

## Visual and verbal neuropsychological functions among students with specific learning disorders

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### ABSTRACT

Individuals use verbal and visual sensations to memorize, learn and successfully deal with the environmental aspects to effectively lead routine and vigorous life activities. Deficits in visual or verbal neuropsychological functions or both will lead the individual's life into a problematic condition. SLD is a cluster of difficulties or inability to acquire academic skills that can be affected by visual and verbal functional difficulties. The present study was aimed to study visual and verbal neuropsychological functional difficulties of students with SLD in comparison to students unaffected by SLD. 80 participants including 40 students with SLD and 40 students unaffected by SLD undergone for the assessment of Intelligence, SLD, visual and verbal neuropsychological functions. Results revealed students with SLD having difficulties in verbal immediate memory and learning, verbal working memory, learning ability, visual immediate memory and learning, visual-motor coordination, visual divided and sustained attention, visual perception and organization and verbal comprehension.

**Keywords:** *Specific learning disorders, Neuropsychology, Visual and verbal functions, Learning*

Perception of information through sensory modality has a principal role in the overall development and survival of the individual. Human being perceives the information majorly through tactile, olfactory, gustatory, auditory and visual sensory modalities for the normal process of information. Human individuals greatly learn various skills and techniques using the visual and verbal sensory modalities further more it is not exceptional for academic skills and techniques. In the modern schooling system emphasis is given to the visual and verbal sensory mode of learning than any other sensory modalities. These perceptual processes are very essential for learning the simple to complex functions which is crucial to lead life easily and successfully. Difficulty in this process appears to be creating obstacles for the achievement of simple and complex goals in the individual's life. Academic learning and achievements determine the possible success in the life of the individual. Even though the exceptions are abundant the role of academic learning and achievements with professional skills and abilities helps the individual to easily find the

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occupations, achieve more goals and lead a prosperous life. Specific learning disorders (Here onwards it will be mentioned as SLD) is a cluster of difficulties or inability to acquire academic skills of reading, writing, spelling, comprehension and arithmetic abilities. Difficulty in academic abilities leads to perform poorly in academics and leads to problems in personal, psychological social and family setup.

As the difficulty in academic learning hinders the achievements and individual with such difficulties struggle to perform in academic functions, later in getting job results in facing difficulty to lead a prosperous life. Researches show evidence about the role of perceptual and memory functions on the difficulty in performing in academic learning functions (Kohli et al, 2006). Profiling revealed difficulties among students with SLD in neuropsychological functions (Shyam & Srinivasan, 2020; Julia & Rosemary, 2002). Difficulty in processing visual and verbal information poses difficulty in acquiring academic skills and techniques as these are the major sensory mode of teaching and instruction in the present education system. To understand the working memory functions of students with SLD, assessment of 97 students studying in 2<sup>nd</sup> to 4<sup>th</sup> grade were compared in 2X2 factorial design, 2 groups were comprised of children with dyscalculia and children without dyscalculia, children with dyslexia and children without dyslexia was undertaken. Phonological loop, visuospatial sketchpad and central executive which are the subcategories of the working memory were focused and the results of the study revealed phonological loop, central executive function deficits with phonological loop having to control of the influence on academic performance. When compared with children with dyscalculia and dyslexia with children without dyscalculia and dyslexia consistent underperformance was observed in children with dyscalculia and dyslexia. (Virginia & Maggie, 2011; Kirsten, Claudia & Marcus, 2008; Michelle et al, 2004). Children with ADHD and children affected by SLD and children with both ADHD with SLD applying neuropsychological testing showed that group of children with SLD having deficits in phonological awareness, verbal memory span, storytelling, verbal IQ, pervasive attention problems and visual-motor functions in comparison to other groups (Rhonda & Rosemary, 2006; Korkman & Personen, 1994). Children with dyslexia and typical readers revealed impairment in the phonological loop but visuospatial sketchpad and the central executive being intact and phonological loop deficit appearing to be specific to the phonological store (Michelle, William & Sam, 2004).

