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A comparative study of reaction time in children with learning disability and typically developing children

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Abstract

This study aimed at addressing and comparing the linguistic tasks in children with Learning disability (LD) and Typically Developing Children (TDC). For this study, 10 children with LD and 10 TDC between eleven to fifteen years of age were administered two linguistic tasks through the DMDX software in order to measure reaction time. The children considered for the study were native speakers of Kannada, the medium of instruction in their schools being English. There were two linguistic tasks namely Non-words and Cluster words. The analysis of the reaction time values has been carried out across groups and across tasks. The comparative results and findings have been depicted in the study. Also, the accuracy with which both the groups responded has been analyzed and presented.

Keywords non-words, clusters, learning disability, linguistic task, Kannada

1. Introduction

There are a variety of disorders that affect the way verbal and non-verbal information is acquired, understood, processed, organized, remembered and expressed. Learning disability is one such disorder caused by a problem in the nervous system that affects how information is received, processed or communicated. The term 'Learning Disability' describes a neurological disorder in which a person's brain is structurally or functionally different. These differences interfere with a person's ability to respond quickly. Their abilities in terms of the processing speed can be studied by adopting reaction time tasks. A simple reaction time task consists of a warning signal and a response stimulus. The period between the warning signal and the onset of the response stimulus is the Preparatory Interval (PI).

The PI starts with the onset of the warning signal and alerts the subject to prepare for the presentation of the response stimulus. During this period, until the onset of the response stimulus, the child is required to maintain

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attention. With the onset of the response stimulus, the child is required to press a key or lever or switch as quickly as possible. In short, reaction time is the time between the presentation of the stimulus and motor response. This simple reaction time task is also referred to as a "Speed of Motor Performance Measure".

Over the course of normal development, reaction times become faster, peaking in adolescence and young childhood and slows again as adults age (Kail, 1991; Cerella & Hale, 1994). Reaction time or brain time is very closely related to integration between the two hemispheres of the brain. Successful integration between the two hemispheres of the brain requires an efficient brain to process information more efficiently; the processing speed must be faster. Thus, reaction time is considered by some researchers as a reflection of global processing speed (Cerella & Hale, 1994). Suppressions, rigidity, and uncoordinated movements are the result of bad timing and faulty integration, and are indicative of poor brain processing ability that can manifest itself in learning problems and learning disabilities, poor academic performance, and many other struggles in life.

In a study conducted by Sroufe (1971), it was found that children with learning disabilities showed a general decrease in physiologic reactivity, which improved with age. Deficits observed were attributed to neurologic immaturity and reflected psychological problems in maintaining attention. These results were consistent with those of studies using simple reaction time tasks (Sroufe et al., 1973).

Another study by Hayes et al. (1986) examined reaction time in children with learning disability. The students demonstrated slower and more variable reaction times on certain tasks than did students without learning disability. The researchers argued that this "failure to automatize basic sub-skills" could relate to dysfunction in the central nervous system. It is interesting to note, however, that there was no difference between the two groups on simple visual reaction time.

Additionally, studies by Larson and Alderton (1990) and Jensen (1992) concludes that lapses of attention and/or working memory led to longer reaction times and that, individuals with higher intelligence have generally better capacities of attention control, preventing such lapses. Besides, there have been a swarm of studies that repeatedly show characteristics of reaction time distributions beyond any measures of central tendency that have been hypothesized and indicate attention towards important aspects of human cognition (Heathcote et al., 1991; Spieler et al., 2000)

There have been numerous studies on reaction time measures and intelligence, but despite the growing body of literature on learning disability, there have been very limited research reports with reference to reaction time in children with learning disability, especially in the Indian context. Hence, a need was felt to provide further corroborative evidence to the existing research findings. Therefore, this study was taken up.

The present study aimed at determining whether there is any difference in the performances of the Kannada speaking children with LD and the TDC on reaction time measures and also to find whether differences existed in the accuracy.

2. Methodology

2.1. Participants

Two groups of 10 children each participated in the study. Each group consisted of 4 boys and 6 girls who were monolingual native speakers of Kannada ranging in age from 8 to 12 years. The experimental group consisted of children who were diagnosed as having learning disability by a multidisciplinary team of qualified specialists including speech-language pathologist and clinical psychologist. The children were profiled using a standardized diagnostic tool, Early Reading Skills (Rae & Potter, 1981) adapted on Indian children by Loomba (1995). They were required to perform two grades or more below their expected grade.

