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Cognitive Flexibility in Children with Learning Disability

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Abstract

A child with learning disability may have underlying abnormality in cognitive processing that often precedes or is associated with learning disorders. If language and the learning difficulties are the result of slow processing speed, then the differences in cognitive flexibility measures are expected in children with learning disability in comparison with age matched peers. Hence the present study was attempted. Participants consisted of 12 children with learning disability and 12 age matched typically developing children in the age range of 9-10 years.

The experimental set comprised of a set of 20 pictures in 4 lexical categories (fruits, stationary items, animals and body parts). The stimuli was then inserted and presented to the participants using DMDX software in such a way that four pictures of the same lexical category appeared one after another on the computer screen following one from a different lexical category.

Participants were instructed to name the pictures immediately upon the presentation of the stimuli. Participant’s response latencies were measured from the application of a stimulus to the detection of a response through naming. Differences between the reaction time for the fourth item and the fifth item was calculated to obtain a cognitive flexibility index.

Results of the independent t-test revealed statistically significant differences between the two groups for the cognitive flexibility index at $p<0.01$. The obtained results were attributed to the deficits in the attentional process and the knowledge representation yielding a prolonged cognitive block in children with learning disability.

Key Words: Learning disability, Processing speed, cognitive flexibility index

Introduction

National Joint Committee for Learning Disabilities (NJCLD)(1981; 1985) defined 'Learning disabilities' as a generic 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 and presumed to be due to central nervous system dysfunction.

Even though a learning disability may occur concomitantly with other handicapping conditions (e.g., sensory impairment, mental retardation, social and emotional disturbance) or environmental influences (e.g., cultural differences, insufficient/inappropriate instruction, psychogenic factors), it is not the direct result of those conditions or influences.

Learning Disorders are diagnosed when the individual's achievement on standardized tests in reading, mathematics or written expression is substantially below that expected for age, schooling and level of intelligence.

The learning problems significantly interfere with academic achievement or activities of daily living that require reading, mathematical or writing skills. There may be underlying abnormality in cognitive processing (e.g., deficits in visual perception, linguistic processes, attention or memory, or a combination of these) that often precede or are associated with learning disorders.

Processing speed is one of the measures of cognitive efficiency or cognitive proficiency. It involves the ability to automatically and fluently perform relatively easy or over learned cognitive tasks, especially when high mental efficiency is required i.e., for simple tasks requiring attention and focussed concentration, and it relates to the ability to process information automatically and therefore speedily, without intentional thinking through.

Catts, Gillispie, Leonard, Kail, Miller (2002) investigated the role of speed of processing, rapid naming and phonological awareness in reading achievement. Measures of response time in motor, visual, lexical, grammatical and phonological tasks were administered to 279 children in third grade. Measures of rapid object naming, phonological awareness, and reading achievement were given in second and fourth grades.

Reading group comparisons indicated that poor readers were proportionally slower than good readers across response time measures and on the rapid object naming task. These results suggest that some poor readers have a general deficit in speed of processing and that their problems in rapid object naming are in part a reflection of this deficit.

Savage, Frederickson, Goodwin, Patni, Smith, Tuersley (2005) found that poor readers performed significantly more poorly than chronological age-matched peers on digit naming speed, spoonerisms and nonsense word reading. King, Lombardino, Ahmed, (2005) reported that children with developmental dyslexia performed significantly slower and less accurately than controls on computerized tests of sight word reading, nonword decoding, and spelling recognition. Miller and Poll (2009) reported that college students with a history of language and/or reading difficulties had slower reaction time in comparison to normal controls. Within the affected group of students, better language skills were associated with faster reaction time.

Cognitive linguistic flexibility is a measure which refers to the ability to shift cognitive linguistic set, aptitude, thought, or attention in order to perceive, process or respond to situations in different ways (Eslinger & Graten, 1993).

It has been dichotomized into reactive flexibility and spontaneous flexibility that may be differentially impaired in persons with communication disorders.

Reactive flexibility is the ability to free shift cognition or behavior in response to changing tasks or situational demands.

This shifting occurs when either external task conditions or self initiated decision require an alternative to the current response be chosen and executed. Different tasks and situations require different type of reactive shifts and presumably different underlying cognitive processes.

Spontaneous flexibility represents the ability to produce diverse ideas, consider response alternatives and modify plans. Semantic spontaneous flexibility is often described as divergent thinking which emphasizes variety, quantity and relevance of information. Naming something quickly and accurately is an essential part of efficient spoken language. It happens so often that most speakers are unaware of its complexity unless the process goes wrong. Also the ability of an individual to free shift the cognition in response to the changing demands varies from individual to individual.

Need of the study

Children with learning disability are slower to process information than normally developing children. The slowing affects processing in all cognitive domains, not just language. So the differences in cognitive flexibility measures can be expected in children with learning disability. There is hardly any focus on this aspect in the literature and so the present study was an attempt in this direction.