The development of mathematical abilities is dependent on multiple cognitive abilities. Studies revealed that short-term memory, working memory, visuospatial skills, processing speed and various language skills were correlated to the development and performance of mathematical functions. A study on 436 children aged between 5 to 17 years and referred for neuropsychological assessment due to various academic and/ or behavioural problems with the intention to compare the mathematic achievement with Full-scale IQ test exhibited children with a relative weakness to impairments in mathematics was more likely to have weakness to impairments in measures involving attention, language, visuospatial skills, memory, reading and spelling. Results also suggested the development of mathematical abilities is multifaceted (Robert et al., 2015). Selective attention, sustaining and switching of attention, verbal fluency, category fluency, design fluency, response inhibition and working memory of children with SLD in comparison to children with ADHD and comorbid SLD and control group revealed a significant difference in the executive functions. Children with SLD showed better interference control than children with SLD and comorbid ADHD which might be due to the interference of the ADHD (Visalakshi & Thenmoli, 2011). Working memory exhibits differently in students with SLD as a learning task exceeds their working memory capacity they often fall behind in learning. Working memory deficits are not a

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deficit in capacity but the deficit in strategy and it can be improved through remedial training and failing may lead to drop out such students from school (Pradeep & Vibha, 2017; Daniel, 2010).

### *Need for study*

In the light of the literature reviewed it can be understood that SLDs are the predominant obstacle for the development of necessary academic skills among students with SLD. Learning happens with perceiving and processing the visual and verbal information to bring the perceived change in academic performance. Understanding the visual and verbal functional difficulties to perform academic functions is essential for understanding performance difficulties. Understanding of visual and verbal aspects of cognitive functions concerning SLD also leads to strategize and plan rehabilitation and remedial measures for the management of SLD. In this perspective present study complements the necessary knowledge for the field of research in the area of SLD.

## **METHOD**

The present study was aimed to explore the visual and verbal neuropsychological functions of students with SLD in comparison to students unaffected by SLD (Performing academically in average or above-average level). The objective of the study was to explore and understand the visual and verbal neuropsychological functions of the students with SLD in comparison to students unaffected by SLD. With the purpose to discover the differences in visual and verbal neuropsychological functions of students with SLD and compare it with the students unaffected by SLD. The hypothesis of the study was there will be no significant difference in visual and verbal neuropsychological functions of students with SLD in comparison to students unaffected by SLD. The exploratory 2-group comparison study design was followed to carry out the present study.

### *Sample*

Initially, 120 participants were selected using a simple random sampling method for the screening and segregate the participants into 2 groups. Participants were drawn from the All-India Institute of Speech and Hearing and various schools in the locality of the Mysore area of Karnataka. After screening, using the purposive sampling method participants (N=80) were deployed to 2 groups in which each group had 40 participants that is students with SLD (n=40) and students unaffected by SLD (n=40). Participants were aged between 11-16 years and studying in 5<sup>th</sup> to 10<sup>th</sup> grade in English medium as the medium of instructions under any stream of the syllabus that is State, C.B.S.E. and I.C.S.E were included. Participants with a history of psychiatric illnesses and neurological disorders other than SLD, frequent changes in the medium of instruction, or multiple changes of schools and those who were suffering from any form of health difficulties other than SLD were excluded from the study. Participants were administered screening tools, a Learning disability assessment scale and an assessment of visual and verbal neuropsychological functions using standardized neuropsychological assessment tools.

### *Measures*

**Sociodemographic datasheet:** Sociodemographic datasheet is a checklist developed by the researcher to collect the sociodemographic information which included name, age, and gender, education qualification socioeconomic status of the participants and their parents/caretakers.

**Standard progressive matrices (SPM; Raven, Raven and Court, 1958):** SPM is a widely used measurement tool for assessment of intelligence it provides trusted nonverbal testing of intelligence as it minimizes the effect of language and cultural biases it is nicely suited for assessing the intelligence of students with SLD and other verbal performance-related difficulties. In the present study, SPM is used as a measure of intelligence as it is suitable to assess the intelligence of both groups of participants.

**Learning disabilities assessment scale (LDAS: Venkatesan, 2011; 2014; 2016; 2017):** LDAS is a battery of three independent age-cum-grade level assessment scales that assesses the reading, writing, and mathematical abilities/ functions of the participants. Initial development of the scale was done by S. Venkatesan and subsequent standardization was also done by Venkatesan and associates. This scale is applied in the present study to assess the presence of Specific learning disorders among the participants.

