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Evaluation of Motor Skill Learning and Action Observation with Transfer by Children with Developmental Coordination Disorder

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ABSTRACT

DSM-5 criteria describes that in order to emphasize the diagnosis for developmental coordination disorder (DCD) there should be marked deficits in performing motor coordination skills, there is a trouble with sequencing and executing the motor skills. Previous research studies explored that children and adults with developmental coordination disorder experiences difficulty in executing the motor skills but those studies doesn't reveal the deficit in executing and learning a new skill. The aim of the current study is to compare the motor skill learning among 5-6 year old children with and without developmental coordination disorder and in the current study grapho-motor learning task which is similar to letter writing was incorporated. Twenty boys participated in the study, 10 with DCD, learned to fabricate and create new letter by connecting the three dots. Training the children with the specific new task and 1 week post training effects and retention were tested and the new letter formation ability with no-dot condition was also examined. The results of the current study conclude that children with DCD experiences difficulty in transfer of the learned task. There is a plateau phase were the learning effects were impaired. However the rate of learning is similar to children without developmental coordination disorder. The study concludes by exploring the motor difficulties expressed by children with DCD and it also examine the underlying mechanism in skill learning.

Keywords

DCD, Dot-joining task, Grapho motor skill, motor skill learning, transfer of skill

Introduction

Developmental Coordination Disorder is a life-threatening condition, which is frequently identified among children in developmental years. However the disorder shares the clinical manifestations like slowness and awkwardness. Children when examined showed marked difficulty in executing skills that demands motor coordination and they often appears clumsy and awkward when they walk and sit[1]. When instructed to perform any kind of goal directed movements, children exhibit difficulty in executing activities of daily living skills. But the difficulties exhibited by them where not from any kind of intellectual disability, visual impairment and neurological defects. When the prevalence of DCD is examined, it has been documented by few researchers that 5-6 year old children had DCD prevalence range from 7 to 15% and the prevalence rate varies based on the country and the way the assessment is executed[2]. DSM-5 criteria elaborates that children with DCD have difficulty in sequencing and coordinating the motor skills which were below their age matched capabilities. Difficulties in motor performance are more prominent while executing the task that demands writing[3]. Handwriting defects reflect a deficit in the memory system. However there are defects in motor, perceptual and cognitive skills. When the literature in past were evaluated there are no

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findings of studies that evaluated the learning retention and practice dependant motor skill learning in children with DCD[4]. Planning of movement skill is impaired and it is particularly evident in visual motor sequencing task. Other research documents the overall lower performance level in children with DCD. In the research study it has been documented that while practicing the visual motor adaptation task by performing the tracing of a curved path, children with DCD experiences trouble[5]. It is made clear that visual motor integration skill is impaired but however it is not made clear that learning the skill which demands motor coordination skill is impaired or the task which requires additional practice sessions with extra support to acquire the skill[6]. Motor skill learning differs at the stage of learning as well as in transfer conditions. Skill acquisition in children presents with motor coordination problem develops relatively slowly as compared to peer group typically developing children. But typically developing children acquire the complicated skills at relatively rapid speed over the single training sessions. Under the environmental influence and on different experimental paradigms, children learn, relearn and acquire the skills. For children with DCD gains in skills acquisition develops over the multiple sessions of practice and training the specific task that demands motor coordination[7]. There are developments at the incremental level. There will be the mechanics of progressive stabilization of acquired memory pattern. Consolidation pattern in memory is acquired through repeated assisted training sessions but the training sessions should be elaborate and it require time and special attention from the therapist to reach success. Triggering the memory consolidation process is successful through training and simultaneously the memory retention is tested after weeks and months of training the new task that demands visual motor integration and coordination of motor skill[8].

