

Evaluation of Accuracy and Consistency of Letter Formation in Indian Children with Developmental Coordination Disorder

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Abstract

Developmental coordination disorder is characterized by difficulty in executing task and activities that demands motor coordination and sequencing it in order. Children with DCD have frequent failure in academics as they have poor handwriting skill and the Handwriting difficulties are frequently trouble children right from their primary schooling. Researchers have documented those children with poor fine motor control experiences handwriting difficulties and the child with DCD takes more pause and they have less efficient letter production than the age matched typically developing children. Lack of automaticity in producing handwriting is due to temporal dysfluency. The factor that underlies this difficulty is the accuracy and consistency in producing letters. The current study aims to provide a better understanding of handwriting difficulty experienced by Indian primary school children and the study evaluates the accuracy and consistency of letter production. A total of 10 children of age group 5-10 years with developmental coordination disorder are included in the study and they were matched with 10 typically developing children in control group. The detailed assessment of speed of handwriting was used and all the children completed alphabet writing and copying task. The results of the study suggested that children with developmental coordination disorder had higher percentage of errors in letter production than age matched control group typically developing children. They experience difficulty with allograph part of handwriting and require handwriting training.

Keywords

Developmental coordination disorder, handwriting, allograph, coordination, sequencing of letters

Introduction

For an efficient writing task, handwriting skill plays a major role and it is an efficient way to communicate. For children with developmental coordination disorder, difficulty in motor coordination results in poor handwriting skill as they have poor hand muscle strength and poor fine motor control, they experience trouble in producing letters with accuracy and consistency. The quality of the written composition begins with spelling and handwriting fluency. The speed of writing depends on the number of letters produced and words written per minute¹. The speed of writing is reflected in the number of letters and words produced in a minute and the speed is automatically reflected in writing and the speed can be a predictor of quality of writing. Academic performance is impaired, if the child experiences difficulty in producing writing in a fast and legible manner. Children with DCD display common characteristics and that includes clumsiness, awkwardness and poor motor coordination².

These children enjoy isolation and they avoids peer group children for multiple reasons and if the isolation is not identified at the early stage, that can lead to psychological distress and majority of the children experiences social

negativism and suicidal tendency. Poor motor coordination is identified at the primary school and it is identified primarily by their school teachers. As teachers spend majority of their time observing the child's academic performance and behavior, they are the one who primarily identify the problem with the child³.

But in Indian schools, teachers were not aware of the characteristic features of the DCD child. Teacher's fails to identify the difficulties as the child with DCD has unexplained difficulty in learning and writing inspite of having higher IQ compared to typically developing children. Group of children known for handwriting defects are children with DCD and they were diagnosed in the category of DCD, if they have no specific medical condition, intellectual disability and any other neurological or musculoskeletal disorders⁴. Handwriting difficulties were elaborated in the diagnostic manual for DCD by American psychiatric association in 2013 and it has been reported most common difficulty for primary school children and it is documented as a frequently reported problem among children with DCD and majority of the referral to occupational therapy services were for handwriting difficulty. Majority of the researchers in the past examined the handwriting component among children with and without developmental coordination disorder and identified that both speed and consistency were the common trouble among children⁵. The aim of the current study was to evaluate the handwriting production among children with DCD by evaluating the accuracy and consistency. Our initial predictions was the child with DCD produce innumerable errors and they are less consistent in reproducing the letters

Methodology

Total number of 20 children participated in the study and we used non-experimental between-group design in the study to analyze the accuracy and consistency of letter formation among Indian children with and without developmental coordination disorder. Children aged 5-10 years participated in the study and 10 children with developmental coordination disorder were matched for their age and handedness with 10 typically developing peer group children recruited from schools. Children were included in the study after explaining the procedure of interventions and assessment methods used and parents were asked to sign in the written informed consent form. They can withdraw from the study at any time and also get the details of their child's progress at any stage of the research by contacting the primary researcher of the study. DCD children were selected and included in the study by recruiting them from the support groups and the details of the study were published in research group website. Parents who were interested contacted the primary researcher and enrolled their children in the research. Initial assessment was done using DSM-V criteria for DCD and MABC-2 was used to evaluate the child's difficulty in motor coordination. The motor difficulties experienced by the children had a significant long term consequences on the activities of daily living skills. As the parents of children confirmed that children included in the study were with no history of neurological and intellectual disorders. They confirmed that their children were not having history of medical defect and they were recruited from places in and around Chennai. Teachers were asked to identify the children with motor difficulties and also children with reading and writing difficulties were included. If any children found to have dyslexia and those with difficulty in reading and writing English language were not included in the study. In order to control the confounding factors the exclusion criteria was framed by considering English language writing as well as reading ability. To identify the Childs motor difficulties the MABC-2 was used and the MABC assesses the three components which comprises manual dexterity, aiming and catching and balance. These motor

difficulties had significant long term impact on the children with developmental coordination disorder. Difficulties in motor coordination results in poor performance in activities of daily living. Parents of children with DCD used to express that their children had difficulty in executing the tasks in daily living that demands motor coordination. British Picture Vocabulary Scale is used to examine the vocabulary that correlates with IQ. The test examines the receptive vocabulary in children with DCD. The performance level of included children in the test components of British picture vocabulary scale is average and it confirms the absence of intellectual impairments. To document the parent reported behavioral problems, strength and difficulty questionnaire was used. Strength and difficulty questionnaire was used to document the behavioral difficulties occur in DCD. It also evaluates the psychological adjustments of children aged 3 to 16 years. The Detailed Assessment of Speed of Handwriting (DASH) was used to evaluate the child handwriting skill. In the current study, from the DASH two tasks were used in the evaluation part. Alphabet writing task was used and the child was instructed to write the alphabets as fast as possible from the memory adapted for 1 minute. Child is instructed to write the letters with good legibility and the written product should be readable. In copy fast task, the child is instructed to copy the sentence provided as quickly for 2 minutes. Here the opportunity is provided for the therapist to examine the individual letterforms. The handwriting sessions conducted in the study took place for 60 minutes and the child was assessed by the primary researcher who is an experienced occupational therapist. During the examination task, the children were seated at a height adjustable table and chair with knees placed at 90 degrees and elbows placed at 2 to 4 cm above the table.