**Auditory verbal learning test (AVLT; (AVLT; Rey, 1958; Taylor, 1959, 1998, 2006)** Auditory Verbal Learning Test (AVLT) is a test of auditory verbal memory and learning it assesses the rate of learning, learning strategies, retroactive and proactive interference, presence of confabulation of confusion in the memory process, retention of information and differences between learning and retention.

**Complex figure test (CFT; Rey, 1941; Osterrieth, 1944):** CFT is a line drawing test, participants are asked to draw a figure first by copying (8.5"x11" Stimulus Card) it freehand (recognition) 3-minute immediate recall trial which is drawing from memory and 30-minutes delayed recall trial is followed. Test-retest reliability coefficients of the memory scores range from 0.76 to 0.89; Interrater reliability ranges from 0.93 to 0.99. This test measures recognition memory and assesses the respondent's ability to use cues to retrieve information. CFT evaluates the relative contributions of encoding, storage, and retrieval processes to visual learning and memory performance.

**Colour trials test (CTT; D'Elia, Satz, Uchiyama & White, 1996):** CTT measures the remote attention, divided attention, sustained visual attention, visual scanning and set shifting abilities that are considered to reflect the frontal lobe perceptual tracking and sequencing abilities. CTT consists of 2 parts, Part 1 is primarily a test of sustained visual attention, and Part 2 assesses frontal systems functioning. Spearman's coefficient on the main measures of the CTT was 0.76 in form-1 and 0.82 in form-2.

**Knox cube Imitation test (KCIT; Howard Andrew Knox, 1913):** KCIT was initially developed for the assessment of intelligence by H. A. Knox. Due to the tests' immense quality of assessing visuospatial information, verbal representations and attentional capacity in the present scenario KCIT is vastly used to assess the Visuospatial working memory. In the present study also KCIT is used to assess the visuospatial functioning of the participants.

**Verbal-n-back (Verbal-n-back; Kirchner; 1958):** Verbal N-back test is a test of working memory in common originally developed by Wayne Kirchner. The test was used to assess the visual and verbal working memory in various neuropsychological and cognitive neuroscience assessments. N-back test is a continuous task that is commonly used to assess the working memory and selective attention through presenting verbal/ visual stimuli and respond to the stimuli in phases. In the present study, this test is used till the 2-back phase to assess the auditory discrimination function with Verbal working memory.

**Token test for children –2<sup>nd</sup> edition (TTFC-2; Ronnie L, David J. E., Frank D; 2007)**

TTFC-2 is a reliable and effective tool for the assessment of receptive language comprehension abilities among the children. The test will have 20 tokens instructor gives 3 trials before giving actual linguistic commands in increasing the level of difficulty to perform. It has the validity of Cronbach's alpha of 0.812 and RTT of 0.923.

**Subtests of Wechsler's Adult Intelligence scale IV (WAIS-IV; Wechsler; 1981, 2003, 2009)**

**Coding:** Coding test used to assess the processing of information it is used to assess the short term memory, learning ability and visual-motor coordination of the participants which is necessary for the function of reading and writing.

**Block design:** It is a perceptual reasoning test used to measure the ability to analyze and synthesize abstract visual stimuli, it also involves nonverbal concept formation, visual perception and organization, simultaneous processing, visual-motor coordination, learning and the ability to separate figure and ground in visual stimuli.

***Procedure***

The present study was conducted by following an exploratory 2-group comparison study design for the purpose of systematic data collection. The study was carried out in the clinical setup of the Department of Clinical Psychology, All India Institute of Speech and Hearing (AIISH), Mysore, and schools situated in Mysore City of Karnataka state in India between years 2017 to 2020. Data collection was conducted in 2 phases with the participants. Screening tools considered of Sociodemographic datasheet, SPM, and LDAS were administered to 120 participants as part of the first phase of the study. Totally 80 participants who have met the inclusion criteria were drawn using purposive sampling techniques as the initiation of phase 2 of the study followed with participants consent has been taken along with school teachers or parents of the participants, sociodemographic and clinical information has been collected using sociodemographic and clinical datasheet continued with the administration neuropsychological assessment tools to assess visual and verbal functions of the participants through using standard procedures of administering the neuropsychological testing. Neuropsychological tests started with the AVLT test then CFT continued with the Colour trials test, verbal n-back test, coding test, Knox cube imitation test, Block Design and in the last TTFC-2 was administered. Analysis and interpretation of the collected data were carried out using the suitable statistical techniques and then preceded for reporting.

