



A COMPARATIVE STUDY ON WORKING MEMORY DEFICIT IN CHILDREN WITH DIFFERENT TYPES OF LEARNING DISABILITIES

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RESEARCH ARTICLE



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Abstract

Students with Learning Disability lead to a slower development of academic skills and abilities, which in turn impedes new learning. As a result of repeated cycle of failure, these students fall further and further behind. Thus, the need to address the academic achievement of students with LD is critical in order to improve their academic outcomes. Working memory is thought of as an active system that processes the information present within short term memory. Limitations in Working Memory capacity have a neurological/ biological base. The main objective of the present study is to find out the working memory deficit in children with learning disability in general and also to find out the difference in working memory deficit among children with learning disability in general and specific to reading writing and calculation disorder. 45 students diagnosed as learning disabilities, age 10-12 years have been selected to the study. Malin's Intelligence Scale for Indian Children and NIMHANS Neuropsychological battery for children manual; Reading, Writing, and Calculation: age appropriate tests were the tests used in the study. The data has been analysed using the appropriate inferential and descriptive statistical methods. The findings of the study shows that children with learning disability in general, Children with Reading and Writing disorder, and children with Mathematical disorder have deficit in verbal working memory. Children with learning disabilities in general have better visuospatial working memory compared to the verbal working memory. It is also found that there is no significant difference among different group of children with learning disabilities with reference to verbal and visuospatial working memory.

Keywords: *Specific Learning Disability, Working memory deficits, Visuo spatial working memory, Verbal working memory*

Context of the study

A learning disability affects nearly every aspects of a child's life and is lifelong challenge (Lerner,2000). Students with Learning Disability lead to a slower development of academic skills and abilities, which in turn impedes new learning (Stanovich, 1986). As a result of repeated cycle of failure, these students fall further and further behind. The academic problems also result in a lower engagement rate of postsecondary schooling, employment or both, compared to typically achieving students (Murray, Goldstein, & Edgar, 1977). Thus, the need to address the academic achievement of students with LD is critical in order to improve their academic outcomes.

Some individuals despite having an average level of intelligence, have real difficulty acquiring basic academic skills. The construct has always attempted to represent people struggling to learn to read, write, and/or do mathematics despite the absence of conditions that interfere with the acquisition of these skills (kirk,1963). These skills include those for successful reading, writing, listening, speaking and / or math. These difficulties might be the result of a learning disability.

National Joint Council on Learning Disabilities (1997) defined Learning Disability as "Learning disabilities is a general term that refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading writing, reasoning, or mathematical abilities. These disorders are intrinsic to the individual, are presumed to be due to central nervous system dysfunction, and may occur across the life span. Problems in self-regulatory behaviours, social perceptions, and social interactions may exist with learning disabilities but do not by themselves constitute a learning disability. Although a learning disability may occur concomitantly with other disabilities (e.g., sensory impairment, mental

retardation, or serious emotional disturbances) or with extrinsic influences (such as cultural differences or insufficient/inappropriate instruction), it would not be a result if those conditions or influences.”

Working memory is thought of as an active system that processes the information present within short term memory. Limitations in Working Memory capacity have a neurological/ biological base. These limitations are multifaceted as to the psychological operations they influence. Limitations in Working Memory capacity cause LD (Swanson & Siegel, 2001). When people are first exposed to tasks that are unfamiliar, their performance is tightly constrained by the limited capacity of their working memory. However, these rigid constraints of working memory tend to disappear once individuals have had sufficient skill building experience with the tasks (Ericsson & Kintsch, 1995). Acquiring almost any academic skill involves acquisition of problem solving routines and knowledge structures that help one to appear more efficient in processing information on that task or in related domains. Research indicates students with LD have smaller working memories for verbal information than their normally achieving peers (Martinussen & Major, 2011; Swanson & Trahan, 1992). This deficit affects their ability to encode, organize, and process information. It also puts students with LD at a distinct disadvantage in terms of study skills, because study skills can place extreme demands on working memory. For example, while accessing basic skills such as transcription, spelling, and outlining, note taking requires a student to (1) attend to information presented verbally and/or visually in a lesson, (2) focus on important information, (3) remember the information, (4) organize the information, and (5) condense or synthesize information.

Significance of the study

The effect of verbal and visuospatial working memory in specific learning-disabled children is poorly understood. Even though many studies were conducted on the effect of working memory deficit in learning-disabled children, the effect of the verbal and visuospatial working memory was not adequately compared among different types of children with learning disabilities. The present study intends to find out the verbal and visuospatial working memory deficit in children with different learning disability conditions. It also aims to compare the verbal and visuospatial working memory deficit among different groups of children with learning disability.

