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A preliminary study on the effect of methylphenidate on motor performance in children with comorbid DCD and ADHD

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ABSTRACT

Attention Deficit Hyperactive Disorder (ADHD) and Developmental Coordination Disorder (DCD) are two developmental disorders with considerable comorbidity. The impact of Methylphenidate (MPH) on ADHD symptoms is well documented. However, the effects of MPH on motor coordination are less studied. We assessed the influence of MPH on motor performance of children with comorbid DCD and ADHD. Participants were 18 children (13 boys, mean age 8.3 years) diagnosed with comorbid DCD and ADHD. A structured clinical interview (K-SADS-PL) was used to determine psychopathology and the Movement Assessment Battery for Children–Checklist were used to determine criterion for motor deficits. The Movement Assessment Battery for Children (M-ABC) was administrated to all participants once under the influence of MPH and once under a placebo pill condition. The motor tests were administered on two separate days in a double-blinded design. Participants' motor performance with MPH was significantly superior to their performance in the placebo condition. Significant improvement was observed in all the M-ABC sub-tasks except for static balance performance. The findings suggest that MPH improves motor coordination in children with comorbid DCD and ADHD but clinically significant improvement was found in only 33% of the children.

1. Introduction

Children with Attention Deficit Hyperactivity Disorder (ADHD) and children with Developmental Coordination Disorder (DCD) appear to share difficulties in motor, academic, social, and emotional functioning (American Psychiatric Publishing, 2000). Comorbidity of DCD and ADHD has been confirmed in several studies (e.g., Kadesjö & Gillberg, 1998; Kadesjö & Gillberg, 2001; Tervo, Azuma, Fogas, & Fiechtner, 2002), with an overlap range of 35–47% between the disorders.

Various studies documented an association between motor coordination problems and ADHD (e.g., Christiansen, 2000; Harvey et al., 2007; Landgren, Pettersson, Kjellman, & Gillberg, 1996; Piek, Pitcher, & Hay, 1999; Rasmussen & Gillberg, 2000; Sergeant, Piek, & Oosterlaan, 2006). Children with DCD are often described as having difficulties with attention focusing, attention span, and inhibition of pre-potent responses (Mandich, Buckolz, & Polatajko, 2003), and perform worse than normally coordinated controls on tasks requiring attention such as reading, writing, and spelling (Dewey, Kaplan, Crawford, & Wilson, 2002). Children diagnosed with ADHD are frequently described as clumsy, having poor coordination, and suffering from poor fine and gross motor functioning (Schoemaker, Ketelaars, van Zonneveld, Minderaa, & Mulder, 2005).

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Methylphenidate (MPH) is widely used for the treatment of ADHD and is considered a first line treatment for children with this disorder (Goldman, Genel, Bezman, & Slanetz, 1998; Swanson et al., 1995). MPH has a positive effect on 60–80% of the children with ADHD, reducing behavioral adjustment problems and improving attention (Tannock, Schachar, & Logan, 1995; Wigal et al., 1999). Less is known about the effects of MPH on motor function in children with ADHD. However, some studies reported that MPH improved fine motor function (Flapper, Houwen, & Schoemaker, 2006; Lange et al., 2007; Leitner, Barak, Giladi, Peretz, & Eshel, 2007; Schoemaker et al., 2005), handwriting (Lange et al., 2007), and postural stability and balance (Jacobi-Polishook, Shorer, & Melzer, 2009; Leitner et al., 2007; Wade, 1976) in children with ADHD.

In contrast to the wide use of MPH in ADHD treatment, it is rarely considered as therapy for DCD. To our knowledge, only one study assessed the affects of MPH on motor performance in children fully diagnosed with comorbid DCD and ADHD (Flapper & Schoemaker, 2008). This study focused on quality of life in children with ADHD/DCD comorbidity, but also reported data suggesting improvement in motor coordination with MPH in these children. Similar to Flapper and Schoemaker (2008) we aimed to test the influence of MPH on the motor performance of children diagnosed with comorbid ADHD and DCD using a double-blind placebo-control repeated measures design. We were particularly interested in whether MPH can ameliorate DCD in a clinically significant manner.