***Ethical considerations***

Informed consent has been taken from all the participants and their parents or teachers who were present at the time of testing. Following the AIISH ethical guidelines after completion of the assessment participation feedback based on performance in the assessment has been provided to the participants. After the completion of the assessments Counselling and Psychoeducation has been provided with information about the further interventions for the participants who were found to have SLD and for the participants unaffected by SLD and found to have minor difficulties in specific neuropsychological functions were also guided by suggesting techniques such as memory enhancement techniques to outcome such difficulties.

**RESULTS**

*Table-1 shows the results of descriptive statistics and independent samples t-test*

	Groups	N	Mean	Std. Deviation	Sig. (2-tailed)
SPM Total score	USLD	40	46.70	5.676	<b>.001**</b>
	SLD	40	40.40	7.945	
AVLT Total learning	USLD	40	57.28	8.811	<b>.001**</b>
	SLD	40	48.43	7.906	
AVLT LTPR	USLD	40	93.10	11.482	.363
	SLD	40	90.40	14.712	
AVLT IR	USLD	40	13.28	1.694	<b>.00**</b>
	SLD	40	11.40	2.193	
AVLT DR	USLD	40	14.18	9.753	.057
	SLD	40	11.10	2.479	
CFT copy	USLD	40	35.63	.705	.038*
	SLD	40	34.48	3.382	
CFT IR	NSLD	40	26.15	6.070	<b>.032*</b>
	SLD	40	22.88	7.321	
CFT DR	USLD	40	25.35	7.000	.096
	SLD	40	22.63	7.458	
Coding	USLD	40	63.28	12.950	<b>.000**</b>
	SLD	40	53.25	11.024	
TTFC total	USLD	40	42.78	2.665	<b>.000**</b>
	SLD	40	38.10	5.610	
Verbal 1-Back	USLD	40	8.80	.405	.058
	SLD	40	8.55	.714	
Verbal 2-Back	USLD	40	6.88	1.305	<b>.005**</b>
	SLD	40	5.88	1.771	
Knox cube	USLD	40	8.98	1.476	<b>.000**</b>
	SLD	39	7.67	1.611	
CT-1 score	USLD	40	55.23	19.631	<b>.000**</b>
	SLD	40	86.58	40.116	
CT-2 score	USLD	40	120.58	52.562	<b>.003**</b>
	SLD	40	162.05	66.514	
BD score	USLD	40	35.10	12.114	<b>.004**</b>
	SLD	40	27.40	11.197	

\* Significant at 0.01 level

\*\* Significant at 0.05 level

**Analysis of Results**

The findings of the present study have been analyzed based on performance in different tests and corresponding neuropsychological functions that are assessed through those tests. The result of 80 participants was segregated into 2 groups of participants and their mean score and standard deviation (SD) with differences found in the t-test is analyzed. Results of SPM revealed significant differences between the groups at the 0.01 level indicating a significant difference in intelligence between the groups of students with SLD and students unaffected by SLD. The mean score of students with SLD was 40.40 and the SD of 7.945 and the mean score of students unaffected by SLD (USLD) was 46.7 with an SD of 5.676.

AVLT test showed a significant difference in total learning and immediate recall between the groups at 0.01 level but no significant differences were found in Long term percent retention (LTPR) and Delayed recall. The Group of students with SLD had a mean total learning score of 48.43 and SD was 7.906, USLD group had a mean score of 57.28 and SD

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was 8.811. In verbal immediate recall mean score of the SLD group was 13.28 and SD was 1.694, Mean score of the USLD group was 11.4 and the SD was 2.193. In LTPR mean score of the SLD group was 93.1 and SD was 11.48, the mean score of the USLD group was 90.4 with an SD of 14.712.

In the complex figure test, there were no significant differences between the group in copy and delayed recall. In copying the mean score of the SLD group was 34.48 and SD was 3.382 whereas the mean score of the USLD group was 35.63 with SD of 0.705. In the delayed recall mean score of the p SLD group was 22.63 and SD was 7.458 and the mean score of the USLD group was 25.35 with an SD of 7.0. A significant difference was found in the immediate recall at 0.05 level in which the mean score of the SLD group was 22.88 and SD was 7.321 and the mean score of the USLD group was 26.15 with the SD of 6.07.