Operational definitions

Learning Disability in General: Learning disability in general refers to lifelong neuro developmental disorder which manifests in childhood as persistent difficulties in learning to efficiently read (dyslexia), write (dysgraphia) or do simple mathematical calculations (Dyscalculia) despite normal intelligence, conventional schooling, intact hearing and vision, adequate motivation and sociocultural opportunity.

Learning Disability Specific to Reading and Writing Disorder: Learning disability specific to reading and writing disorder refers to lifelong neuro developmental disorder which manifests in childhood as persistent difficulties in learning specifically to read (dyslexia) and write (dysgraphia).

Learning Disability Specific to Mathematic Disorder: Learning disability specific to mathematic disorder refers to lifelong neuro developmental disorder which manifests in childhood as persistent difficulties in learning specifically to do simple mathematical calculations (Dyscalculia). They face difficulties in basic computational skills of addition, subtraction, multiplication and division, rather than of more abstract mathematical skills involved in algebra, trigonometry, geometry or calculus.

Verbal Working Memory: Verbal working memory involves the ability to maintain information in mind and to perform an activity for learning, reasoning, or producing a result. It is a measure of the capacity of individuals to hold information in mind with the purpose of completing a task and helps them to remember the rules within a game or task.

Visuospatial Working Memory: Visuospatial working memory manipulates the visual information stored in the brain to process information. Visual-spatial working memory skills involve the ability to recall shapes and colours as well as their locations and movements. These skills aid children in letter/number recognition, reading, writing, and math. Each of these tasks typically involve some level of visualization in order to follow along in a story or complete complex math problems.

Objectives of the study

1. To find out the verbal and visuospatial working memory deficit in children with learning disability in general -Group 1
2. To find out the verbal and visuospatial working memory deficit in children with learning disability specific to reading and writing disorder -Group 2
3. To find out the verbal and visuospatial working memory deficit in children with learning disability specific to mathematic disorder– Group 3
4. To compare the verbal and visuospatial working memory deficit among children with learning disability with respect to the specific learning disability conditions

Hypotheses of the study

1. There is no significant deficit in verbal and visuospatial working memory in children with learning disability in general
2. There is no significant deficit in verbal and visuospatial working memory in children with learning disability specific to reading and writing disorder
3. There is no significant deficit in verbal and visuospatial working memory in children with learning disability specific to mathematic disorder
4. There is no significant difference in verbal and visuospatial working memory deficit among children with learning disability with respect to the specific learning disability conditions

Methodology

Research Design used for the present study is descriptive survey method.

Sampling design of the study is purposive sampling. A total of 45 students with learning disabilities between the age ranges of 10-12 years have been selected for the study from different schools at Secunderabad. In order to select the sample for the study, the researcher used NIMHANS Neuropsychological battery for children manual; Reading, Writing, and Calculation and Malin's intelligence scale for the Indian children (MISIC). Those Children scored IQ level above 85 and have normal visual acuity and hearing were only included in the study. The selected children were further classified in to two sub groups according to the scores obtained in NIMHANS Neuropsychological battery for children manual test. The classification of sample is as following;

Group No.	Condition	N
Group 1	All children with learning disabilities irrespective of their nature of learning disability condition (General)	15
Group 2	Children with learning disability specific to reading and writing disorder	15
Group 3	Children with learning disability specific to mathematic disorder	15

Tools used for the study

The following standardized tools were used for the present study

Sl.No	Name of the tool/test	Purpose in the study
1	Malin's intelligence scale for the Indian children (MISIC)	For the selection of sample
2	NIMHANS Neuropsychological battery for children manual; Reading, Writing, and Calculation	For the selection of sample and to classify the sample based on the nature of learning disability condition viz. Reading, Writing, and Calculation
3	NIMHANS neuropsychological battery for children manual	To find out the verbal working memory deficit in children with learning disabilities identified by administering the tests listed as SI No. 1 & 2
4	N back task of visuospatial working memory	To find out the visuospatial working memory deficit in children with learning disabilities identified by administering the tests listed as SI No. 1 & 2

Details of each tool mentioned above is given below:

1. **Malin's intelligence scale for the Indian children (MISIC).** This test is the Indian adaptation of popular American Test Wechsler Intelligence Scale for Children done by Dr. Arthur J Malin. This test covers the age range of 6 to 15 years and comprises of 11 subtests which were divided into two groups i.e Verbal and Performance Intelligence. Reliability and validity of the test has been assured.
2. **NIMHANS Neuropsychological battery for children manual; Reading, Writing, and Calculation:** Age appropriate tests. Reading, Writing and calculation skills were assessed using this test. It is a curriculum based assessments for the children attending school.
 - a. **NIMHANS Neuropsychological battery for children manual; Reading test:** Reading ability was assessed in terms of the subject's ability to read a passage correctly and reading comprehension, spelling errors, difficulty in reading single words, reading, deficit in phonological processing. Scoring for reading ability is done quantitatively in terms of presence and nature of errors. Number of correct answers given for reading comprehension is recorded.

