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# Research in Developmental Disabilities



## Effect of internal versus external focus of attention on implicit motor learning in children with developmental coordination disorder



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### ABSTRACT

Children with developmental coordination disorder (DCD) struggle to learn new motor skills. It is unknown whether children with DCD learn motor skills more effectively with an external focus of attention (focusing on impact of movement on the environment) or an internal focus of attention (focusing on one's body movements) during implicit (unconscious) and explicit (conscious) motor learning.

**Purpose:** This paper aims to determine the trends of implicit motor learning in children with DCD, and how focus of attention influences motor learning in children with DCD in comparison with typically developing children.

**Methods:** 25 children, aged 8–12, with ( $n = 12$ ) and without ( $n = 13$ ) DCD were randomly assigned to receive instructions that focused attention externally or internally while completing a computer tracking task during acquisition, retention, and transfer phases. The motor task involved tracking both repeated and random patterns, with the repeated pattern indicative of implicit learning.

**Results:** Children with DCD scored lower on the motor task in all three phases of the study, demonstrating poorer implicit learning. Furthermore, graphical data showed that for the children with DCD, there was no apparent difference between internal and external focus of attention during retention and transfer, while there was an advantage to the external focus of attention group for typically developing children.

**Conclusion:** Children with DCD demonstrate less accuracy than typically developing children in learning a motor task. Also, the effect of focus of attention on motor performance is different in children with DCD versus their typically developing counterparts during the three phases of motor learning.

**Implications:** Results may inform clinicians how to facilitate motor learning in children with DCD by incorporating explicit learning with either internal or external focus of attention within interventions.

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## 1. Introduction

Affecting 5–6% of school-age children, developmental coordination disorder (DCD) is a neuromotor disability in which a child's motor coordination difficulties significantly interfere with activities of daily living and academic achievement (American Psychiatric Association, 2013). These children typically have difficulty with fine and/or gross motor skills, motor performance, and learning new motor skills. Due to their motor difficulties, children with DCD tend to disengage in activities and play, which can lead to social isolation, depression, and decreasing the quality of life (Candler & Meeuwssen, 2002; Kennedy-Behr, Rodger, & Mickan, 2011; Kirby, Sugden, & Edwards, 2010; Wang, Tseng, Wilson, & Hu, 2009; Zwicker, Harris, & Klassen, 2013).

Motor learning is associated with practice or experience that leads to permanent changes in performance, and can be further divided into implicit and explicit learning (Schmidt & Lee, 2005). Gentile describes these two types of learning processes as occurring simultaneously during the acquisition of functional motor skills (Gentile, 1998). Explicit learning is encoded as facts or events which occur when a child consciously attempts to put into place a known movement based on the demands of a task, whereas implicit learning processes are characterized by slow development and are not under conscious control (Gentile, 1998; Zwicker & Harris, 2009). Currently, there is little known about the interaction of implicit and explicit learning during typical and atypical development.

When compared to those who are typically developing, children with DCD experience notable differences in motor skill acquisition and retention (Missiuna, Mandich, Polatajko, & Malloy-Miller, 2001). They also have greater difficulties in generalizing a learned motor task (Missiuna, 1994). Previous research by Gheysen, Van Waelvelde, and Fias (2011) demonstrates that children with DCD are unable to recognize repeated sequences; however, the study by Wilson, Maruff, and Lum (2003) shows that children with DCD are capable of learning sequences using an implicit learning process. Candler and Meeuwssen (2002) also compared the implicit learning of children with and without DCD. They found that children with DCD demonstrate the ability to recognize perceptual cues and use them for performance enhancement on a computer game without explicitly expressing knowledge of the cue, which is indicative of implicit learning. Although group differences were not significant, this may be explained by the simplicity of the task that was used. Not withstanding these mixed findings, recent meta analysis showed that there is a generalized deficit in motor performance and procedural learning in individuals with DCD (Wilson, Ruddock, Smits-Engelsman, Polatajko, & Blank, 2012); however, there is little information about how implicit learning affects performance during each phase of acquisition, retention, and transfer.

Current practices in pediatric rehabilitation suggest that using explicit cognitive approaches are effective intervention strategies for children with DCD (Sugden, 2007). Implicit and explicit learning processes are also consistent with the principles of intrinsic and extrinsic feedback in motor learning theories (Zwicker & Harris, 2009). Some researchers have argued that calling conscious attention to task-relevant features actually impedes performance (Candler & Meeuwssen, 2002). This argument is similar to the one given for the disadvantage of focusing internally during task acquisition (internal focus of attention) (Emanuel, Jarus, & Bart, 2008; Wulf, Shea, & Lewthwaite, 2010).

Physical and occupational therapists often try to direct the learners' focus of attention to different environmental cues or body movements in order to improve motor skill acquisition. Altering the learners' focus of attention to an external cue (focusing on the impact of the movement on the environment) as opposed to an internal cue (focusing on one's own body movements) has shown to be more beneficial for motor skill acquisition in adults (Beilock, Carr, MacMahon, & Starkes, 2002; Edwards & Rothwell, 2011; Emanuel et al., 2008; Freedman, Maas, Caligiuri, Wulf, & Robin, 2007; Missiua, Rivard, & Bartlett, 2003; Wulf et al., 2010; Zachry, Wulf, Mercer, & Bezodis, 2005; Zentgraf & Munzert, 2009). This could be because when people consciously try to control their own movements, as with an internal focus of attention, the automatic motor process is suppressed, whereas an external focus allows the automatic process to occur implicitly (Emanuel et al., 2008; Wulf et al., 2010). An external focus of attention may also speed up learning by making the motor skill an unconscious, automatic process, and has been shown to increase accuracy of body movements (Wulf et al., 2010; Zachry et al., 2005).

Limited research has been conducted on the effects of focus of attention on motor skill acquisition in typically developing children, and in children with DCD in particular. Current research demonstrates that, contrary to findings with adults, an external focus of attention in children could interfere with learning (Emanuel et al., 2008). As children might be novice learners, an internal focus of attention could be more beneficial because their automatic motor system has not yet developed (Emanuel et al., 2008). Consequently, it can be hypothesized that individuals with developmental disorders such as DCD tend to attend more internally due to their lack of experiences. However, as far as we know, no study examined the effects of focus of attention in children with DCD during each phase of motor learning.

In summary, motor learning processes in children with DCD have been studied using various methods; however, further research is warranted in order to close the prominent gaps in the literature that have been identified. The main purpose of this study was to determine if children with DCD demonstrate implicit learning in each phase of motor learning in comparison to typically developing children. The secondary purpose was to determine whether an internal or external focus of attention is more beneficial for motor learning in children with DCD. It was hypothesized that children with DCD would show poorer learning under implicit learning conditions when compared to their typically developing peers. Also, we hypothesized that there would be a difference in the effects of focus of attention on the motor learning of children with and without DCD.

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