

Auditory N Back Test Performance in Children With and Without Specific Learning Disability

Darshan Devananda*, Harshan Kumar

Department of Speech Language Pathology, JSS Institute of Speech and Hearing, Karnataka, India

Research Article

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***For Correspondence:**

Darshan Devananda, Department of Speech Language Pathology, JSS Institute of Speech and Hearing, Karnataka, India

E-mail: darshandevdb@gmail.com

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ABSTRACT

Background: Auditory working memory is an important brain executive function helps in storing information for limited time and uses whenever necessary. Children with learning disability often show deficits in working memory which is important in learning processes. Thus, the current work was carried out to investigate the auditory working memory in children with learning disability using N Back test in comparison with typically developing children.

Methods: Group 1 consist 30 children with Specific learning disability and group 2 consists 30 children with typically developing children. Auditory N1 back and N3 back test was administered on all the participants to measure the auditory working memory and subjected to suitable statistical analysis.

Results: The obtained results indicated a significant difference in the auditory working memory task in both N1 back and N3 back tests for typically developing children and children with specific learning disability.

Conclusion: The current study suggests that the auditory N-back test can be included in the assessment protocol of Specific learning disability. The study also highlights the need to consider auditory working memory in intervention for children with SLD as it can improve their academic performance and advocates in cognitive therapy trials for children with specific learning disability.

INTRODUCTION

Specific Learning Disability (SLD) is a neurodevelopment disorder characterized by inability to listen, think, speak, read, write and calculate ^[1]. Children with Learning Disabilities (LD) are heterogenic in nature as they exhibit potential difficulties in many different areas ^[2]. According to, some children with LD learn to adjust and exhibit no difficulty but some struggle throughout their lives to perform simple things and thus LD can be considered as a life-long condition though it starts in childhood. SLD can be seen with the severe discrepancy between achievement and intellectual ability in one or more areas, oral expression, written expression, listening comprehension, reading comprehension, basic reading skills, mathematics, calculation, reasoning or spelling ^[3].

Several research evidences have reported wide variety of characteristics associated with LD ^[4]. Children with learning disabilities often have difficulty in academic performance during their elementary school years and also showed discrepancy in academic achievements, puzzling to teachers, slow learning rate though they have strengths similar to their peers in several areas ^[5]. An estimation reported that about 90% of children with learning disability have reading difficulties with the low estimates of approximately 60% and thus considered to be the most common academic difficulty observed among children with LD and continues from the primary grades through the end of formal schooling, including college ^[6].

Researchers have reported that many of the children with LD have difficulties with reading fluency ^[7] which can be defined as the rate of accurate reading or correct words uttered per minute, as it is an important indicator of reading ability ^[8]. Children with fluency problems may read aloud word-by-word without appropriate inflection, but they find difficulty to relate the patterns of spoken language to the printed words. Recent research has revealed a great deal about the elementary nature of children's reading disabilities and the type of instruction that has to be followed to remediate reading problems ^[9,10].

Diagnostic and Statistical Manual of Mental Disorders (DSM 5, 2015) has described SLD as a deficit that impact on the academic achievement and affects learning process as a consequence of altered auditory Working Memory (WM). Hence they find it difficult in reasoning, thinking, following multistep commands etc. WM is a cognitive mechanism which forms an underlying process to store the information during complex and demanding activities. It is assumed that WM to be a temporary storage system under attention control that underpins our capacity for complex thought. Auditory WM is one such brain executive function which refers to the capacity to maintain information for limited time, as it aids in holding new information and use them whenever required ^[11].

Working memory can be measured in both visual and auditory modes. There are various tests available to measure the capacity of working memory in which visual WM will be measured by recalling visual information. Similarly, Auditory WM is measured by recalling auditory information. The N-Back test is one such frequently used experiment to measure auditory WM ^[12].