The control group consisted of children who exhibited no learning problems and were functioning well at academics. Those children with no history of language, hearing, neurological, developmental, sensory, intellectual or emotional and oro-facial abnormalities were included in the study. They were screened for voice, articulation, fluency and language. Oral mechanism examination and hearing screening was carried out to rule out any abnormality. Six of the children with learning disability had previously received speech therapy and four of them were currently attending therapy. All the children were studying in English medium schools; were right-handed, from families of middle and upper socioeconomic status. The socio-economic status was screened using the NIMH socio-economic status scale developed by Venkatesan (2009). The scale has sections of occupation, education, annual family income, property, and percapita income. Interpretation on this scale showed middle and upper socio-economic status for the families of all participants for both the LD and TDC groups.Both groups of children were matched further on their Intelligence Quotient (IQ). All the participants' mother tongue was Kannada language who attended English medium schools within the city of Mysore in the state of Karnataka, India.

Ethical procedures were used to select the participants. The parents were explained the purpose and the procedures of the study and an informed verbal and/or written consent were taken. The tasks were carried out in the presence of the investigators. The participants were told that they will be given some tasks to perform and that they were required to respond to the tasks in accordance with the instructions provided for each task. The participants were also informed by the caregiver/investigators beforehand that they were being involved in a research experiment and as to what these tasks were eliciting from them. The participants were familiar with the investigators who were carrying out the tasks on them. Also, these participants were not previously acquainted with tasks similar to the ones carried out in the current study.

2.2. Description of tasks

2.2.1. Non-Word (NW) Task

Non-words and words were displayed randomly and the participant had to judge whether the stimuli presented is a word or a non-word; for example, 'Drag' is a word and 'Blauff' is not.

2.2.2. Cluster Word (CW) Task

The participant was asked to identify if the word displayed on the screen is a cluster or not; For example, 'Knife' is a cluster; whereas, 'Cat' is not.

The stimuli for the non-word task was extracted from the non-word graded reading test (Snowling et al., 1996); and the stimuli for cluster task was extracted from ERS Early Reading Skills (Rae & Potter, 1981). The description of the tasks is as follows:

Table 1

Description of reaction time (RT) tasks

Tasks	**Description**	**Example Stimuli**	**Reaction time measurement (milliseconds)**
a) CW Task	Press 'Yes' key if the stimulus presented is a cluster word. 'No' key if not	"Rattle" and "Rumble" words on the same screen one beside the other	Time from completion of one stimulus to key press.
b) NW Task	Press 'Yes' key if the stimulus presented is a word, 'No' key if not	"Sit" and "Bit" words presented simultaneously one below the other	Time from completion of one stimulus to key press.

2.3. Data collection and processing

All tasks were presented on a laptop computer using the DMDX software, and children responded by striking a key on the keyboard. For each task two trials were given, following which the actual ten stimuli were presented which were randomly ordered. For all the tasks, the child was expected to give a key press response, and the child pressed one key (marked "yes" in green color) for a yes or positive response and a different key (marked "no" in red color) for a negative response. The children were instructed well before the task had begun and later the trials were provided to make sure that they understood the task well. The environment was conducive for the children to maintain their focus and attention since the test was conducted in a silent environment with participants seated comfortably on a chair while the monitor distance from participant's eyes was maintained at about 50 centimeters.

The tasks were divided into two sessions; which required a total of twenty to thirty minutes to complete. Both sessions contained two subtasks, each of linguistic and non-linguistic type. All the children performed the tasks in the same order. Children were instructed always to respond as quickly as possible without affecting the accuracy. A set of practice trials as many times as necessary was administered to ensure that the child understood the task. For all tasks, the children were instructed to rest both their hands just above the keys to be used, which was marked by words "yes" and "no" in specific colors and respond appropriately.

2.4. Data analysis

The mean reaction time and the accuracy of the tasks given were analyzed for both the groups for each of the tasks. This was later compared within tasks and across tasks for both groups.

