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Influence of methylphenidate on motor performance and attention in children with developmental coordination disorder and attention deficit hyperactive disorder

Orit Bart[a,*], Liron Daniel[a], Orrie Dan[b], Yair Bar-Haim[c]

[a] *The Department of Occupational Therapy, School of Allied Health, Medical Faculty, Tel Aviv University, Israel*
[b] *The Center for Psychobiological Research, Department of Psychology, The Max Stern Yezreel Valley College, Israel*
[c] *The Adler Center for Child Development and Psychopathology, School of Psychological Sciences and School of Neuroscience, Tel-Aviv University, Tel Aviv, Israel*

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ABSTRACT

Individuals with attention deficit hyperactive disorder (ADHD) often have coexisting developmental coordination disorder (DCD). The positive therapeutic effect of methylphenidate on ADHD symptoms is well documented, but its effects on motor coordination are less studied. We assessed the influence of methylphenidate on motor performance in children with comorbid DCD and ADHD. Participants were 30 children (24 boys) aged 5.10–12.7 years diagnosed with both DCD and ADHD. Conners' Parent Rating Scale was used to reaffirm ADHD diagnosis and the Developmental Coordination Disorder Questionnaire was used to diagnose DCD. The Movement Assessment Battery for Children-2 and the online continuous performance test were administrated to all participants twice, with and without methylphenidate. The tests were administered on two separate days in a blind design. Motor performance and attention scores were significantly better with methylphenidate than without it ($p < 0.001$ for improvement in the Movement Assessment Battery for Children-2 and $p < 0.006$ for the online continuous performance test scores).

The findings suggest that methylphenidate improves both attention and motor coordination in children with coexisting DCD and ADHD. More research is needed to disentangle the causality of the improvement effect and whether improvement in motor coordination is directly affected by methylphenidate or mediated by improvement in attention.

1. Introduction

Attention deficit hyperactive disorder (ADHD) and developmental coordination disorder (DCD) are two developmental conditions that may cause motor, academic and social dysfunctions (APA, 1994). Their coexistence was documented in several studies, and as many as 35–47% of the children with ADHD were diagnosed as having comorbid DCD (Kadesjö & Gillberg, 2003; Martin, Piek, Baynam, Levy, & Hay, 2010). A number of studies have described the link between motor coordination dysfunction and ADHD (Sergeant, Piek, & Oosterlaan, 2006). Children with ADHD are often clumsy, and have difficulties in gross and fine motor movements and balance (Fliers et al., 2010; Racine, Majnemer, Shevell, & Snider, 2008;

* Corresponding author. Tel.: +972 3 6409104; fax: +972 3 6409333.
E-mail address: oritbert@post.tau.ac.il (O. Bart).

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Shum & Pang, 2009). Children with DCD often exhibit problems in attention span, attention focusing, and decreased response inhibition, similar to children with ADHD (Mandich, Buckolz, & Polatajko, 2003). Children with DCD also have difficulties in performing attention-demanding tasks, such as writing. Neuroimaging studies show that children with DCD show decreased activation in the dorsolateral prefrontal cortex, which is involved in attentional control (Zwicker, Missiuna, Harris, & Boyd, 2011) and in the attentional brain network (Querne et al., 2008).

Sensory-motor and attention functions are intimately associated (Davis, Pass, Finch, Dean, & Woodcock 2009; Emanuel, Jarus, & Bart, 2008). Limited recruitment of attention functions is needed for the performance of simple automatic motor actions, whereas massive attentional control is required for the performance of complex motor tasks (Wulf, Shea, & Lewthwaite, 2009). Functional anatomy indicates that the cerebellum is important for both cognitive and motor functions, demonstrating massive reliance on prefrontal cortex-cerebellum connectivity and co-activation during performance and planning of motor actions (Diamond, 2000; Kalmbach, Ohyama, Kreider, Riusech, & Mauk, 2009).

