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Motor coordination, empathy and social behaviour in school aged children

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## **Summary**

Children with motor coordination problems are known to have poor social skills and emotional difficulties. The current study investigated whether children with poor motor ability have poorer emotion recognition skills and whether these could be linked to problems in social behaviour. It was hypothesised that difficulties in empathic ability may be related to the poor visual-spatial processing ability identified in children with Developmental Coordination Disorder (DCD: APA, 1994). Two groups of 39 children each, one with motor difficulties, the other control children matched on age and gender, were compared on a set of six emotion recognition scales that measured both verbal and perceptual aspects of empathic ability. Children with motor difficulties were found to perform more poorly on scales that measure the ability to recognise static and changing facial expressions of emotion. This difference remained even when visual-spatial processing was controlled. The relationship between motor coordination, emotion recognition and social behaviour was further examined in a sample of 234 typical children aged between 6 and 13 years of age. When controlling for emotion recognition and visuo-spatial organisation, a child's motor ability remained a significant predictor of social behaviour.

**Shortened title: Motor coordination and empathy**

Motor skills play a critical role in a child's functioning in social and emotional domains. Studies have shown that poor motor coordination can impact on children's sense of competency, their success within their peer groups, their academic achievement and even their selection of recreational activities (Cantell, Smyth & Ahonen, 1994; Losse, Henderson, Elliman, Hall, Knight & Jongmans, 1991). The relationship between motor skills and social or emotional functioning is usually thought to be indirect. That is, poor motor skills may result in poor performance in individual and team games/sports, which may reduce a child's sense of competency. This in turn reduces success within peer groups, may reduce academic achievement (e.g., Cantell et al.), and increase the child's experience of anxiety and depression (Francis & Piek, 2003; Schoemaker & Kalverboer, 1994; Skinner & Piek, 2001). Alternatively, it is possible that the processes responsible for poor motor skills may affect social performance by reducing the child's ability to perceive socially relevant cues. This issue is addressed in the current paper.

Movement problems severe enough in children to interfere with daily living describes a disorder identified by the American Psychiatric Association (APA, 1994) as Developmental Coordination Disorder (DCD). The motor impairment is "below that expected given the child's age and intelligence", and cannot be attributed to a general medical condition. The prevalence of these motor problems has been estimated to be up to 6 percent of children between the ages of five and eleven years (APA).

According to Gillberg (1992), children with DCD and other disorders of attention, motor control, and perception commonly have empathic ability deficits, which may account for impaired social functioning. Empathic ability is one of several

generic terms that refer to the ability to “conceptualise other people’s inner worlds and to reflect on their thoughts and feelings” (Gillberg, 1992, p. 835). Empathy is seen from a developmental perspective as a basic building block of social interaction. It has been argued that empathic ability in children plays an important role in the development of moral judgment, pro-social behaviours and childhood social competence (Thompson, 1987).

Empathic ability is functionally dependent on several basic processes, including the ability to accurately perceive visual cues within interpersonal contexts (Dyck, Farrugia, Shochet & Holmes-Brown, 2004; Minter, Hobson & Pring, 1992). As a result, a child’s inability to accurately perceive visual or other sensory cues predictably limits the ability to decode and label the emotional expressions of other people, a key component in the ability to understand the experience of other people.

Children with DCD have a broad range of perceptual problems, including visuo-spatial processing (Coleman, Piek & Livesey, 2001; Lord & Hulme, 1987), kinesthetic processing (Piek & Coleman-Carman, 1995) and cross modal integration (Wilson & McKenzie, 1998). Based on the results of a meta-analysis by Wilson and McKenzie, the most substantial deficits appear to be in the area of visuo-spatial processing, often measured by complex visuo spatial tasks such as block design and object assembly subtests from the WISC-III intelligence tests (Wechsler, 1991). This deficit has been related to impaired emotion recognition ability (Dyck et al., 2004). If Parush, Yochman, Cohen and Gershon (1998) are correct in arguing that children with DCD reproduce pictorial designs incorrectly because they fail to visually perceive them accurately, it may also be the case that children with DCD will have particular difficulty in recognising facial expressions of emotion because the expressions were inaccurately perceived and decoded.