N-Back test is a continuous task used as an assessment in cognitive neurosciences and Clinical psychology to measure the capacity of working memory. N Back test is valuable as it does not solicit a verbal response and can be applied in individuals with oral language alterations. This task requires codification, temporary storage and response, as it is necessary for the children to update and maintain information continuously in the WM to readily access it. The N Back task uses 1, 2 or 3 back-digits either in visual (N-Back visual) or auditory (N-Back auditory) presentations. 1 back means that the subject has to remember the position of the item, one turn back. 3 back means the subject has to remember the position of the item two turns back and so on ^[13]. The participant need to identify the current item displayed is as same as that presented back with varied position in each series.

Auditory WM plays a significant role in the performance of many cognitive tasks and also in determining individual characteristics like general Intellectual Quotient (IQ) and academic achievements ^[14]. Studies have also showed that auditory WM capacity contributes to proficiency in language comprehension, solving mathematical problem and following verbal directions ^[15-18]. Children with SLD often have difficulty in performing at proficient levels as a consequence auditory memory skills in academic environment. As there are limited studies and test tools available to measure the auditory working memory performance in children with SLD in Indian scenario. The need of measuring the auditory working memory was much essential clinically. Thus, the present study aims at determining the capacity and performance of auditory working memory in children with SLD using auditory N Back test.

MATERIALS AND METHODS

Participants

A total of 60 children between 9-12 years with mean age of 10 years were selected by considering the exposure towards formal academic learning and availability of children. Participants were divided into two groups and each group consist 30 participants. Group 1 consisted of children with SLD and Group 2 consisted of Typically Developing (TD) children with no medical ailments, psychological problems, speech, language, hearing and cognition problems. Children who fail to perform the task and difficult in understanding instructions for the task and exhibit any associated conditions like systemic illness, medical ailments, hearing loss and other psychological problems were excluded from the study. The consent was obtained from all the participants prior to the study.

Stimulus

N-Back task is a process of temporary storage and response that is frequently used to measure WM. The 1 back and 3 back stimuli of N Back auditory was considered in the present work. A list of 50 words drawn from different categories (Vehicles, fruits, animals, objects, and colors) with bi syllable and tri syllabic structures were selected and randomly distributed. Later a familiarity test was conducted among those categories out of which 30 stimulus were selected as target stimulus based on frequency and familiarity of the words and recorded digitally in stereo at 44.1 kHz.

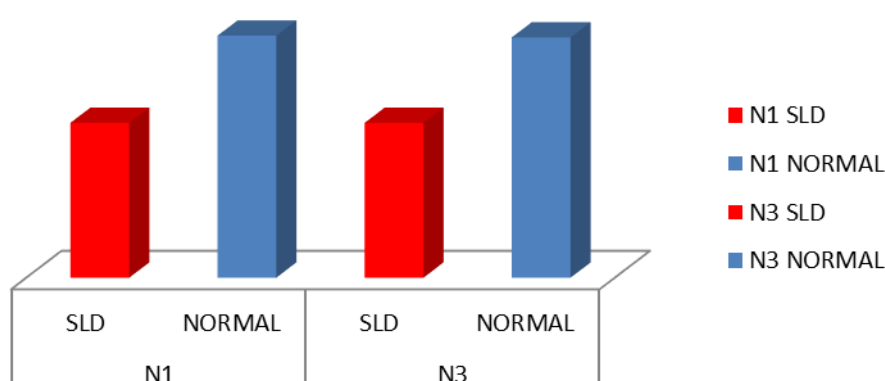
Recording

The recording was carried out in sound treated room designated for audio logical evaluation. The child was made to seat comfortable on the chair facing a laptop (Dell Inspiron, 15, 3000) on the table and clear instructions were given with trial run of the N back auditory task to make them understand. The sequences of 500 milliseconds auditory stimuli recorded, with one second inter stimulus intervals, and were presented binaurally using calibrated Sennheiser headphones. The actual test administration was carried out based on the child's understanding following trial run to remember 1 back and 3 back task. Children were asked to indicate by gestures to point at which the stimulus is repeated in both one turn back task (task 1) or three turn back task (task 2). Based on the observation of the participant response the examiner score 1 for every correct response and score 0 for incorrect responses. The total scores obtained by each participant were noted. The obtained data were tabulated and subjected to suitable statistical analysis.

