Fine and Gross Motor Ability in Male and Female Adolescents with and without Developmental Coordination Disorder

Grant B. Baynam (G.Baynam@curtin.edu.au)
Jan P. Piek (J.Piek@curtin.edu.au)
School of Psychology
Curtin University of Technology, Perth WA 6845 Australia

Abstract

The present study examined fine and gross motor ability of male and female adolescents with and without Developmental Coordination Disorder (DCD). Sixty-four girls and 37 boys were compared across gender and level of motor ability measured with the McCarron Assessment of Neuromuscular Development (MAND). Although there was no significant difference in gross motor ability, adolescent males with DCD evidenced lower fine motor ability than females with DCD. The implications of these findings are discussed with reference to the necessity to assess specific sources of deficit, as well as gender differences in movement ability when tailoring intervention strategies, particularly within the academic setting.

Introduction

For those individuals who demonstrate difficulty with many of the motoric skills, such as running, jumping, catching and even buttoning clothes (Henderson & Hall, 1982), manipulation of the environment with the same degree of ease as their more coordinated peers is not possible. This is the case for adolescents with Developmental Coordination Disorder (DCD) (Diagnostic and Statistical Manual of Mental Disorders [DSM-IV], 1994), where motor impairment is "sufficient to produce functional performance deficits not explicable by the child's [chronological] age or intellect, or by other diagnosable neurological or psychiatric disorders" (Polatajko, Fox, & Missiuna 1995).

In order to assess movement ability, it can be useful to consider movement in terms of its fine and gross motor constituents - variation among these allowing for a more complete picture of individual differences. Indeed, individuals of lower level motor ability such as those with DCD, have been found to vary greatly in the type of motoric deficit they possess (Henderson, Rose, & Henderson, 1992), a variability which may be increased by gender differences as the individual makes the transition from childhood to adolescence.

Since it does not appear that young children will 'grow out' of their motor problem as they age (Cantell, Smyth, & Ahonen., 1994; Losse et al., 1991), it is important to assess the impact of such coordination difficulties in adolescents. Before the onset of puberty, boys and girls are quite similar in their body composition (body-fat to muscle ratio), strength and limb lengths (Gallahue & Ozmun, 1998). Post-pubertal changes seen in boys include, an increase in testosterone, a doubling of the ratio of muscle to fat, increases in lean body mass, and increases to arm and calf-circumferences, factors providing a biological advantage in performance for any task requiring size and strength (Thomas & French, 1985). In their meta-analysis of 64 movement ability studies, Thomas and French (1985) found that boys perform better on motor tasks involving the running dash, standing jump, agility run, and, sit-up performance, tasks all involving gross motor movements of the body. Girls were found to be slightly, but statistically significantly, better at tasks involving fine eye-motor coordination and flexibility, tasks more closely related to fine motor coordination.

The aim of this study was to examine the fine and gross motor abilities of adolescents with and without DCD, and investigate the influence of gender on the motor difficulties experienced by children with movement problems. If differences exist for the two genders, this has important implications for intervention.

Method

Participants

Two groups of children aged between 11 years 9 months and 15 years 5 months were included in the study. Children were included in the DCD group (21 females and 13 males) if their score was equal to or below 84 on the Neuromuscular Development Index (NDI) of the MAND. The control group consisted of children (21 females and 14 males) with scores of 95 and above on the NDI. No statistically significant differences between the DCD and control groups were found in terms of gender t (67) = -.148, p = .883. Statistically significant difference between the DCD and control groups was found for age, t (67) = 2.938, p = .009. Table 1 gives the means and standard deviations for the NDI and age in each group for males and females.

Table 1: Means and Standard Deviations for NDI score, and AGE (Groups)

			NDI	Age
DCD	Female	*M*	78.33	14.50
	(n= 21)	*SD*	4.15	.92
DCD	Male	*M*	76.54	13.81
	(n=13)	*SD*	4.52	1.05
Control	Female	*M*	106.86	13.24
	(n=21)	*SD*	9.79	.94
Control	Male	*M*	111.57	13.82
	(n=14)	SD	14.69	1.34

Measures

The McCarron Assessment of Neuromuscular Development (MAND) was designed to assess children from 3.5 to 18 years of age in terms of their fine and gross motor development. The test is made up of 5 fine motor items and 5 gross motor items for a total of 10 items assessing one- and two- handed dexterity, grip strength, jumping, and balance skills. The fine motor tasks are: Beads in a box (right and left hand), Beads on a Rod (eyes open and close), Finger Tapping (right and left hand) Nut and Bolt (large and small bolt), and Rod Slide (right and left hand). The gross motor tasks include: Hand Strength (right and left hand), Finger-Nose-Finger (eyes open and closed), Jumping for Distance, Heel-Toe-Walk (forward and backward), and Standing on One Foot (eyes open and closed on each leg).The sum of the 10 scaled scores is converted to a Neuromuscular Development Index (NDI) with a mean of 100 and a standard deviation of 15. Test-Retest reliability coefficients as provided by McCarron (1982) are fine motor score, r=.98; gross motor score, r=.96; and total motor score, r=.99.