Aim of the study

To compare the cognitive flexibility in children with learning disability and age matched typically developing children.

Method

Participants

Participants were divided into two groups. Clinical group consisted of 20 children with learning disability in the age range age range 9-10 years. These children were formally evaluated and diagnosed to have learning disabilities based on Diagnostic and statistical manual (DSM-IV) by an experienced psychologist. All of these children were receiving therapeutic intervention from psychologist and speech language pathologist at the time of the testing. Control group consisted of 20 children in the age range of 9-10 years with no history of speech, language and neurological disorder. All the participants in both the groups had normal or corrected-to-normal vision.

Materials

The experimental set comprised of 20 pictures of 4 lexical categories (fruits, stationary items, animals and body parts). Later, these words were transferred and stored in DMDX software. The stimuli was then inserted into a single sequence and presented to the participants such that four pictures of the same lexical category appeared one after another following which one from a different lexical category appeared on the computer screen. Hence the stimuli consisted of four blocks, each having five pictures organized in the above mentioned manner.

Instrumentation

DMDX software is an extension of the original DOS program based on Windows 95/98 environment, which can be programmed according to the test stimuli. It gathers environmental experimental stimulus. Its strength lies in its precise control. It is appropriate for perceptual experiments (auditory, visual) where very accurate timing is required. Computer based coding system is used for observational data recording. It provides researcher a reliable and accurate way of coding observational data.

Programming the stimuli

The software was programmed so that the 20 pictures used as stimuli were automatically displayed on the screen one by one for 2000 msec. There was 3000 msec interstimulus interval between two stimuli. Each trial consisted the appearance of a fixation point (‘+++’) for 500 ms, followed by the presentation of the target word, displayed for 2000 ms. With the help of DMDX, these stimuli were randomized for each participant. DMDX software measures the reaction time (the time interval between application of a stimulus and detection of a response) for naming the stimulus.

Procedure

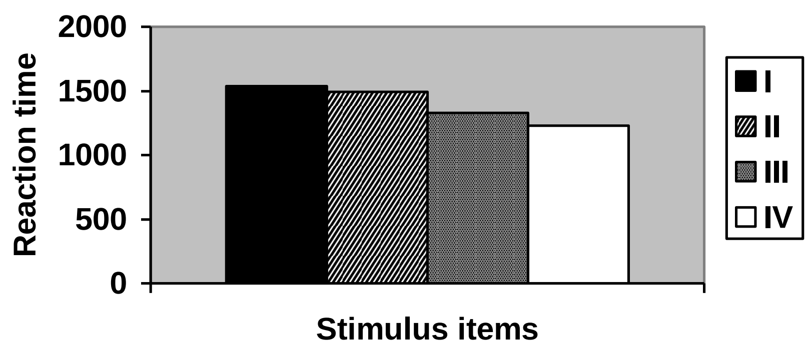
Participants were tested individually, in a silent room. The list of items was presented on a HP laptop computer with a LCD monitor. Participants were instructed to name the picture immediately upon the presentation of the stimuli. At the beginning of the experiment, a trained experimenter carefully read and explained the instructions to the participants. The responses were recorded with the help of a microphone connected to the computer.

Participant's response latencies were measured from the application of a stimulus to the detection of a response through naming. Care was taken that only vocal responses from the were recorded. This was done through software called CheckVocal where the stimulus spectrograph of the recorded response was shown. The experimenter could thus differentiate the initiation of response from other background noises. It also had an option to see the graphical version of presented stimulus which helped to recognize if the subject's responses were correct or wrong.

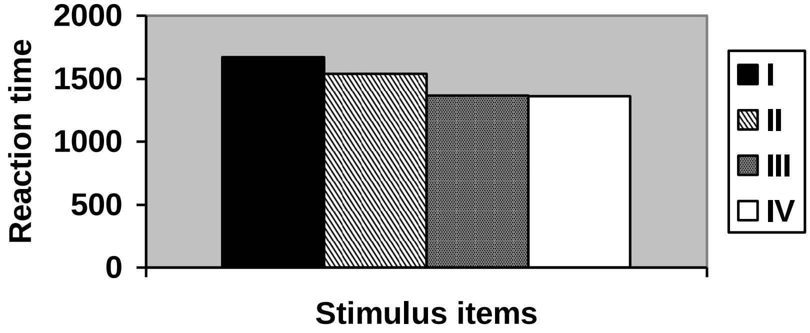
Results

The present study investigated the cognitive flexibility in children with learning disability. Differences between the prime and the target items are shown in graphs (1 and 2) for both the group of children.