- b. **NIMHANS Neuropsychological battery for children manual; Writing test:** Writing to dictation and copying a passage is a measure of writing and to rule out agraphia. The material used are 10 age appropriate words for dictation and a passage for copying. Number of correct words written to dictation comprises the score for dictation. A maximum score of 10 for dictation and score of 10 for a passage copied correctly was given. Maximum score obtained on the writing test is 20.
 - c. **NIMHANS Neuropsychological battery for children manual; Calculation test:** Basic calculation skills are assessed in terms of simple and graded additions, subtraction, multiplication, and knowledge of tables to assess age appropriate normal levels of calculation skills and to rule out dyscalculia in the clinical sample. Age appropriate sums of simple and graded addition, subtraction, multiplication and tables are given to assess basic calculation skills. Number of correct solutions comprises the score. Maximum score obtained is 20.
3. **NIMHANS neuropsychological battery for children manual:** Verbal working memory test- N-Back task. It is a measure of the working memory. Verbal working memory has three important components i.e. storage, manipulation of information and rehearsal. This test consists of a “1 back task” and “a 2 two back”. The subject has to say YES for each consecutively repeated sound and NO for the other sounds he/she heard. In the two back task as each sound is presented the subject has to decide whether or not it matched the sound that appeared two items back in the sequence and if so the subject has to respond in terms of YES or NO. In scoring of ‘n’ back test, one mark is given for the correct response in one-back test and two marks will be given for the correct response in two back test.
4. **N back task of visuospatial working memory.** N back task is a measure of visuospatial working memory to assess executive control and active maintenance of spatial information. The Material used are in the test are 36 cards for 1 back task, 36 cards for two back task and record form. The card is successively placed on the table in the same location. Each card is presented at the rate of two seconds per card. As each card is presented the subject has to decide whether the location of the dot in the present card matches with the location of the dot in the card. In two back tasks the subject has to decide whether or not the location of the dot in the present card matches with the location of the dot which appeared two cards before the present card presented to the subject. If so the subject has to say ‘yes’ otherwise say ‘no’. 1 Back task and 2 back tasks are scored separately. Scoring is done in terms of number of correct responses called hits and the number of omissions called misses.

Procedure

Initially, children with learning problems are chosen from the different schools in Secunderabad with the help of the class teachers. A total of 60 students were identified for the study. These children were assessed using the Malin’s intelligence scale for the Indian children (MISIC) and NIMHANS Neuropsychological battery for children manual; Reading, Writing, and Calculation age-appropriate tests. All the children with above average IQ and with learning disability were selected for the study.

A total of 45 children with learning disabilities were selected for the study. From the total sample selected, three groups were formed as follows;

Group 1 /(General)	15 Children with Reading, Writing and Mathematical disorders
Group 2	15 Children with Reading and Writing disorder
Group 3	15 Children with Mathematical disorder

These children selected in three groups were assessed using NIMHANS neuropsychological battery for children manual; Verbal working memory test and visuospatial working memory test.

Results and Discussion

The main objective of the study is to find out the working memory deficit in children with learning disability in general and also to find out the difference in working memory deficit among children with learning disability in general and children with learning disability specific to reading writing and calculation disorder. The data has been analysed using the appropriate inferential and descriptive statistical methods. Result of the study is following

Table 1
Working memory deficit in children with learning disability in general

Types of working memory	Test administered	N	Mean score	Norm score	Percentile rank
Verbal working memory	‘1’ back test	15	6.2	8	10
	‘2’ back test		6.4	11	5
Visuospatial working memory	‘1’ back test		8	6	50
	‘2’ back test		3.7	3	50

When analysing the Mean, Norm score and Percentile rank scores obtained for 1’ back and 2’ back verbal working memory tests show that the children with learning disability in general have deficit in verbal working memory. Whereas in the area of

visuospatial working memory, the Mean, Norm score and Percentile rank scores obtained for 1' back and 2' back tests show that the children with learning disabilities have better Visuospatial working memory. It can be inferred from the above findings that the children with learning disabilities in general have better visuospatial working memory compared to the verbal working memory.