The first aim of the current study was to assess whether children with motor coordination problems have problems across a range of empathic abilities. We predicted that deficits were most likely to be observed on empathic ability tasks that place greater demands on perceptual processes, and especially on visual perceptual processes. Using the Emotion Recognition Scales (ERS: Dyck, Ferguson & Shochet, 2001), verbal and perceptual aspects of empathic ability can be measured separately. It was expected that tasks requiring more 'direct' perceptual processing such as emotion recognition tasks (facial cues, vocal cues) will be affected compared with other tasks (comprehension and vocabulary) which have a larger verbal component, and children with movement problems would display lower scores than their age matched peers in the control group. In their recent study, Schoemaker, Van der Wees, Flapper, Verheij-Jansen, Scholten-Jaegers and Geuze (2001) noted that children with DCD experience deficits in visual perception but also in other modalities such as proprioceptive and tactile perception. It was of interest in the current study to determine whether vocal cues, hence auditory perception, is also affected. Given that poor performance on the emotion recognition tasks requiring direct perceptual processing may be linked to the poor perceptual organisation of children with DCD, subtests from the WISC III performance IQ measure that assess visuo-spatial organisation were used as a covariate in a subsequent analysis to investigate this.

We further predicted that, in a representative sample of children, there would be a significant relationship between motor coordination, visuo-spatial processing and social behaviour. If processing deficits are primarily responsible for poor social skills, then, when perceptual organisation is controlled, the impact of motor ability on social behaviour would disappear. Social problems were measured by parent report of

social behaviour using the social subscale of the Child Behavior Checklist (CBCL; Achenbach, 1991).

## **Method**

### Participants

The participants were 234 children (113 boys, 121 girls) between 6.67 and 12.91 years of age. Participants were recruited from 42 schools in the Perth metropolitan region, which were chosen to represent the distribution of academic achievement within the state of Western Australia.

From the total sample, 39 children were identified as being within the range of movement identified for children with DCD. They scored at or below 80 on the McCarron Assessment of Neuromuscular Development (MAND; McCarron, 1982). This cut-off is stricter than the 15th percentile (NDI score of 84: Tan, Parker & Larkin, 2001), as recommended by Geuze, Jongmans, Schoemaker & Smits-Engelsman (2001). Twenty nine of these children had mild motor difficulties (scoring between 71 and 80), and 10 moderate motor difficulties (scoring between 70 and 55). None were identified with severe motor difficulties (<55).

All participants in both groups were required to have a Verbal IQ of 80 or above to exclude the impact of intellectual disability. Each group consisted of 17 females and 22 males (n=39). The mean age, VIQ, PIQ and MAND scores for each group are given in table 1.

Insert Table 1 about here

From the remainder, 39 children who scored at or above 100 on the MAND were selected for the control group. They were matched with the motor difficulty (MD) group on age and gender. None of the 78 children had previously diagnosed

neurological or behavioural disorders. Based on Geuze et al.'s (2001) recommendations, given that the children were all from mainstream schools and were in good health, there was no need to do a medical or neurological examination to ensure that criterion C of the DSM-IV diagnosis was met. An examination of the scores on the Child Behavior Checklist identified several children who scored within the range of a diagnosis. Specifically, for the children with movement problems, 1 was within the range of both internalizing and externalizing problems, two scored highly on the anxiety scale, 2 on the attention scale, 2 on the social problems scale and 1 on the delinquency scale. For the control group, 1 scored high on the delinquency scale and 1 on the somatic problems scale.