Methodology

The primary aim of the current study was to test the retention of knowledge and skill learning as well as the transfer ability among children with developmental coordination disorder. In the study training, 24 h post-training effect on transfer of skill, and 1-week post-training retention of skill were examined and also the study aim to analyze the transfer ability of children with DCD after weeks of intervention. 5-6 year old children with DCD were included in the study and they were compared with the peer group children. Letter writing task, grapho motor tasks like invented letters were used to evaluate the writing efficiency. The task used us ILT which is similar to letter writing practice. The task was designed to evaluate the Childs attention abilities and it minimizes accuracy demands. The task acquisition was associated with handwriting proficiency. In the current study, the domains of item training, consistency in performance, consolidation, memory retention of task and transfer of skill is evaluated in children with and without developmental coordination disorder. Twenty boys were included in the study and they were of age group 5-6 years and 10 boys with DCD and 10 with typical development and they were matched on nonverbal IQ scores. Children with DCD were recruited from child's development centers and clinics. After screening the children with DCD by the neurologist for other developmental disorders like Developmental Language Disorder and Specific Language Impairment. DCDQ is administered to confirm DCD suspects. Children participated in the study, before they participate in any therapy sessions. Children in the control group were from the same locality and they were referred from primary school teachers. Parents were not aware of the symptoms of other developmental disabilities.

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SRM institutional ethical committee approved the study. Parents were provided with informed consent form and after their approval, children were participated in the study. Indian education system allow children to write letters from kindergarten and the child with DCD experience difficulty and encounter handwriting related problems. Children were included in the study if they meet the criteria of the DSM-5 classification and the motor ability was tested using the MABC-2. In Movement assessment battery for children, if the total score lies in the range at or below 16th percentile were classified as having DCD. Children in the control group had an MABC-2 total score above 25th percentile indicating typical development. Children encounter handwriting problem and this affects their academic performance as these children experience difficulty in getting pass grade in academics. Childs visual motor skill was evaluated using VMI subtest of the Beery-Buktenica Developmental Test of Visual-Motor Integration.

Performance on VMI test was associated with handwriting legibility. At the initial ILT test, all the participants scored above 25th percentile on the VMI subset that suggests that there is an intact visual motor accuracy. For an efficient ILT production, children in both the group were asked to remember three movement sequences. Initial two letter segments, then next letter and followed by an additional movement at the end of each line. Short term memory ability was tested using number recall and the hand movement test of K-ABC was used. A self-regulation test was used to evaluate the academic achievements. Based on the referral made from the child developmental and therapy centers in and around Chennai there are no medical conditions associated with these children. The Beery-Buktenica Developmental Test of Visual-Motor Integration was used to evaluate visual-motor integration skills. The Motor Control (MC) supplement was used in the current study. The 2 test integrates 27 figures of enhancing complexity. The ability of the child to copy geometric figures and draw the figures through dots and within the boundary lines were evaluated. Encircle dots task was initiated after delivering brief instructions to the patient. The task must be completed as quickly and as accurately. The child should encircle all 3 dots in continuous way. At the beginning of each task, this experimental session is repeated. They were instructed to follow the dots to produce letters. They should not be revealing the shape of the letter prior to completion and training. The shape of the letter can range between two segmented line joining the dots and an arched line going through the dots. Between performance children were encouraged with the comments, good, you did it well.

Results

Table 1 demonstrates the descriptive data of the participating children. Children in both experimental and control group did not differ in their scores in Beery-VMI, Beery-MC, and the Hand Movement scores. There is a significant difference exhibited for MABC-2 scores in the subtests of manual dexterity, ball catching task and in balance. A repeated measures analysis of variance (rm-ANOVA) was applied to evaluate the ILT production time, accuracy, and fluency data (Table 2).

Table 1: Demographic data

characteristics	Children with DCD	Typically developing children	t	d	p
Age	72.62	71.78	0.23	.12	.734

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Beery VMI raw	13.12	14.16	0.78	.21	.412
Berry MC raw	12.11	13.21	1.43	.40	.212
Number recall	5.11	4.12	1.63	.54	.110
MABC-2 raw	54.23	80.12	6.62	2.12	.000
MABC-2 Ball skill	19.20	65.34	6.22	2.21	.000
MABC- 2 Manual dexterity	13.23	45.56	3.89	1.23	.001
MABC-2 Balance	20.12	48.43	3.79	1.23	.001

Table 2: Group difference in learning and transfer performance

Task	Children with DCD - mean	Children with typical development- mean	d
Production time	32.41	30.65	0.72
Total accuracy	13.21	15.67	0.63
Accuracy alternatives	13.45	14.55	0.75

Discussions

Transferring of learned ability and skills were evaluated at the end of the training sessions particularly after the child is specialized with performing the skill appropriately. Efficient training is tested in terms of speed and accuracy and previous researchers documents that Indian children with DCD following 7 weeks of training with appropriate motor protocol shows efficient gains in motor skills in terms of speed and accuracy[9].