Coding test revealed a significant difference in performance between the groups at 0.01 level indicating differences between the groups in learning ability and visual-motor coordination in which mean score of SLD group was 53.25 and SD was 11.024, USLD group had the mean score of 63.28 and SD was 12.95. In TTFC results showed a significant difference between the groups at 0.01 level, SLD group had a mean score of 38.1 with an SD of 2.665 and the mean score of the USLD group was 38.1 and the SD was 5.61 indicating a significant difference in the function of verbal comprehension.

In the verbal n-back test 1-back test showed no significant difference in verbal attention between the groups where the SLD group had the mean score of 8.55 SD of 0.714, the USLD group had the mean score of 8.80 and SD of 0.405. In the 2-back test results showed a significant difference in verbal working memory between the groups at 0.01 level, the mean score of the SLD group was 5.88 and SD was 1.771 whereas the USLD group had the mean score of 6.88 and SD was 1.305. And the Knox cube test revealed a significant difference in visuospatial working memory and visual perception between the groups at 0.01 level. The mean score of the SLD group in the Knox cube test was 7.67 and SD was 1.61, the USLD group had the mean score of 8.98 and SD was 1.305.

In colour trials test colour trials-1 and colour trials-2 both showed a significant difference in sustained and divided visual attention between the groups at 0.01 level. In colour trials-1 SLD group had a mean score of 86.58 and SD of 40.116, the USLD group had a mean score of 55.23 and SD of 19.631. Colour trials-2 test mean score of SLD group was 162.05 and SD was 66.514 whereas USLD group had the mean score of 120.58 and SD was 52.562. Block design test showed a significant difference in the visual perception and organization between the groups at 0.01 level of significance. The mean score of the SLD group was 27.40 and SD was 11.197, whereas the USLD group had a mean score of 35.10 with the SD 12.114.

## DISCUSSION

The study of neuropsychological functionality among students with SLD has a history of more than 3 decades various studies have explored and experimented with the neuropsychological functions of the students with SLDs. In this approach present study is an attempt to understand specifically the visual and verbal neuropsychological functions of the students with SLD. A study done by Plauss et al (1998) showed that learners actively select relevant verbal and visual information, organize the information into coherent mental representations and integrate newly constructed visual and verbal representations, indicating the importance of understanding learning strategies of students especially students with

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SLDs. Present study results indicated students with SLDs having a significant difference in intelligence, total learning ability, and immediate recall of information, learning ability and visual-motor coordination, verbal comprehension, visuospatial working memory and visual perception visuospatial working memory and visual perception, sustained and divided visual attention, visual perception and organization. It was corroborated with the study done by Kohli et al, (2006) showed students with SLD having deficits in intelligence, attention and concentration which can pose hurdles in the recall of previous experiences while learning.

Students with SLD was not differing neuropsychological functions of visual and verbal attention, delayed recall for visual and verbal information which was in contradiction of previous studies which suggested students with SLD having difficulty in verbal and visual attention when measured using normative scales (Ricardo & Sylvia, 2010; William, 2013). A significant difference was not found in LTPR indicating learning as temporal lobe function as students with SLD will have lesser ability to learn but can sustain the learned information for a longer duration after learning.

### ***Limitations of the study***

The present study was done on relatively a smaller sample size, study on a large sample will help to generalize the results with more confidence. Availability of neuropsychological testing tools specific for the assessment of visual and verbal neuropsychological functions of students with SLD have been given more comprehensive results.

### ***Suggestions for further studies***

Planning a study with more structured sampling and appropriate assessment tools can be attempted. With the visual and verbal modalities of functioning other functions including motor and other executive functions can be explored to understand vastly about the area of SLD and its related neuropsychological functions.

## **CONCLUSIONS**

The present study revealed various functional difficulties in the visual and verbal modality of neuropsychological functions in students with SLD. In comparison with USLD participants, SLD participants displayed significant differences in general intelligence, verbal immediate memory and learning, verbal working memory, learning ability, visual immediate memory and learning, visual-motor coordination, visual divided and sustained attention, visual perception and organization and verbal comprehension functions. No significant differences were found in LTPR and delayed memory of learned information, verbal attention tasks. Amongst students with SLD when compared with the students unaffected by SLD Indicates a necessity for profiling of visual and verbal neuropsychological functions as an aid forremedy and rehabilitation.

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***Conflict of Interest***

The author declared no conflict of interest.

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