As it is difficult to operationalise, most studies investigating DCD have not measured whether the poor motor ability impacts on academic achievement or daily living (Geuze et al., 2001). Henderson and Barnett (1998) argue against the strict adherence of this criterion (B) of the DSM-IV diagnosis of DCD as “the inclusion of any such criterion detracts from the importance of motor competence in its own right” (p.461). Despite their criticism, we have chosen not to use the term DCD for the group of children identified here with movement difficulties (the MD group).

### Measures and Apparatus

*McCarron Assessment of Neuromuscular Development (MAND)*. The MAND is a standardised test of motor skills comprising 10 tasks, including five tests of gross motor skills and five tests of fine motor skills. These scaled scores are summed and then used to determine the Neuromuscular Development Index (NDI), which has a mean of 100 and a standard deviation of 15. The MAND has acceptable test-retest reliability (.67-.98), criterion validity and concurrent validity (McCarron, 1997).



*Wechsler Intelligence Scale for Children- 3<sup>rd</sup> Edition (WISC-III)*. The WISC-III (Wechsler, 1991) measures the general mental ability in children aged between six and sixteen years, eleven months. Performance IQ was estimated with the Block Design and Picture Completion subscales, which measure the ability to “interpret and organise visually perceived material” (Sattler & Saklofske, 2001, p. 232). Verbal IQ was estimated with the Vocabulary and Information subscales. The WISC-III is one of the most frequently used measures of intelligence in children, in both clinical and research populations (Sattler, 2001), and has excellent internal consistency, test-retest reliability, criterion and construct validity.

*Emotion Recognition Scales (ERS)*. Participants’ empathic ability was measured using the five subscales of the ERS (Dyck et al., 2001, 2004). The ERS include measures of emotion recognition (Fluid Emotions Test, Vocal Cues Test) and emotion understanding ability (Emotion Vocabulary Test, Comprehension Test, Unexpected Outcomes Test).

The Fluid Emotions Test (FET; Dyck et al., 2004) measures the ability to recognise static and changed/changing facial expressions of emotion. This is a computer-presented test and items are drawn from Matsumoto and Ekman’s (1995) colour slides of adults expressing one of seven emotions (e.g., anger, happiness) or a neutral expression. Each item consists of two pictures of a Japanese or Caucasian male or female expressing one of the seven emotions or a neutral expression. The participant is asked what emotion is being expressed in the first picture. After responding, the image is gradually (over 4 seconds) transformed to another person expressing a different emotion. Participants identify, as quickly as they can, the second emotion. Initial accuracy (ACC-1; initial emotions correct); and speed given accuracy (SGA; the speed of accurate post-morph responses) were measured.. These

scales are internally consistent (ACC-1,  $\alpha = .90$ ; SGA,  $\alpha = .94$ ), have good concurrent validity (Dyck et al., 2004), and are useful in identifying empathic ability deficits in children with autism spectrum and non-spectrum disorders (Dyck et al., 2001).

The Vocal Cues Test (VCT; Dyck et al., 2004) measures the ability to recognise vocal intonations specific to different emotions. The VCT “Unreal” scale consists of 43 items in which emotions are expressed using non-semantic content: numerals, letters, nonsense syllables. The emotions sampled are identical to those in the FET. Responses are scored correct (1) or incorrect (0). This scale is internally consistent ( $\alpha = .93$ ) and has good concurrent validity (Dyck et al., 2004).

The Emotion Vocabulary Test (EVT) measures the ability to define emotion words (e.g., what does the word “angry” mean?). The response format of the EVT is open-ended and initial responses may be queried in order to resolve ambiguities in the initial response. The EVT is internally consistent ( $\alpha = .82 - .89$ ), moderately related to other ERS, and strongly related to other measures of vocabulary (Dyck et al., 2001, 2004).

