Variables		**NVLD**	**ADHD**	**Healthy group**
N		15	15	15
Mean		9.53	10.27	10.67
SD		2.134	2.404	2.127
Gender	Male	10 (66.7%)	10 (66.7%)	6 (40%)
	Female	5 (33.3%)	5 (33.3%)	9 (60%)
Education	1 to 3 standard	3 (20%)	2 (13.3%)	5 (33.3%)
	4 to 6 standard	8 (53.4%)	7 (46.6%)	8 (53.3%)
	7 to 9 standard	4 (26.7%)	6 (40%)	2 (13.4%)
Language spoken	Two or more	15 (100%)	15 (100%)	15 (100%)
Handedness	Right	14 (93.3%)	14 (93.3%)	14 (93.3%)
	Left	1 (6.7%)	1 (6.7%)	1 (6.7%)

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Table 1 shows the socio-demographic variables. It showed that in children with NVLD as well as ADHD, majority of children were males than females while in healthy control, majority was of female than male. In children with NVLD and ADHD, majority of children belonged to 4th to 6th standard followed by 7th to 9th standard and 1st to 3rd standard while in the healthy control group, majority belonged to 4th to 6th standard followed by 1st to 3rd standard and 7th to 9th standard. Each child spoke more than two languages and in each group, 93.3% were right handed while 6.7% were left handed.

Table 2: Comparison of Children with NVLD, ADHD and Healthy Control on Verbal Fluency task, Verbal and Visual N back task.

Variable		**N**	**Mean**	**S.D.**	**F**	**p-value**
Verbal fluency (FAS)	NVLD	15	6.00	1.00	2.27	.12
	ADHD	15	5.73	1.22		
	Healthy control	15	6.67	1.44		
Verbal N back 1 Hits	NVLD	15	6.07	1.39	2.20	.12
	ADHD	15	6.80	1.57		
	Healthy control	15	7.13	1.30		
Errors Verbal N back 1	NVLD	15	3.27	1.75	2.92	.06
	ADHD	15	2.60	1.99		
	Healthy control	15	1.73	1.44		
Verbal N back 2 Hits	NVLD	15	7.13	2.13	2.69	.08
	ADHD	15	7.40	3.04		
	Healthy control	15	9.27	2.96		
Errors Verbal N back 2	NVLD	15	12	3.42	4.24	.02
	ADHD	15	10.80	4.43		
	Healthy control	15	7.60	4.85		
Visual N back 1 Hits	NVLD	15	5.93	1.22	0.43	.65
	ADHD	15	6.33	1.79		
	Healthy control	15	5.73	2.22		
Errors Visual N back 1	NVLD	15	7.87	2.29	13.44	.01*
	ADHD	15	8.20	2.39		
	Healthy control	15	4.07	2.58		
Visual N back 2 Hits	NVLD	15	3.47	1.12	1.50	.23
	ADHD	15	4.40	1.86		
	Healthy control	15	3.80	2.39		
Errors Visual N back 2	NVLD	15	11.87	2.39	58.95	.01*
	ADHD	15	10.33	2.29		
	Healthy control	15	3.60	1.96		

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Table 2 shows that three groups did not differ significantly from each other on Verbal Fluency task, Verbal N-back 1 score, N-back 1 error score and Verbal N-back 2 score. However, a significant difference was observed for Verbal N back error score at F=4.24, p=0.02. Tukey Post-hoc Analysis suggests NVLD group made significantly more errors in Verbal N-back 2 than their healthy control counterpart at p= 0.02. Table also shows that there was significant difference in all three groups with respect to errors in visual N back 1 (F= 13.44, P= 0.01) as well as errors in visual N back 2 (F= 58.95, P= 0.01). The Tukey Post hoc analysis revealed there exists a statistical significant difference with respect to errors in visual N back 1 & visual N back 2 test between NVLD and healthy group at p= 0.01 and between ADHD and healthy group at p= 0.01.

Table 3: Comparison of Children with NVLD, ADHD and Healthy Control on Memory Span task, WCST task and Maze task.

Variable		**N**	**Mean**	**S.D.**	**F**	**p-value**
Memory span task	NVLD	15	5.47	1.73	2.21	.12
	ADHD	15	6.60	2.06		
	Healthy control	15	6.93	2.19		
Set shifting (WCST)	NVLD	15	0.92	0.26	13.02	.01**
	ADHD	15	1.82	0.41		
	Healthy control	15	1.96	0.49		
Planning (Maze)	NVLD	15	15.67	2.64	0.83	0.44
	ADHD	15	14.29	3.77		
	Healthy control	15	15.47	2.85		

Table 3 shows that three groups did not differ significantly from each other on memory span task measuring visuospatial working memory and on maze task (measuring planning). A significant difference (F=13.02, P=0.01) was found with respect to set-shifting (WCST) in all three groups. The Tukey Post hoc analysis of the test showed there exists a statistical significant difference between NVLD and ADHD at p=0.01 and between NVLD and healthy control at 0.01.