Methylphenidate (MPH) is considered an effective medication for ADHD and is widely used to reduce symptoms in children with this disorder (Buitelaar & Medori, 2010). MPH attenuates behavior problems and improves attention focusing and response inhibition capacities in 60–80% of patients (DeVito et al., 2009). Recent findings indicate that the influence of MPH on hyperactivity, impulsivity, and attention, is more robust in children with ADHD who also present with motor problems (Stray, Ellertsen, & Stray, 2010). Thus also pointing to a functional association between certain motor deficits and the behavioral symptoms of ADHD.

Much information is available on the influence of MPH on attention. Much less is known about the influence of MPH on motor function. Extant data suggest that MPH improves fine motor function (Flapper, Houwen, & Schoemaker, 2006) writing skills (Schoemaker, Ketelaars, Van Zonneveld, & Minderaa, 2005) and postural stability and balance (Jacobi-Polishook, Shorer, & Melzer, 2009; Leitner et al., 2007) in children diagnosed with ADHD. Unlike its widespread use in the treatment of ADHD, MPH is hardly ever being prescribed to children with DCD, and thus, assessment of the influence of MPH on motor function is restricted to populations of children with coexisting DCD and ADHD. A study focusing on the quality of life of children with ADHD and DCD, showed improvement in motor coordination after taking MPH (Flapper & Schoemaker, 2008). A different study assessed the motor performance of children with both ADHD and DCD at two time points; once after having received MPH and once after having received placebo. An improvement in motor function was documented in all children, but it reached a level of significance in only 33% of them (Bart, Podoly, & Bar-Haim, 2010). The authors suggested that the children whose motor function did not improve under the influence of MPH may not have improved attention with MPH either. The aims of the present study were to assess the effects of MPH on both attention and motor function in children with coexisting DCD and ADHD, and to test whether functional changes in both domains are correlated. Therefore in our study we assess, in addition to motor function, attention before and after taking MPH.

2. Method

2.1. Study participants

Thirty children with coexisting ADHD and DCD participated in the study (24 boys, mean age 8.22 years, SD = 1.11, range 5.10–12.7). All the participants were diagnosed with ADHD and DCD by a neurologist or psychiatrist. The diagnosis of ADHD was confirmed by the Conners' Parent Rating Scale (Conners, Sitarenios, Parker, & Epstein, 1998) and the diagnosis of DCD was confirmed by the Developmental Coordination Disorder Questionnaire (Wilson et al., 2007). Twenty-six of the children had combined type ADHD, and four children had a predominantly inattentive type ADHD. All the children scored above the 70th percentile on the attention difficulties scale, and 55th percentile on the hyperactivity/impulsivity scale of the Connors Parent Rating Scale (CPRS-R). Based on parental reports all children had a score below 46 on the Developmental Coordination Disorder Questionnaire (DCDQ), an indication for a clinically significant DCD. All the participants were treated regularly with MPH: Ritalin SR/LA ($n = 8$, 26.7%); Ritalin 10 mg ($n = 7$, 23.3%); extended release methylphenidate–Concerta ($n = 10$, 33.6%); and Ritalin 20 mg ($n = 5$, 16.7%).

Children with other developmental problems (e.g., autism, cerebral palsy), sensory loss (e.g., hearing difficulties), or other psychiatric diagnoses based on parent-reports were excluded from the study. The study was approved by Tel Aviv University's Ethics Review Board.

2.2. Measures

The online continuous performance test OCPT; eAgnosis Inc., Newark, DE; (Raz, Bar-Haim, Sadeh, & Dan, 2012) is a standard CPT designed for delivery over the Internet (demonstration available at http://www.checkadhd.com/onlineCPTresearch.php). The task uses two geometric stimuli, a triangle and a circle, both presented in a light blue color in the middle of the screen against a gray background. The participants are instructed to respond to the triangle shape as quickly as possible by pressing the space bar on the computer's keyboard, and not to respond to the circle shape. The task lasts 18 minutes and contains two conditions, low target frequency and high target frequency. The first half of the test (low target frequency condition) is boring and fatiguing, while in the second half of the test (high target frequency condition), the participant expects to respond most of the time but must occasionally restrain the tendency to respond. Three measures can