The Comprehension Test (CT) measures the ability to understand the emotional consequences of exposure to an emotion-eliciting context (e.g., Susan is given a new bicycle for her birthday. What will Susan feel?). CT items sample the seven emotions in the FET, ‘social variants’ of emotions (e.g., pride, shame) and variations in the intensity of emotions (e.g., terror versus fear). Emotion causes include ‘material causes’ (e.g., loss/gain of an object), ‘social causes’ (e.g., interpersonal rejection), and ‘intrapsychic causes’ (e.g., failure to achieve one’s goals). The CT has acceptable reliability ( $\alpha = .64 - .79$ ) and is moderately related to other ERS and to measures of intelligence (Dyck et al., 2001, 2004).

The Unexpected Outcomes Test (UOT) measures the ability to apply reasoning skills and knowledge of the causes of emotions to explaining apparent incongruities between an emotion-eliciting context and the emotion elicited by the context. UOT items provide information about a situation that is likely to cause an emotional response in a protagonist (e.g., “John likes a girl called Susan, and he wants her to go to the movies with him. When he asks her, she says yes”). Items then indicate what emotion has been experienced (e.g., “On their way to the movies, he is very angry”). In each case, the emotion differs from what is usually expected to occur in the situation. The child is asked to explain the apparent incongruity. The UOT has adequate reliability ( $\alpha = .73 - .81$ ) and is moderately to strongly related to other ERS and to measures of intelligence (Dyck et al., 2001, 2004).

*Child Behavior Checklist (CBCL; Achenbach, 1991)*. This is a standardised questionnaire designed to measure internalising and externalising behaviour problems in children aged 4 to 12 years. The parent form of the CBCL was used, where parents indicated the presence and degree of each of 113 child behaviours which are grouped into 8 subscales. The social subscale, consisting of 8 items, was used in the current study as a measure of social problems.

### Procedure

This project adhered to the ethical guidelines set out by the National Health and Medical Research Council of Australia. Children in grades 2 to 7 in Perth primary schools were invited to participate in ‘Project KIDS’ which is a large-scale, long running project in which data are collected for child-related research in school holiday periods. Therefore, the data relevant to the current study were collected along with information pertaining to other projects.

Principals were contacted by mail seeking permission to contact parents via the school to recruit children. Parents who gave permission for their child to participate returned the completed registration and consent form in the prepaid envelope. A letter confirming enrolment was then sent to parents with a CBCL form to complete and return as soon as possible in the prepaid envelope supplied. .

Children were allocated to one of 20 groups, each consisting of up to 12 participants. Each group was tested on a separate day. In order to maintain the children's interest and motivation, and to maximise their enjoyment, children were provided with a scenario at the beginning in which their job was to colonise a fictional planet. For each puzzle or game (test) completed, participants were given coloured tokens that could then be redeemed for items that could be used to colonise the planet at the end of the day. Testing was conducted in three 90-minute sessions. The first test session was followed by a 30-minute recess, and the second by a 60-minute lunch break. Testing was administered by a team of researchers conducting related studies with the data collected. Order of test administration was not uniform, with each child having his/her own schedule.

## **Results**

### *Motor coordination and empathic ability*

Means and standard deviations for each of the six ERS scales for the two groups are given in Table 2. Multivariate ANOVA was used to assess whether children with poor motor coordination also have empathic ability deficits. The results indicated that the two groups differed on the linear combination of variables [ $\Lambda(6, 71) = .79, p = .010$ ]. Univariate tests showed that the multivariate result is mainly due to

the lower scores of the MD group on the two scales measuring recognition of facial emotion cues [ACC-1:  $F(1, 76) = 8.85, p = .004$ ; SGA:  $F(1, 76) = 11.30, p = .001$ ].

