THE DEVELOPMENTAL COORDINATION DISORDER QUESTIONNAIRE 2007 (DCDQ'07)©

Administration manual for the DCDQ'07 with psychometric properties

www.dcdq.ca

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Acknowledgements

The purpose of this report is to provide evidence on an instrument, the Developmental Coordination Disorder Questionnaire (DCDQ), used to identify children with Developmental Coordination Disorder (DCD). With the improvements made to this instrument, more children who experience these motor challenges can receive increased support. The impetus for the revision of the DCDQ, and for this manual, is due to the continued collaboration and professional support provided to me over many years from many colleagues --most importantly, Nancy Pollock, Cheryl Missiuna and Dido Green. They have acted as advisors, giving freely of their time and sharing their valuable experience. I sincerely thank them for their ongoing support. I am also grateful for the opportunities to partner with Gwen Roberts and Loralie Clark over the years. The Behavioural Research Unit at Alberta Children's Hospital supported the development of the original DCDQ and of this revision, which has been very much appreciated.

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SECTION I

Introduction

The original version of the Developmental Coordination Disorder Questionnaire (DCDQ) was first published in 1999 and reported in the American Journal of Occupational Therapy in 2000 (Wilson, Kaplan, Crawford, Campbell, & Dewey, 2000). After several years of widespread use and translation into several other languages, a second study to revise and re-validate the questionnaire was undertaken in 2004. This resulted in the current version of the questionnaire, which is known as the DCDQ'07 and is considered to be a more robust instrument (Wilson, Crawford, Green, Roberts, Aylott, & Kaplan, 2009). Scientific information and evidence on the use of the questionnaire refers to the DCDQ'07, although the questionnaire that is given to parents is known as the "Coordination Questionnaire".

The following section will outline general information about administering the questionnaire, followed by frequently asked questions (FAQ's). Studies supporting the recommendations here are referenced and found at the end of this section.

Administration of the DCDQ'07

Using the Coordination Questionnaire with Families

To avoid parents being concerned that a medical condition is being evaluated, the questionnaire is labelled "The Coordination Questionnaire". It is recommended that this two page questionnaire be copied double sided, and that the parents receive only one sheet, **without** the score sheet.

Prior to Administration

Before giving the questionnaire to a parent, it is recommended that a contact name and phone number be written into the space on the first page so that parents can call if they have questions about the meaning of an item. Should questions of this nature arise, this contact person should be knowledgeable about DCD, or know to whom to refer the question. The validity of the results will be increased if parents have the opportunity for clarification.

It is recommended that the two page questionnaire be *copied double sided*. The Score Sheet *on the fourth page should be kept separate* from the questionnaire itself. It is recommended that parents are **not** given the Score Sheet.

Time to Complete

The DCDQ'07 usually takes parents about 10-15 minutes to complete. As much as possible, arrange for the parent completing the questionnaire to do so in a non-distracting environment.

Respondents

This questionnaire was developed for parents, as parents know their children the best and can reliably report developmental problems. Only the data from parent report was used to develop the scoring system; therefore, the DCDQ'07 is intended to be used with parents.

However, clinicians and researchers are experimenting with having both parents, or one parent and the child's primary school teacher, complete it. Sometimes two or more respondents have completed the questionnaire separately, but in other situations they have conversed while completing one form. Although the inter-rater reliability appears to be satisfactory, no conclusive studies have been done.

When the perspective of two adults gives a more complete or more accurate evaluation of the child's motor performance, this practice is likely to increase the validity of the score. However, it must be remembered *that the scores were developed solely on parent response*, so if the respondents have divergent opinions on the child's performance, or if the two forms have very different scores, the parent's score should be the one reported. The fact that others who know the child score the items differently can be noted but it would be inappropriate, for example, to use the score of a teacher or coach alone when interpreting the results of the DCDQ'07.

Written or Verbal Administration

During the development of the original DCDQ, parents were given the choice of completing a paper version of the questionnaire on their own, or of completing it over the phone along with the interviewer while they read their paper copy. For the DCDQ'07 study, most parents completed a paper copy independently but a small proportion completed it with an occupational therapist. All of these methods of completion, *independently, with a professional, or over the phone,* are valid forms of administration.