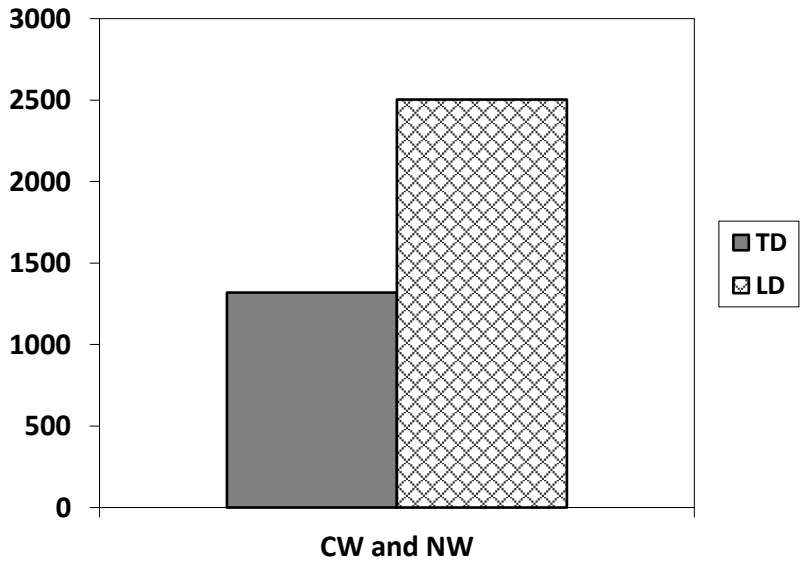
3. Findings

The data were analyzed and statistically treated using the SPSS software (version 10) to determine if there was any significant difference in the reaction time of typically developing children and children with learning disability. The overall linguistic reaction time was calculated using mixed ANOVA with group as an independent factor. Linguistic tasks were the dependent variables within the subject factors. The descriptive statistics revealed the mean and standard deviation of the control and experimental group for linguistic tasks as shown in Table 2. It is seen in the Table 2 that the mean reaction times of children with learning disability was 5147 milliseconds while the reaction time in the typically developing children was 2661 milliseconds. This is depicted in the Figure 1.

Table 2
Mean and standard deviation of reaction times in typically developing children and children with learning disability for the tasks

Tasks	**Group**	**Mean**	**Standard Deviation**
CW Tasks	TD	1318.97	459.69
NW Tasks	LD	2503.09	727.68

TD- Typically developing children, LD-Children with learning disability



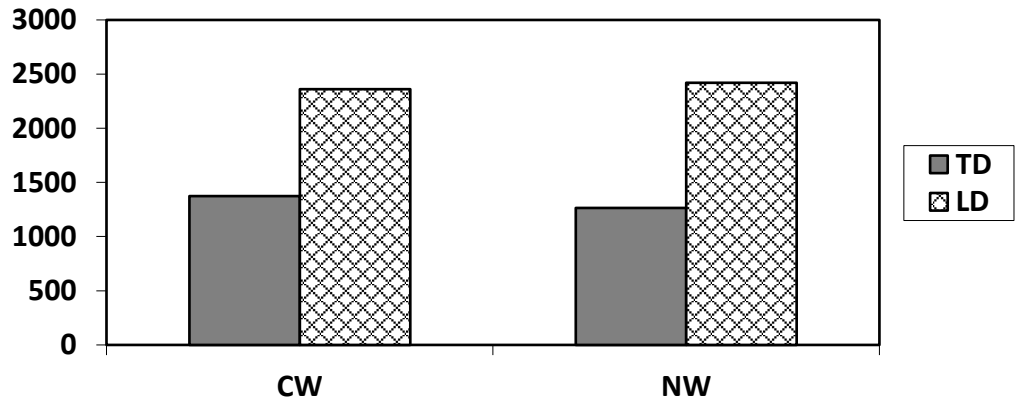
TD- Typically developing children, LD-Children with learning disability
Figure1: *Average reaction time across groups and both tasks.*

The means and standard deviation for each of the tasks for both the groups are depicted in table 3. It is evident from the table that the mean reaction times for all the individual tasks in children with learning disability are greater than the typically developing children. The same has been shown in the Figure 2.