Insert table 2 about here

Because the two groups are known to differ on the subtests of Performance IQ, we assessed whether the group differences on the empathic ability measures are attributable to the performance IQ difference by conducting a multivariate analysis of covariance in which Block Design and Picture Completion scores were entered as covariates. The results indicate a significant effect remained for the main between-group factor [ $\Lambda(6, 69) = .74, p < .002$ ]. The univariate analyses show that Block Design was significantly related to a measure of recognition of facial emotion cues [SGA:  $F(1, 74) = 5.509, p = .022$ ]. When effects due to the covariates were controlled, the group with poor motor control continued to obtain significantly lower scores on the two measures of the ability to recognise facial emotion cues [ACC-1:  $F(1, 74) = 9.973, p = .002$ ; SGA:  $F(1, 74) = 14.99, p = .0002$ ], and also on one measure of emotion understanding [UOT:  $F(1, 74) = 5.43, p = .022$ ].

### *Social problems*

Hierarchical regression was used on the total sample of 234 children to investigate the relationship between social problems and motor ability (NDI) when performance IQ, the six emotional recognition tasks and other relevant variables were taken into account (table 3). Only those variables that were significantly correlated with NDI and/or social problems were included. Social problems and NDI were found to be negatively correlated ( $r = -.26, p < .01$ ). Age and Verbal IQ were found to correlate

with the NDI score, and were entered into the regression equation on the first step. This was statistically significant ( $R^2 = .031$ ). On Step 2, Performance IQ plus the six ERS measures were entered and were found to have a significant effect ( $R^2_{\text{Change}} = .064$ ). When NDI was entered in the last step, it was found to be a significant predictor of social problems once the other variables were accounted for ( $R^2_{\text{Change}} = .057$ ).

Insert table 3 about here

## **Discussion**

While it has been established by Dyck et al. (2001) that children with other childhood disorders such as Asperger's disorder and Attention Deficit Hyperactivity Disorder (ADHD) display deficits in empathic ability, this is the first study to demonstrate that children with poor motor coordination are less competent in the ability to recognise emotions. As such, the current study provides support for Gillberg's (1992) contention that DCD should be recognised as an "empathy disorder". However, the fact that the delay in acquiring empathic ability was specific to recognizing facial expressions of emotions, and not to the ability to recognise vocal emotion cues or to understanding emotions, suggests that to regard DCD as an empathy disorder would be an inaccurate generalisation. The finding that children with poor motor coordination have more difficulty recognising facial cues of emotions yet display no differences in conceptually understanding emotions strongly support Cutting and Dunn's (1999) argument that emotion recognition and understanding tasks reflect different aspects of social cognition. It should be noted that once

performance IQ was controlled, a difference between the groups was identified for the unexpected outcomes test. This was a surprising outcome.

The present study has shown that children with motor coordination problems are less accurate and slower in responding to facial emotion cues. This finding is clearly valuable when considered in the context of a child's social functioning within their peer group. Lemerise and Arsenio (2000) postulated a model of social information processing in which they argued a child's perceptual ability is vital in detecting and interpreting social and affective cues from others. These findings suggest that children with DCD may be disadvantaged in the ongoing social process with their peers as they may have more difficulty detecting the emotional states of others and using this information to guide their behaviour in social contexts.

Children's level of motor ability was negatively correlated with social problems. It was argued that these problems may be related to the child's inability to appropriately process social and affective cues. However, through hierarchical regression analysis, it was found that when perceptual organization and emotional recognition measures were controlled, motor ability continued to predict social problems. Therefore, although perceptual deficits may be partially responsible for poorer social functioning such as poor peer relations, isolation and lower self perception (Cantell et al., 1994; Losse et al., 1991; Skinner & Piek, 2001), it is clear that other unknown factors contribute to the child's ability to function in complex social situations.

While the present study has yet to explain the exact nature of the relationship between empathic abilities and motor coordination, it has shown children with motor coordination problems do have specific deficits in empathy. The findings related to deficits in recognition of facial emotion cues support the notion that children with

DCD may be disadvantaged in the social domain, which in part may account for their established social and academic problems in childhood. These findings also have implications for selection of treatment of motor coordination problems. Mandich, Polatjko, Macnab and Miller (2001) reviewed the range of treatments available for children with DCD and they noted that the lack of an established causal mechanism to explain all motor coordination problems resulted in the type of treatment provided being based upon differing theories of motor development and learning. Given the findings in the current study, consideration of treatment options may need to include enhancing both the physical and social skills of children with DCD in order to improve the level of age appropriate functioning.