If English is the second language, or if the parent's reading ability is not clear, reading the questions to the parent and helping them respond is important for validity of the results.

After Parent Completion

When the DCDQ'07 is completed, the clinician or researcher should review it for missed items or items where more than one score is circled. Ask the parent for clarification, if needed.

Note: A total score can only be calculated if *all* items are scored. Missing one score will prevent you from obtaining a total score and having an indication of DCD.

If the parent does not know how to grade an item, or has not seen their child perform a particular activity, ask them if there is any one else who would know (e.g., the other parent, a caregiver, a teacher or a coach). Ask if the parent can make an arrangement to consult that person about the child's ability, or if they will give you permission to do so before the questionnaire is completed.

Scoring the Revised DCDQ'07

Computing the Chronological Age

Enter the date that the DCDQ was completed and the child's date of birth (D.O.B.) on the first page of the questionnaire. Compute the chronological age by subtracting *(first)* the days, then the month and *finally* the year of birth. For example, if the questionnaire was completed on March 21, 2007, and the child was born on February 2, 2000, the child's chronological age would be calculated as shown in this table:

	Yr	Mon	Day
DCDQ completion	2007	03	21
Child's D.O.B.	2000	02	02
Chronological age	7 yrs	1 mon	19 day

	Year	Month	Day
DCDQ completion	~~2007~~ 2006	14 ~~02~~ ~~03~~	51 ~~21~~
Child's D.O.B.	2000	06	28
Chronological age	6 years	8 month	23 days

If the day of the month in which the child was born is larger than the day of the month of questionnaire completion, add 30 days to the day of testing and subtract one month from the month of testing. Similarly, if necessary, a month of testing can be borrowed by adding 12 months to the month of testing and subtracting one year from the testing year, as shown above in the table on the right.

Computing a Total Score

Re-enter the numbers circled for all items of the questionnaire onto the Score Sheet (fourth page).
Total each column to compute the three Factor Scores.
Add all Factor Scores to compute a Total Score.
Double check your addition.

Interpretation of Scores for the DCDQ'07

Using the child's chronological age at the time the questionnaire was completed; find the appropriate age grouping on the left column of the table on the next

page. Scan across that row to find the range of scores which the child's score falls. This range will indicate whether the child's score is an "Indication of, or Suspect for, DCD", or "Probably not DCD".

Age Group	**Indication of, or Suspect for, DCD**	**Probably not DCD**	**Sensitivity and Specificity**
5 years 0 months *to* 7 years 11 months	**15 - 46**	**47 - 75**	Sensitivity=75.0% Specificity=71.4%
8 years 0 months *to* 9 years 11 months	**15 - 55**	**56 - 75**	Sensitivity=88.6% Specificity=66.7%
10 years 0 months *to* 15 years	**15 - 57**	**58 - 75**	Sensitivity=88.5% Specificity=75.6%
Overall sensitivity and specificity <u>adjusted for age</u> (using the age related cut-off scoresabove)	Cut-off scores for each age group, as shown above: Sensitivity =84.6% Specificity =70.8%		

<u>Sensitivity and Specificity</u>

It is sometimes desirable, especially when a finding is not clear, to report the sensitivity and specificity of the test scores. The most accurate predictive values of the DCDQ`07 are reported in the table above according to the different age ranges. However, if overall values for the questionnaire are required, the overall sensitivity is 84.6% and the specificity is 70.8%.

Sensitivity is the degree of accuracy that an instrument identifies children with the condition.
Specificity is the degree of accuracy in identifying children who do not have the condition.
Predictive Values include sensitivity and specificity.

The purpose of a screening instrument is to identify whether a child has a particular condition. Rarely is a screening tool alone100% accurate in identifying all of the children with a condition, while at the same time not falsely identifying any children without the condition.