To understand the difficulties elicited by children with DCD, there is a need to distinguish the nature assists and various forms of impairment in skill learning. When the literature is reviewed it has been made clear that motor skill learning in children with DCD were tested and documented with the initial practice and skill acquisition. Few studies evaluated the effects of training effects following the initial training sessions and the results of the studies documents that motor training in children was slower and less accurate as compared to typically developing peer group children[10].

When the simple task of handwriting is examined, it has been observed that motor performance is sensitive to temporal constraints. Researchers examined and conclude that when children were asked to write letters fast and when the model for tracing the letter writing was removed, children experienced more difficulty. Motor learning was similar in children with DCD and typically developing age matched peer group population but children with motor coordination difficulty experiences learning difficulty in task that demands sequence-specific learning[11].

Learning the general task and sequence specific task was comparable and it is observed that visual motor integration and sequence learning were used to elicit learning task. Where the children were not attentive to learning the task[12]. Deficits in skill learning will have impairment in efficient learning. Tracing task was used to train children with DCD

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at the initial stage of learning and progression is made in later stages of learning task. Following repeated learning task, children with DCD showed increased learning speed but there is impairment in learning the accuracy of task[13]. Speed-accuracy trade off is there among children with coordination difficulty, children with typical development were more accurate and maintained the rate of performance. Learning retention was tested using balance-exercise video games at constant and variable phases and concluded that children lack perceptual motor adaptations. Snapp et al in 2016 concluded that any sort of training will yield positive result but children with DCD after tracing 3D shape; they find difficulty in acquiring the tracing task demands from a 2D shape drawing. Transfer of motor learning and motor task demands were not studied in detail[14]. Farmer et al in 2016 concluded that not all children identified with developmental coordination disorder is found to have the same amount of motor difficulty and few children were found to have capability similar to age matched peer group children. But the common defect reported in children with DCD is the handwriting difficulty[15]. They were found to have poor handwriting and it was observed in majority of children with DCD and also in typically developing peer group children. The observed handwriting pattern is less legible, more variable and less organized as well as less assured. These children with developmental coordination disorder struggle in learning and skilled production of writing. When instructed to write, they require more time and assistance as well as practice than the typically developing peer group children. For letter production they demand the spatial guidance[16]. Jolly et al in 2010 documented that children with DCD lacks writing legibility and they experience difficulty in writing letters followed by dictation and copying. In copying task, when the model was removed, children with DCD were unstable and they demands a larger temporal and spatial perception gaps[17]. Developmental coordination disorder is marked by the characteristic hallmark feature clumsiness and it is a frequently stirring life-threatening condition. Clinical manifestations include slowness, clumsiness and difficulty in focusing as well as attention towards performing the goal-directed movement[18]. In the current study we aimed to examine the motor skill acquisition ability and the capability of the child to transfer the abilities. 5–6-year-old children with and without DCD were evaluated with the use of a writing like task which demands grapho-motor learning. While performing the grapho motor task, children were instructed to identify the letter as well as to produce them by connecting the dots[19]. This letter task was tested in 4 scenarios, training phase, 24 house post training retention, 1 week post training effects and transfer of skill with no dots were tested. Children with DCD showed skill retention as well as acquisition but however the production of letters was less fluent than the typically developing peers. Transfer of skill and learned abilities is vital as well as central for learning everyday's activities of daily living skills. The current study explains the difficulties faced when learning a new motor task[20].

Conclusion

In the current study, we suggest that children with DCD showed significant improvement following ILT grapho motor tasks they practiced consistently. But when progressing to no dot condition, there is less accurate experimental task condition prevails among children with developmental coordination disorder. When comparing typically developing peer group children, DCD children took more time to complete the task to enable the task completion with accuracy. Thus the study concludes that there are deficits in forming internal models for grapho motor tasks.

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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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