2. Methods

2.1. Participants

Participants were 18 children (13 boys), clinically diagnosed with comorbid ADHD and DCD. Mean age was 8.3 years (SD = 2.05; range = 5.3–11.5 years). Children were recruited from public child-development clinics. Inclusion criteria were: (a) diagnosis of ADHD based on the Schedule for Affective Disorders and Schizophrenia for School-Age Children Present and Lifetime Version (K-SADS-PL; Kaufman et al., 1996); (b) a score below the suspected clinical cutoff on the parent-reported Movement Assessment Battery for Children–Checklist for DCD (below the 15th percentile). Parental reports on the M-ABC Checklist were confirmed with the behavioral M-ABC scores under the placebo condition (16 participants were within clinical range for DCD and 2 were within the suspected range); and (c) ADHD being successfully treated with a regular daily dosage of MPH. Exclusion criteria were presence of severe central nervous system dysfunction (i.e., mental retardation, cerebral palsy, or autism), severe sensory loss (i.e., visual or auditory impairment), or any indication of psychiatric disorders other than ADHD based on physicians report and the K-SADS-PL. Five children were diagnosed as having ADHD predominantly inattentive type, three with ADHD predominantly active-impulsive type, and 10 had the ADHD Combined Type. The average age in which participants started using MPH was 6.11 years (SD = 1.21). Table 1 describes the different MPH type medications used by the participants.

2.2. Assessment measures

2.2.1. Background questionnaire

This questionnaire gathered information from parents about their education, place of living, number of children in the family, as well as specific information concerning their child's history of MPH treatment (type of medication, dosage, period of use, compliance, and side effects).

2.2.2. Schedule for Affective Disorders and Schizophrenia for School-Age Children-Kiddie-Sads-Present and Lifetime Version (K-SADS-PL; Kaufman et al., 1996)

The K-SADS-PL is a widely used semi-structured clinical interview addressed to parents and assessing past and present psychiatric disorders in children and adolescents. The interview includes specific questions for each disorder and is based on the diagnostic criteria of the DSM-IV. The K-SADS-PL was administered by a child clinical psychology graduate student, who achieved acceptable reliability ($>$ 85%) with a senior and experienced child clinical psychologist.

2.2.3. Movement Assessment Battery for Children–Checklist (M-ABC Checklist; Henderson & Sugden, 1992)

The M-ABC checklist is a screening questionnaire shown to have a high correlation with the behavioral M-ABC test. The questionnaire consists of 5 scales with 12 items each. Scores on each item range from 0 to 3. Higher scores are indicative of

Table 1
Number and percent of Children using each MPH type medication.

Percent	Number of children	MPH TYPE
44.4	8	Ritalin 10 mg
27.8	5	Ritalin 20 mg
11.1	2	Ritalin SR/LA
16.7	3	Concerta
100.0	18	Total

motor problems. For reliability and validity data of the M-ABC checklist see Schoemaker, Smits-Engelsman, and Jongmans (2003). To be included in the study parents had to report DCD symptoms that placed their child below the 15th age-normed percentile, recommended as clinically meaningful cutoff.

Movement Assessment Battery for Children (M-ABC; Henderson & Sugden, 1992). The MABC is the most commonly used motor assessment for children aged 4 to 12 years (Missiuna, Rivard, & Bartlett, 2006). The assessment covers four sub-categories with two behavioral assignments each: (1) Manual Dexterity, (2) Ball Skills, (3) Static Balance, and (4) Dynamic Balance. Difficulty of motor assignments is adjusted by age, with different assignments for 4–6-year-old, 7–8-year-old, 9–10-year-old, and 11–12-year-old. Each of the eight assignments is scored on a scale ranging from 0 to 5. Lower scores represent better task performance. The total impairment score (0–40) can be converted into a percentile score. A score lower than the 15th percentile is indicative of suspected DCD and a score lower than the 5th percentile is considered a definite indication for a diagnosis of DCD.

2.3. Procedure

The study was approved by the research ethics committee at Tel Aviv University. The parents of children who appeared to meet preliminary inclusion criteria for the study based on clinical interviews conducted by neuro-developmental physicians were further interviewed using the K-SADS-PL and completed the M-ABC Checklist. Those who met inclusion criteria for the study were invited to participate in two sessions of data collection conducted 4–14 days apart ($M = 8.44$, SD = 3.09). All parents read and signed an informed-consent form.

The study applied a double-blind within-subject research design in which neither the child nor the experimenter knew whether M-ABC performance was assessed under the influence of MPH or a placebo. This was achieved by keeping the research assistant who administered the M-ABC blind to the order of the MPH/placebo administration. Specifically, medication/placebo was delivered in a separate office by a different research assistant not involved in any aspect of the study except MPH/placebo administration.