When evaluating a screening tool such as the DCDQ`07, the degree of accuracy in identifying children with possible DCD (sensitivity) must be compared to the accuracy in correctly identifying children who do not have the condition (specificity). This "trade off" is common to all diagnostic tests because when one of these predictive values increases, the other decreases. By design, the DCDQ'07 is most accurate in identifying children who may have DCD. It may identify

children who do not have the condition, but further motor testing should reveal whether DCD is indeed present.

Factor Scores

The DCDQ'07 consists of 15 items, which group into three distinct factors. The first factor contains a number of items related to motor control while the child is moving, or while an object is in motion, and is labelled "Control during Movement". The second factor contains "Fine Motor and Handwriting" items and the third factor relates to "General Coordination". These factor scores alone do not provide an indication of whether the child may have DCD. However, when the scores of each of the factors are examined relative to the scores of the other factors and when they are then compared with formal and informal assessment results, these factor scores offer supporting evidence for the identification of particular motor strengths and challenges a child is experiencing.

Distribution of Scores

The total score for the revised, 15-item version of the DCDQ'07 ranges from 15 to 75. It has a mean of 61.79 with a standard deviation of 10.21.

How to Report the Results of the DCDQ'07

As outlined above, the DCDQ'07 cannot be used alone to identify DCD. When using the questionnaire in a verbal or written report about a child, the terms "indication of possible DCD", "suspect for DCD", or "probably not DCD" should be used. A diagnosis of DCD cannot be made by this test alone.

How the results of the DCDQ'07 are reported depends partly on the reason it was used:

> As a screening tool for DCD, a statement to accompany a low score on the questionnaire might read:
> *"the results of the parent-completed Developmental Coordination Disorder Questionnaire (DCDQ'07), a measure developed to screen for DCD, suggests that this child has more difficulty with motor skills than his/her peers. Standardized motor testing confirms this or should be completed to confirm this."*

> As part of a multiple procedure assessment for the diagnosis of DCD, a statement to accompany a low score on the questionnaire might read:
> *"the results of the parent-completed Developmental Coordination Disorder Questionnaire (DCDQ'07), a measure which provides an indication of children's everyday motor functioning at home, at play and at school, indicates that this child struggles in essential day-to-day activities that children must participate in to learn and to become more independent. The score of ___ would meet Criterion B of the DSM-IV requirements for a diagnosis of DCD".*

As part of an assessment of daily living skills, a statement to accompany a low score on the questionnaire might read:

"The parent-completed Developmental Coordination Disorder Questionnaire (DCDQ'07) is a measure of specific motor tasks and activities which a child would typically encounter in daily life. The score of ___ indicates that this child struggles to successfully participate in daily activities.

Three scenarios concerning the clinical use of the DCDQ'07 can be found at the end of Section I.

Frequently Asked Questions

Does it make a difference if the mother or father completes the questionnaire?	Many clinicians believe that mothers and fathers will have different perspectives of the answers given on the DCDQ; however, no studies have indicated how these different perspectives might influence the score on the DCDQ. The questionnaire could be administered to both the mother and father, scores on each item compared, and then differences discussed and adjusted to obtain a score that accounts for both perspectives.
Can a teacher complete the DCDQ?	Because the cut-off scores for the DCDQ were developed using parent report, it is recommended that parents and teachers complete the questionnaire together if the perspective of the teacher is being sought. Several studies have been recently completed in which teachers have completed the DCDQ. Although parent and teacher report of motor skills have not demonstrated high levels of agreement, Keijsers, et.al. (2009) found that teacher report using the DCDQ correlated more highly with the Movement Assessment Battery for Children (MABC) than did parent report. Monteiro, et. al. (Under Revision) developed two Greek adaptations of the DCDQ for use with teachers (n = 10) and parents (n = 89), and found that relative agreement for individual items was high but overall correlation was not significant ($p = 0.056$). Teacher report was significantly related to MABC scores, but correlation between the MABC and the parent completed DCDQ was not significant.
When is the best time to give the DCDQ?	Some clinicians give the questionnaire at the time of referral for a motor problem in order to provide direction on what assessments may be most useful. Others combine it with a standardized assessment, or use it following assessment to confirm the results of standardized tests. A range of information may be gained when used at different times
Do the results of the DCDQ always agree with other tests?	By design, the DCDQ is structured to identify more children than most normative, standardized tests of motor skills. In this way, it acts like a "coarse sieve" to