RESULTS AND DISCUSSION

The scores obtained on task 1 and task 2 in group one and group two were subjected to statistical analysis using SPSS software (Version 17). The mean scores obtained for Group 1 for both task 1 was 8.7 (SD=2.94) and task 2 was 8.7 (SD=3.71). The Group 2 for both the tasks showed better mean scores of 13.6 (SD=1.17) and 13.5 (SD=1.08) respectively. The mean scores obtained between the groups in both the tasks showed that typically developing children performed better in comparison to children with SLD as depicted in the Figure 1 below.

Figure 1. Representation of Task 1 and Task 2 performance of both Group 1 and Group 2. (Note: (■) N1 SLD and N3 SLD; (■) N1 Normal and N3 Normal).



The mean scores obtained for task 1 and task 2 were compared between the groups and tasks using independent sample t test and results revealed significant differences between the groups ($p < 0.001$) in both the tasks and indicates that TD children performed significantly better compared to children with SLD. Similarly the comparison between the tasks showed significant difference of auditory 3 back test in both group 1 and group 2 ($p < 0.01$) in comparison to auditory 1 back test ($p < 0.00$) as shown in Table 1.

Table 1. Results of Independent sample t test of task 1 and task 2 for both the groups.

Group	Task	Significance	Df	Standard Error
(Group 1) SLD	T1 (1 Back)	0.000	9	0.93155
	T2 (3 Back)	0.001	9	0.37118
(Group 2) TD	T1 (1 Back)	0.000	9	1.17426
	T2 (3 Back)	0.001	9	0.34157

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The obtained results of the current observation suggested that TD children performed better in both the tasks in comparison to children with SLD. Both the groups showed significant difference between the task performances and performed better in task 1 in comparison to task 2. The findings also revealed that there was no intra group stimulus effect observed in both children with SLD and TD children as they performed equally in both bi syllables and tri syllabic stimulus structures.

The finding of the current study is in consonance with the earlier research evidences. Children with SLD often exhibit problems in working memory due to various factors that influence their learning processes ^[12,14]. Auditory processing deficits, lack of exposure, neurological influences and other psychosocial factors might influence the child's performance in working memory.

As the child develops or proceed further in learning process and appropriate interventional strategies in learning new things and practice would advocate the child to perform better in learning process and thus the ability of memorizing would strengthen and make them perform better in cognitive tasks ^[14].

Auditory WM involves the temporary storage and manipulation of information that is assumed to be necessary for a wide range of complex cognitive tasks such as storing information for demanding activities, which is required for a Child's daily routine in class room setting as they have to follow instructions, lessons taught in class and complete class room activities ^[12].

When they are unable to meet these demands they exhibit distractible behavior and poor academic performances. Thus, measuring the auditory working memory in children with SLD is much essential in diagnosis and planning rehabilitation as it is very crucial in developmental period of any school going children and may affects the ability of a person to comprehend sentences, monitor executive function and influence the executive function. The study thus highlights the need of measuring auditory working memory in children with SLD using N back test as it is a reliable tool for assessing auditory WM.

CONCLUSION

The findings of the present study indicated that there was a significant difference in the auditory WM task in N1 back and N3 back tests for typically developing children and children with specific learning disability. Auditory N-back test thus, can be included in the diagnostic assessment protocol and also for documenting the cognitive therapy trials in children with SLD. It also highlights the need to consider auditory WM as a domain for rehabilitation of children with SLD as it can improve their academic performance.

LIMITATIONS

The sample size of the study was only 30 children and the stimuli used were only bi-syllables and tri syllables structure. The study would be even stronger with larger sample size and multi syllable structure. The study lags in studying the effect of age and gender. The effect of higher age group or higher grades with age and gender matched study can be taken in further studies.

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