The present study had to deal with a potential intervening factor related to effects of learning/practice on motor performance on the M-ABC. Specifically, it is plausible to expect improvement in M-ABC performance from the first to the second session as a function of practice rather than MPH as was found in previous studies (Leemrijse, Meijer, Vermeer, Lambregts, & Adèr, 1999; Van Waelvelde, Peersman, Lenoir, & Smits-Engelsman, 2007). One way to overcome such practice effects is to randomly assign participants into MPH/Placebo order of administration. However, a more conservative way of reducing concerns of practice effects is to administer one's critical condition in an order that works against the study's hypotheses. That is, because we expected MPH to improve motor performance the M-ABC was always administered first after children took their regular MPH medication dosage. In the second session, children were assessed again with the M-ABC but this time after taking a placebo pill. Thus, if indeed there was an improvement in children's performance on the M-ABC due to simple training effects, such improvements in the placebo condition (always administered second) would work against our study hypothesis of improved motor function due to MPH intake. In both the MPH and placebo conditions care was taken that at least 45 minutes had passed between MPH/Placebo intake and M-ABC assessment.

3. Results

Planned contrasts were used to compare the performance of children on each of the M-ABC sub-tests as well as the percentile score with and without MPH. MPH improved most aspects of motor function as measured by the M-ABC test (see Table 2).

Analysis of the impact of MPH on DCD percentile scores indicated that mean scores were within the clinical range without MPH ($M = 2.39$, SD = 3.12), and improved into the range of suspected DCD only with MPH ($M = 10.33$, SD = 14.67), $F(1, 17) = 6.58$, $p < 0.02$. Further inspection of individual data showed that 16 out of the 18 participants showed improvement on the M-ABC total raw score following MPH intake. However, only five participants functioned in the normal range with MPH (above the 15th percentile), one participants improved to the suspected DCD range (between the 5th and 15th percentiles), whereas 12 children remained within clinical range for DCD despite the noted improvement on raw scores, $\chi^2(2) = 5.91$, $p = 0.05$.

Table 2
Differences between children's function on the M-ABC with and without MPH (Means, Standard Deviations, *t*, *p*, and Cohen's *d* effect size values).

Effect size *d*	*p*	t(17)	Placebo *M* (SD)	With MPH *M* (SD)	
0.45	0.03	2.32	10.44 (2.96)	8.81 (4.12)	Manual dexterity
0.43	0.03	2.45	4.86 (3.44)	3.47 (2.99)	Ball skills
0.16	1.00	1.73	2.75 (1.44)	2.22 (1.75)	Static balance
0.26	0.006	3.16	5.69 (2.71)	4.08 (3.17)	Dynamic balance
0.29	0.001	4.19	23.69 (7.90)	18.5 (9.30)	Total score

4. Discussion

The findings of the present study indicate that MPH significantly improved motor performance in children with comorbid DCD and ADHD. Significant improvement on the M-ABC scales was noted for manual dexterity, ball skills, and dynamic balance tasks, all of which rely heavily on attention recruitment and persistence in addition to motor coordination. In contrast, MPH was associated with only minor not significant improvement in static balance control. Nicolson and Fawcett (1990) suggested that attention is not required for static balance as it is controlled by an automatic system. This pattern of findings is also similar to the pattern reported by Flapper and Schoemaker (2008) indicating that MPH may primarily affects the attention components of movement and motor planning.

The present finding should be interpreted with caution. First, it is evident that two thirds of the children in the present sample continued to perform poorly on the M-ABC tasks despite MPH intake and despite the fact that their ADHD symptoms are being treated successfully by MPH. Second, for the children who did improve in motor function with MPH, this improvement may have been through a direct effect of MPH on motor systems or alternatively mediated via attentional mechanisms. The design of the present study does not allow for the conclusion that attention deficits are the only, or even primary, cause for motor difficulties in children with DCD. Finally, our sample is rather small and may not be representative of the whole population of children with comorbid ADHD and DCD. For instance, MPH may differentially affect motor function in children with different subtypes of ADHD.

Future studies could assess concurrent effects of MPH on both attention and motor function in children with comorbid DCD and ADHD and directly test for mediation effects of attention on the association between MPH and motor performance. In addition, future studies may wish to assess the effects of MPH on children with DCD without ADHD, thereby unraveling the effects of MPH on motor function.

In conclusion, the present study suggests that it is important to explore the associations between MPH, DCD, and ADHD as it might help to better understand the nature of the comorbidity between these two conditions. Importantly, despite the overall improvement in motor function with MPH, it is important to stress that clinically significant improvement in motor function following MPH intake was found in only 33% of the children. Thus, future studies with larger samples are needed to clarify whether MPH therapy could be justified for certain children with developmental coordination disorders.

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