Results

TABLE 1: Mean, standard deviation, ages and performance scores for DCD and TD Groups

Measures used	DCD Group	Typically developing children	p-value
Age	10.21	10.67	.344
MABC-2 Scores	3.25	42.23	<.001
Manual dexterity	6.21	50.34	<.001
Aiming and Catching	22.67	68.87	<.001
Balance	5.23	30.25	<.001
BPVS-2	110.6	123	<.001

TABLE 2: Median production errors on both tasks- DASH

Incorrect letters	DCD	TD	p-value
Similar error in both task	90.12	65.56	.070
Different error in both task	11.01	0.00	<.001

Children included in the DCD group had high production errors when compared with the typically developing children group (Table 1). As shown in Table 2, the DCD group had a higher percentage of errors in alphabet task

Discussion

To explore further in detail, researchers started using real time monitoring of movements of the pen using the writing tablet technology. Prunty et al in their research in 2013 identified that children with DCD spend a major time in

pausing the writing as compared to typically developing children. In our previous research work, we have examined the fine motor control and handwriting ability of Indian children with developmental coordination disorder. Intrinsic hand muscle strengthening over handwriting performance was examined in our previous research work⁶. The pausing behavior of handwriting was analyzed by analyzing the location of pauses. Prunty et al in 2014, concluded that children with developmental coordination disorder had produced higher ranges of pauses between the words as compared to typically developing children. These within word pauses were depicted as the indicators for lack of automaticity. Fluency in producing the phrases depends and demands automaticity⁷. It has been compared that skilled and efficient writers have the capability in programming or sequencing the spelling and movement components in a continuous way without any pause.

Prior to commencing any word, the skilled writers program the spelling of the words and orient the movement composition for the sequence of words before commencing it. The ability to execute the word and commencing it is the highest capability to train for children with developmental coordination disorder. Children with DCD find it more difficult to execute the word without stopping it⁸. However children with DCD fail to acquire the skill and it is mandatory to examine the reasons for the deficit to incorporate the therapeutic interventions in clinical practice. It is also documented by the previous researchers that DCD can co-occur with autism spectrum disorder, ADHD, DLD, SLI and dyslexia⁹. These difficulties that co-occur in few children with developmental coordination disorder that further impact the handwriting process. Sumner et al in 2014 documented those children with dyslexia produces less words in a minute than the age matched typically developing peer group children. In order to explore the deficits in children with DCD it is mandatory to examine the concurring conditions in the handwriting of children with DCD. The unique role of motor coordination needs assessment to further confirm the deficits among children with DCD¹⁰.

In 1967, Fitts and Posner confirmed that for a child to become an extensive learner with enhanced automatic and fluent skill component, he or she should follow extensive practice of movement pattern and skill. At the age of 2 to 3 years, children were engaged in writing task and that is quite distinguishable from drawing task¹¹. At their 3 to 4 years they reproduce the linear stroke pattern, segment letterforms and produce small clusters of letters. They engage in natural development of language and motor skills and with formal instructions these movement patterns were produced with refined pattern. Refined movements were acquired through repeated practice attempts. The result of refined movement pattern will produce more specific letter shapes and forms¹².

Van Galen's in 1991 developed theoretical model of handwriting and in that they have described the motor commands and feedback required for producing efficient letters are referred to as allograph. The set of motor commands that necessitates the details of essential actions. To establish a through motor commands there is a need for elaborate knowledge on letterform and sequence of strokes with the direction in which the strokes were formed¹³. The tendency to produce less legible letters and overwriting and also adding letters to already framed letters were the contributing factors for handwriting difficulty. Rosenblum et al in 2008 established that children with DCD find difficulty in learning a new letter and new pattern of producing it¹⁴. They experience difficulty in producing strokes with consistent velocity and with variability. By analyzing the various factors which underlying the letter production like place where the letter is produced, direction and speed as well as stroke pattern. Analyzing handwriting will help to better understand the demands to be settled for children with DCD¹⁵. Zirinski et al in 2008 evaluated the different letterforms among children with DCD. Their primary focus is on handwriting legibility and spatial arrangement and

analysis of shape of the letters produced. Till date, no studies evaluated the individual letters and taken into account the difficulties expressed by children with DCD. This kind of evaluation will help to determine the difficulties with forming letters in a specific order and pattern. Through the results of the study, focused interventions can be scheduled¹⁶

Conclusion

Previous researchers have evaluated the quality of letter produced in children with DCD in the classroom and in the clinical settings. The current study was the first to examine the accuracy of letter formation by analyzing handwriting production. Further research is needed to process and expand this method of research further.

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Availability of data and other materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request. Please mail and reach us in monisha_ravikumar@srmuniv.edu.in

Ethics approval and consent to participation

The study was approved by the Institutional Ethics Committee (Human Studies) of the SRM Institute of Science and Technology, Kattankulathur with Approval No. 1755/IEC/2019. Written informed consent for interviews was obtained from all participants. The privacy and confidentiality of all the participants was strictly maintained.

Competing interests

Authors declare no conflict of interest

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