Factor Analysis of the MAND has identified four factors involved in movement tasks. Persistent Control measures controlled eye-hand coordination and the ability to focus attention while inhibiting extraneous motor movements. Muscle Power involves dynamic contraction of large muscle groups. Kinaesthetic Integration is involved with the control of balance and orientation of the body in space. Bimanual Dexterity is two-handed coordination and the ability to correctly integrate kinaesthetic stimuli through the hands. (McCarron, 1982)

Procedure

A total of 200 letters containing information sheets, parental consent forms, and medical history questionnaires were disseminated to parents through participating schools. Testing sessions took place during the participants' normally timetabled physical education or health education classes. In order to mimic the school environment as closely as possible, testing sessions lasted between 45 and 55 minutes depending upon the school's timetable for the day.

Results

Two separate 2(group) x 2(gender) ANCOVAs, with age as a covariate, were conducted to assess the differences in fine and gross motor ability.

The assumptions of Analysis of Covariance were tested prior to analysis. Univariate normality was assessed via exploratory analysis. For the fine motor scores, the assumptions of normality and linearity were not violated. A moderate deviation from normality was noted for the gross motor scores. Analysis of the fine and gross motor scores by gender showed that the data were normally distributed for girls, but moderately skewed for boys. As a gender difference was of interest for this hypothesis, the variability of the distribution was unmodified in the analysis, with all results treated with caution due to the departure from normality.

For fine motor ability, the main effect of gender was found to be non-significant, $F(1,64) = 3.04$, $p = .09$. The main effect of coordination group (DCD or control) was found to be significant, $F(1,64) = 52.08$, $p = .00$. Adolescents with DCD were found to have significantly lower fine motor control than adolescents in the control group. As seen in Figure 1, the interaction of group and gender was found to be significant, $F(1,64) = 7.28$, $p = .01$. The simple effect of group for females was found to be significant, $F(1,64) = 11.22$, $p < .05$. Adolescent females with DCD showed significantly lower fine motor coordination than female controls. The simple effect of group for males was also significant, $F(1,64) = 44.05$, $p < .05$. Males with DCD evidenced significantly lower fine motor coordination than control males.

For controls, the simple effect of gender was not significant, $F(1,64) = 0.69$, $p > .05$. Males and females in the control group did not significantly differ in terms of their fine motor coordination. For adolescents in the DCD group however, the simple effect of gender was significant, $F(1,64) = 8.24$, $p < .05$. Females with DCD showed significantly higher levels of fine motor coordination than their male counterparts.

For gross motor ability, a significant main effect of gender was found, $F(1,64) = 8.42$, $p = .01$. Boys evidenced significantly higher gross motor ability than girls. The main effect of coordination group (DCD or control) was also significant, with adolescents in the DCD group scoring significantly lower on measures of gross motor ability, $F(1,64) = 6.76$, $p = .01$. The interaction was found to be non-significant, $F(1,64) = .70$, $p = .40$.

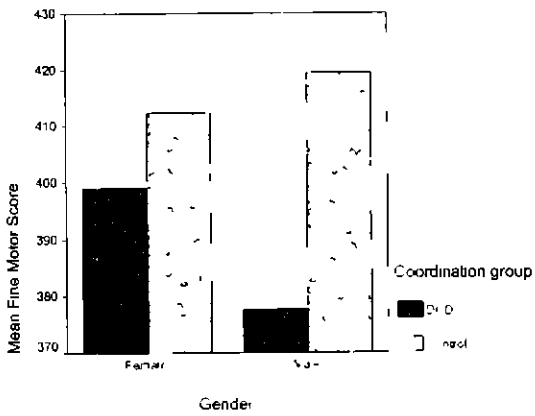

Figure 1: Means for fine motor score across group and gender.