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Table 1: MD (n= 39) and Control (n= 39)Group sample profiles for age, Verbal IQ, Performance IQ and MAND scores (NDI).

|                      | <b>Age<br/>(Years)</b> | <b>Prorated<br/>Verbal IQ</b> | <b>Prorated<br/>Performance IQ</b> | <b>MAND<br/>NDI Scores</b> |
|----------------------|------------------------|-------------------------------|------------------------------------|----------------------------|
| <b>MD Group</b>      |                        |                               |                                    |                            |
| <b>Mean</b>          | 9.89                   | 112.0                         | 111.4                              | 72.71                      |
| <b>SD</b>            | 1.97                   | 16.68                         | 18.31                              | 7.24                       |
| <b>Range</b>         | 6.91-12.91             | 83-145                        | 79-146                             | 55-80                      |
| <b>Control Group</b> |                        |                               |                                    |                            |
| <b>Mean</b>          | 9.99                   | 113.6                         | 117.9                              | 112.05                     |
| <b>SD</b>            | 1.99                   | 14.52                         | 15.97                              | 9.98                       |
| <b>Range</b>         | 6.91-12.91             | 83-151                        | 87-155                             | 100-155                    |

**Table 2:** Means and standard deviations of scores on the emotion recognition tasks for the MD and control groups.

|      | <b>MD Group</b> |           | <b>Control Group</b> |           | <b>Significance</b> |
|------|-----------------|-----------|----------------------|-----------|---------------------|
|      | <b>Mean</b>     | <b>SD</b> | <b>Mean</b>          | <b>SD</b> |                     |
| ACC1 | 18.33           | 3.14      | 20.41                | 3.02      | <b>.004</b>         |
| SGA  | 77.02           | 19.82     | 94.54                | 25.80     | <b>.001</b>         |
| VCT  | 19.87           | 5.42      | 21.61                | 4.42      | .124                |
| EVT  | 10.23           | 4.27      | 10.74                | 5.11      | .632                |
| CT   | 9.36            | 2.65      | 10.15                | 2.32      | .163                |
| UOT  | 6.23            | 3.31      | 7.71                 | 4.26      | .090                |

**ACC1:** Total pre-morph emotions correctly identified, **SGA:** Speed given accuracy, **VCT:** Vocal Cues test, **EVT:** Emotion Vocabulary test, **CT:** Comprehension test, **UOT:** Unexpected Outcomes test.

Table 3. Heirarchical regression analysis examining the predictors of social problems (N=234).

|        | Predictors  | $\beta$   | R Square Change | F <sub>Change</sub> | df    | P    |
|--------|---|---|-----------------|---------------------|-------|------|
| Step 1 | Age<br>Verbal IQ  | .080<br>-.149*  | .031            | 3.33                | 2,211 | .038 |
| Step 2 | Age<br>Verbal<br>PIQ<br>ACC1<br>SGA<br>VCT<br>EVT<br>CT<br>UOT        | .327**<br>.014<br>-.074<br>.080<br>-.194*<br>-.025<br>-.226*<br>.028<br>-.102           | .064            | 2.073               | 7,204 | .048 |
| Step 3 | Age<br>Verbal<br>PIQ<br>ACC1<br>SGA<br>VCT<br>EVT<br>CT<br>UOT<br>NDI | .259*<br>-.005<br>-.049<br>.086<br>-.119<br>-.001<br>-.226*<br>.039<br>-.094<br>-.254** | .057            | 13.645              | 1,203 | .000 |

\*p<.05, \*\*p<.01