Table 2
Working memory deficit in children with learning disability specific to reading and writing disorder

Types of working memory	Test administered	N	Mean score	Norm score	Percentile rank
Verbal working memory	'1' back test	15	7.13	8	10
	'2' back test		7.33	11	5
Visuospatial working memory	'1' back test		7.63	6	50
	'2' back test		4	4	75

When analysing the Mean, Norm score and Percentile rank scores obtained for 1' back and 2' back verbal working memory tests show that the children with learning disability specific to reading and writing disorder have deficit inverbal working memory. Whereas in the area of visuospatial working memory, the Mean, Norm score and Percentile rank scores obtained for 1' back and 2' back tests show that the children with learning disabilities have better Visuospatial working memory. A marked difference was noted in the above findings that the children with learning disabilities specific to reading and writing disorder have better visuospatial working memory compared to the verbal working memory.

Table 3
Working memory deficit in children with learning disability specific to mathematic disorder

Types of working memory	Test administered	N	Mean score	Norm score	Percentile rank
Verbal working memory	'1' back test	15	6.93	8	10
	'2' back test		6.8	11	5
Visuospatial working memory	'1' back test		7.44	7	50
	'2' back test		3.33	3	50

When analysing the Mean, Norm score and Percentile rank scores obtained for 1' back and 2' back verbal working memory tests show that the children with learning disability specific to mathematical disorder have deficit inverbal working memory. Whereas in the area of visuospatial working memory, the Mean, Norm score and Percentile rank scores obtained for 1' back and 2' back tests show that the children with learning disabilities specific to mathematical disorder have better Visuospatial working memory. In the findings, a marked difference was noted among the verbal and visuospatial working memory that the children with learning disabilities specific to mathematic disorder have better visuospatial working memory compared to the verbal working memory.

Table 4

Comparison of verbal working memory deficit among children with learning disability with respect to the specific learning disability conditions

Group	Variable	Test administered	N	Mean	SD	F-value
Group 1	Verbal working memory	'1' back test	15	2	1.89	1.04*
Group 2				.87	1.13	
Group 3				1.07	1.05	
Group 1		'2' back test	15	11.67	2.32	0.81*
Group 2				10.67	1.45	
Group 3				11.2	2.54	

*Not significant at 0.05 level

When analysing the Mean, SD and F value scores (1.04 & 081) obtained from 1' back and 2' back verbal working memory tests show that there is no significant difference among different group of children with learning disabilities with reference to verbal working memory.

Table 5

Comparison of visuospatial working memory deficit among children with learning disability with respect to the specific learning disability conditions

Group	Variable	Test administered	N	Mean	SD	F-value
Group 1	visuospatial working memory	'1' back test	15	3.13	1.77	0.93*
Group 2				3.07	0.85	
Group 3				2.33	2.13	
Group 1		'2' back test	15	2.27	1.83	0.49*
Group 2				2.13	1.41	
Group 3				2.67	1.35	

*Not significant at 0.05 level

When analysing the Mean, SD and F value scores (0.93 & 0.49) of three groups in 1' back and 2' back visuospatial working memory tests show that there is no significant difference among different group of children with learning disabilities with reference to visuospatial working memory.

Findings

1. Children with learning disabilities in general have better visuospatial working memory compared to the verbal working memory
2. Children with learning disabilities specific to reading and writing disorder have better visuospatial working memory compared to the verbal working memory.
3. The children with learning disabilities specific to mathematic disorder have better visuospatial working memory compared to the verbal working memory.
4. there is no significant difference among different group of children with learning disabilities with reference to verbal working memory.
5. there is no significant difference among different group of children with learning disabilities with reference to visuospatial working memory.

Conclusion

Limitations in Working Memory capacity cause Learning Disability. (Swanson & Siegel,2001). When people are first exposed to tasks that are unfamiliar, their performance is tightly constrained by the limited capacity of their working memory. The verbal working memory deficit in the learning disabled children have been affecting in all the day to day functioning. This result matches with the study of Passolunghi, M. Chiara (2004) who examined the relationship among working memory, mathematic ability, and the cognitive impairment of children with difficulties in mathematics. The results suggest a general working memory deficit in children with MD, specifically in the central executive component of Baddeley's model and primarily in the ability to inhibit the irrelevant information.

A similar type of research findings was found in the literature which indicates students with LD have smaller working memories for verbal information than their normally achieving peers (Martinussen & Major, 2011; Swanson & Trahan, 1992). This deficit affects their ability to encode, organize, and process information. It also puts students with LD at a distinct disadvantage in terms of study skills, because study skills can place extreme demands on working memory.

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