When the four factor scores were examined separately, adolescents in the DCD group were found to be significantly lower on the measures of persistent control, $F(1,64) = 34.33$, $p = .00$, muscle power, $F(1,64) = 17.06$, $p = .00$, kinaesthetic integration, $F(1,64) = 21.77$, $p = .00$, and bimanual dexterity, $F(1,64) = 22.82$, $p = .00$ (see table 2). The main effect of gender for the two groups was significant for muscle power only, $F(1,64) = 23.05$, $p = .00$. Adolescent males scored significantly higher ($M = 105.92$, $SD = 3.59$) on the measure of muscle power than their female ($M = 83.84$, $SD = 2.87$) counterparts.

Table 2: Means and Standard Deviations for MAND Factor Scores by Group

		DCD	Control
Persistent Control	*M*	79.92	111.28
	SD	3.74	3.67
Muscle Power	*M*	84.97	104.79
	SD	3.36	3.29
Kinesthetic Integration	*M*	87.91	107.33
	SD	2.91	2.85
Bimanual Dexterity	*M*	83.41	62.14
	SD	2.74	2.69

Discussion

The results partially supported the prediction that compared to girls, boys would score higher on measures of gross motor ability, but lower on the measure of fine motor ability. However, several interesting findings emerged from these analyses. As expected, adolescent males in the sample scored significantly higher on the measures of gross motor control than did the females. Unexpectedly, the females did not score significantly higher than the males on measures of fine motor ability. Although the group means were in the predicted direction, the difference was not a statistically significant one.

Analysis of the factor scores of the MAND revealed that the main source of difference in motor ability between the boys and girls was in terms of their muscle power. Boys evidenced significantly higher muscle power than girls. This result was expected due to the maturational changes that occur in boys during puberty. Increases in lean-muscle mass and shoulder-to-hip ratio, predispose the adolescent male toward tasks that involve strength attributes (Thomas & French, 1985). Indeed the MAND provides specific gender based norms for the hand-strength and distance-jump subscales, the indexes of muscle power for the test (McCarron, 1982). However, it is clear from the current study that these norms do not adequately take into account the gender difference in muscle power for the Australian sample tested here. This may point to a possible cultural difference.

Unlike the tests of gross motor ability, the MAND does not have any specific gender based norms for the fine motor tests. That the males and females did not significantly differ in terms of their fine motor ability was quite surprising given research findings that suggest that females would perform better than boys on measures involving fine motor coordination (Thomas & French, 1985). The failure to find a significant difference between the male and female controls in terms of their fine motor ability may be attributed the inequality of the group sample sizes. There were fewer males than females in the present study. It is therefore possible, that the sample mean for females was a closer estimate of the true population mean for females, than the sample mean for males was of the true population mean for males. This sample size (and hence statistical power) difference may have attenuated the true group differences making interpretation of the results difficult.

The results of the analyses for fine motor ability, however, revealed a slightly more complex picture than first expected. A significant difference in fine motor ability was noted between the DCD and control adolescents. Adolescents with DCD scored significantly lower on the measures of fine motor control. The presence of a significant interaction between gender and coordination group however, indicated that males and females did differ in terms of their fine motor coordination. The simple effects analyses revealed that females with DCD scored significantly higher on measures of fine motor ability than their male

counterparts. Thus, for the DCD group, the results were in the predicted direction.

The finding that adolescent males and females at the lower end of the motor coordination spectrum, differ significantly in their fine motor ability, has implications for intervention strategies employed in academic settings. Poor fine motor coordination can present a particular problem to the adolescent in the academic environment. Geuze and Börger (1993) have reported that adolescents with DCD have more frequently repeated a grade by the time they reach middle school. A result not altogether unsurprising, since effective participation in the academic setting requires the adolescent to be able to take notes quickly and efficiently, and to complete essays and assignments by hand (Cantell et al., 1994; Rose, Larkin, & Berger, 1997), tasks requiring fine motor coordination.

The results of this study suggest that this may become a particular problem for male adolescents, especially since the motor problems found in adolescents with DCD more consistently involve tasks of manual dexterity (Geuze & Borger, 1993). Timely and careful intervention is therefore necessary to ensure that minimal disruption to academic life is encountered. Future research may benefit from the examination of this differential relationship of fine and gross motor ability in younger males and females. If similar patterns of deficit can be identified in childhood, appropriate, specific intervention strategies can be developed. Early intervention is essential when one considers the research that has demonstrated the deleterious impact that low movement ability will have upon self-worth in adolescent life (Skinner & Piek, 2001).

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