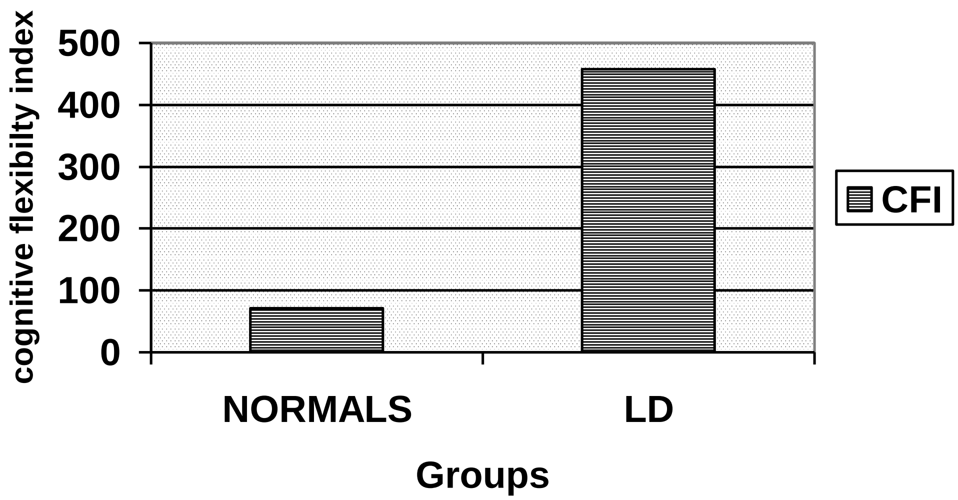
Graph 1: Semantic priming in Typically Developing children



Graph 2: Semantic priming in children with Learning Disability



Graph 3: Cognitive flexibility index in children with Learning disability



From the above graphs, it is clear that priming effect is observed in both the group of children i.e., there is a reduction in the reaction time for the target items in comparison to the prime item. Differences between the most primed item (fourth item) and the inserted item (fifth item) was calculated to obtain a cognitive flexibility index. Results of the independent t-test revealed statistically significant differences between the two groups for the cognitive flexibility index at $p<0.01$

Discussion

The results of this study indicate that children with learning disability require more time to shift their cognitive set in response to changing stimuli when compared to typically developing normal children and are slower to process information. The slowing affects processing in all cognitive domains, not just language.

If language and the learning difficulties are the result of slow processing speed, then the differences in cognitive flexibility measures can be expected in children with learning disability. But there is poor research focus on this till date to establish difference in the cognitive flexibility measures between children with learning disability and typically developing children.

Hence the present study was attempted and the results revealed significant differences between the two groups for the cognitive flexibility index indicating that children with learning disability require more time to shift their cognitive set in response to changing stimuli when compared to typically developing normal children.

Reactive flexibility is the ability to free shift cognition or behavior in response to changing tasks or situational demands. This shifting occurs when either external task conditions or self initiated decisions require an alternative to the current response, be chosen and executed. Children with learning disability may take more time to process the incoming information in response to changing needs as noted in this study.

This is in consonance with the previous studies indicating slowed processing speed in children with learning disability (Savage, Frederickson, Goodwin, Patni, Smith, Tuersley 2005; King, Lombardino, Ahmed, 2005).

However, the detection of changing lexical category requires an element of pre-conscious attention related to the coding of attributes of lexical category which may be impaired in children with learning disability; and to adequately detect change, one may have to, quickly adapt to a local processing mode, to process the nature of the change (Becker, Pashler, & Anstis, 2000).

The main characteristic of cognitive flexibility is the occurrence of a change or shift in the attentional control level or in the representation of a task, which leads to a change in the strategy performed. The central executive is the cognitive structure which has been thought to be involved in such processes of change.

Therefore, similar neurological substratum related to executive functioning (prefrontal cortex and its circuitry) has been proposed as the neuropsychological base of cognitive flexibility. Evidences from fMRI points to dorsal pathway (as well as dorso-lateral pre-frontal cortex) activation in change detection (Schmitz et al., 2003). This raises the question of whether the deficit is in the pathways sub-serving the alerting function. However this is not investigated in the present study.

When children with learning disability perform a task, her/his behavior needs to be adapted to the environmental conditions in which the task is being performed. However, these conditions continue to change as the task develops, therefore in order to be flexible these children have to focus attention on these conditions.

In addition to this, in order to adapt her/his behavior to the new conditions, children with learning disability needs to restructure her/his knowledge so as to effectively interpret the new situation and the new task requirements.

Cognitive flexibility, therefore, depends on attentional processes and knowledge representation which is probably impaired in children with learning disability. This is related to cognitive inflexibility i.e., when the person seems to be focused in certain lexical category and ignoring others as a result of priming, as a consequence she/he continues with the course of action that she/he was carrying out.

In the case of cognitive inflexibility, the person continues with the same strategy that she/he has been using even though the conditions change. This prompts us to consider that cognitive inflexibility is a form of cognitive block for a prolonged duration in children with learning disability.

Conclusion

The present study investigated the cognitive flexibility in children with learning disability and the results revealed significant differences for the cognitive flexibility index indicating that children with learning disability require more time to shift their cognitive set in response to changing stimuli when compared to typically developing normal children. The obtained results can be attributed to the deficits in the attentional process and the knowledge representation yielding a prolonged cognitive block in children with learning disability.

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