V. DISCUSSION

The present study was conducted to assess executive functioning in children with non-verbal learning disability. The study was comparative in nature regarding how variables differ in children with NVLD, ADHD and healthy control.

In the test of verbal fluency assessed by FAS, it was found that there exists no statistical significant difference among children with NVLD, ADHD and healthy control as mentioned at table-2. The result revealed

that children with NVLD, ADHD and healthy control have similar verbal fluency skills. The present study showed results consistent with previous study done on children and adolescents with the syndrome of nonverbal learning disability (NVLD) in which they found that NVLD displayed well-developed rote verbal skills.[10] This could be because they do not have difficulty in comprehending and decoding verbal component as compared to visual spatial tasks wherein they fail to decode non-verbal and visual cues.[2]

The Post hoc analysis of the test of verbal working memory as assessed by Verbal N Back revealed that there was statistical significant difference with respect to errors in verbal N back 2 in all three groups as found at table-2. It means as compared to a healthy group, children with NVLD made more errors (omissions and commissions). In the test of visual working memory as assessed by Visual N Back, post hoc analysis showed that there exists a statistical significant difference among the three groups with respect to errors in visual N back 1 and errors in visual N back 2 both as described at table- 2. It means as compared to a healthy group, children with NVLD and ADHD made more errors (omissions and commissions) than healthy group. Also, error scores of children with ADHD were better on verbal task than visual task which could be because visual task demanded more attention and was comparatively more complex which might have caused differences in the performance. The present study showed results were consistent with previous study done on children with NVLD where researchers examined executive functioning in children with NVLD and found deficits in visual-spatial working memory and visual imagery.[11]

In the test of visuospatial working memory (table-3) measured by Memory span task, it was found that there exists no statistical significant difference among children with NVLD, ADHD and healthy control. The result revealed that children with NVLD, ADHD and healthy control had similar skills for visuo-spatial working memory. However, the present study was inconsistent with the findings of previous research which found deficits in visual-spatial working memory in children with NVLD.[12] The inconsistency in this task could be due to less complexity of this test as compared to other tests measuring visual-spatial abilities. Difficulty in other tasks measuring visual-spatial abilities is evident in the performance of children with NVLD.

Findings of the test of set-shifting measured by WCST revealed there is a statistical significant difference among all three groups (table-3). It means that children with ADHD performed better than children with NVLD and also healthy control performed better than children with NVLD on the task of set-shifting. The present study has been found to be consistent with various previous studies which have examined several components of executive functioning in children with NVLD and found significant weaknesses in the areas of attention control and cognitive shifting among children with NVLD. When their performance was compared to controls, children with NVLD performed poor than controls.[11,13]

In the test of planning assessed by Maze (table- 3), it was found that there is no statistical significant difference among all three groups. It means there is no significant difference with respect to planning skills in children with NVLD, ADHD and healthy control. However, the present study is not consistent with the previous study wherein they have found that children with NVLD showed poor psychomotor, tactile perceptual, visual-spatial-organizational and planning skills. The findings are also inconsistent with meta-analysis study done on ADHD children where researchers found deficits in executive functions in set shifting, planning, working memory, inhibition, attention, and initiation.[14] The inconsistency in the current study could be because of

multiple reasons such as use of one task of planning than using multiple tests, not having an standardised criteria for NVLD and small sample size.

VI. LIMITATION & FUTURE DIRECTIONS OF STUDY

The present study has few limitations. The study had a small sample size. No gender difference was assessed. Specific regional characteristics of the population under study may lead to restriction in generalization. Medication use was also not controlled in the present study; children were taking a wide variety of medications at the time of testing, therefore, it is difficult to know how pharmacological management might have impacted the present findings.

VII. CONCLUSION

This study provides information about executive functioning in children with non-verbal learning disability. Study showed that children with ADHD and healthy control performed better than children with NVLD on the task of cognitive set-shifting. From the clinical perspective, it has been found that there are cognitive deficits in children with NVLD. Children with ADHD have better executive functioning as compared to children with NVLD. The study found that there were deficits in visuo-spatial abilities in children with NVLD. The results can be further used therapeutically for the purpose of intervention and management of such children.

VIII. CONFLICTS OF INTEREST

There are no conflicts of interest.

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