Table 3
The mean and standard deviation of typically developing children and children with learning disability for both the tasks

Tasks	**TD**		**LD**	
	Mean	**SD**	**Mean**	**SD**
CW Tasks	1372.73	570.79	2360.00	894.67
NW Tasks	1265.20	570.26	2420.61	808.44

TD- Typically developing children, LD-Children with learning disability



TD- Typically developing children, LD- Children with learning disability, CW- Cluster Word Task, NW- Non-Word Task

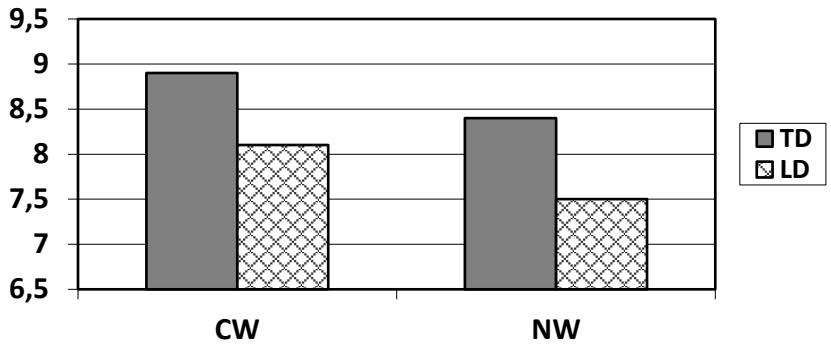
Figure 2: *Average reaction times across groups and tasks*

An attempt was also made to determine the accuracy of responses in both the groups for linguistic and non-linguistic tasks using mixed ANOVA. It is seen from the table 4 that there was no much difference between the accuracy of responses of both groups of children.

Table 4
Accuracy of responses across groups

Tasks	**TD**		**LD**	
	Mean	**SD**	**Mean**	**SD**
CW Tasks	8.9	1.1	8.1	0.7
NW Tasks	8.4	1.3	7.5	1.5

TD- Typically developing children, LD- Children with learning disability



TD- Typically developing children, LD- Children with learning disability, CW- Cluster Word Task, NW- Non-Word Task
Figure 3: *Average correct responses (accuracy) across groups and tasks*

These findings are in good agreement with the findings of Dykman et al. (1970), Spring (1971), Czudner and Rourke (1972), Sroufe (1971, 1973) and Hayes et al. (1986) which suggested that children with learning disabilities processed information at a slower rate than children without learning disabilities.

In a paper presented by Spring et al. (1972), 22 poor readers were matched on sex, age and IQ with normal readers on a simple reaction time task. It was found that the reaction time was found to be longer for poor readers on the task. This result was interpreted by the authors as a support for a theory that some children with a certain learning disability respond to laboratory tasks with sub-optimal levels of arousal compared to their age matched typically developing peers.

Partially supporting this theory, there is another study by Boydstun et al. (1968) and Satterfield et al. (1971) in which electro dermal measures of arousal were longer for children with learning disability than for normal controls.

These results have implications with respect to intervention programs of children with learning disability. It is recommended that reaction time assessment should be a part of the diagnostic protocol. Emphasis should also be placed on such reaction time tasks being incorporated in the therapy schedule so as to facilitate increase in their overall processing speed. The results also strongly suggest the need for proper recommendations for appropriate accommodations, consistent with identified areas of weakness particularly in their classrooms. For example, extra time should be provided especially with respect to linguistic tasks. The information regarding the reaction time should be incorporated in the counseling process too; where the caregivers could be counseled about the importance of reaction time and to provide more weightage to the accuracy of the child's responses rather than the speed; especially in the initial stages of training, thereby reducing the pressure and stress on the child. The difficulty with the linguistic tasks in both the groups of children can be attributed to their overall proficiency in the language. Hence, the linguistic tasks must be given greater importance during the intervention program.

It can be concluded from the present study that the children with learning disability have longer reaction times in comparison with the typically developing children, but the accuracy with which they respond is identical.

The investigators of the present study do realize that the age range considered for the study was wide (8-12 years). This could have influenced the results obtained with respect to the reaction time and accuracy. Further work can be undertaken using tasks that are carefully chosen for the processes and knowledge that the subjects require, and difficulty is graded across task domains. In addition, the reaction time on other domains such as motor tasks also can be assessed. This may provide a better picture of overall performance of such children across various tasks. Longitudinal studies may reveal information about the changing patterns of reaction times across the groups. Also, carrying out the study in a larger group of participants will aid in understanding the underlying mechanisms in children with learning disabilities with greater clarity. Similar studies can also be carried out on children with learning disability before, during and after the intervention program which may reveal the effect of therapeutic treatments.

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