	screen and identify children who may have problems. It is more likely to over-identify children than to miss a child who has a problem (Schoemaker et al., 2006). Use of standardized tests will confirm the presence of motor deficits in the event that the DCDQ over-identifies a problem. It is also important to remember that the DCDQ measures performance in day-to-day skills, which is different than the "snap-shot" of motor performance measured with standardized tests. The test is therefore not expected to agree highly with standardized tests; research has confirmed that this is true for the DCDQ as well as for other parent and teacher questionnaires.
Can the DCDQ be used before and after treatment as an outcome measure?	The DCDQ was used as an outcome measure in an intervention study in the United Kingdom, and its effectiveness is reported in Green and Wilson (2008), (the summary can be found in Section III). The questionnaire can measure progress, although parent perceptions of their children's challenges are often different than the scores from standardized testing or from the child's perception, which raises the question of whose perception is the most valid.
What is the test-retest reliability of the DCDQ?	Although the recent re-validation study did not include a measure of test-retest reliability, other researchers have measured this property. Tseng, Fu, Wilson and Hu (2010) and Prado, Magalhaes and Wilson (2009) have found high reliability (0.94 and 0.97 respectively).
How often can the DCDQ the administered?	In the Green and Wilson (2008) study, the DCDQ'07 was administered every six months for two and a half years, without any signs that the repeated administration influenced parents' perceptions. Some clinicians repeat the questionnaire following treatment, usually within six to ten months. We believe it can be re-administered within a 3 to 6 month period, but have not studied this specifically.
Why are the last 2 questions on DCDQ worded in the negative?	The original DCDQ had 17 items, and half were worded in the negative. Over the 10 years it was in use, we found two common problems: first, some parents (between 5 and 10 percent) did not notice that

	the wording changed from the positive statements on the first page to the negatively-worded statements on the second page. They continued to mark items with the same scores (e.g., 4 or 5) as they did for the first half of the questionnaire. This resulted in an invalid score, but one that the average clinician may neither notice nor account for. Secondly, when negatively worded statements are used, it is necessary to reverse the scoring before computing the final score. We found that some clinicians had difficulty doing this recalculation, which would, again, produce an invalid score. In the re-validation study, we tried to introduce new, positively worded statements to replace the negative ones. While this was successful with some items, there were two phrases which 'performed' very strongly (i.e., strongly contributed to the total score) as they were originally written: "bull in a china shop" and "fatigue". In order to include these items without having to reverse their scoring, they are written in the double negative.
Can the DCDQ be used with children under five years of age?	Although the sample of children in the re-validation study included a few children who were in kindergarten but were not yet five years of age, there were too few to recommend the use of the DCDQ'07 for children under five years. A new questionnaire is in the process of being developed for three and four year old children (Rihtman, T., Wilson, B.N., Parush, S. (2011) Development of the Little Developmental Coordination Disorder Questionnaire for Preschoolers and Preliminary Evidence of its Psychometric Properties in Israel. Research in Developmental Disabilities. 32(4):1378-1387)
Are there any characteristics or attributes of parents which may affect the way they report on their children's motor skills?	There many things that might affect how a parent answers the questions on the DCDQ. Their knowledge of normal child development and whether they regularly observe their child in play or organized motor activities are obvious factors. Whether parents are reluctant to have "labels" applied to their child, compared to whether they are hoping to get a diagnosis and support for their child, will also influence how they answer. And the age of the child might also influence a parent's motivation and "energy" level, especially if they have been searching

	for help for a period of time. Semi-structured interviews can help determine if the score on the DCDQ seems to be an accurate reflection of the child's abilities. An example of this technique is given in the article by Missiuna et al. (Missiuna et al., 2008).
Can the questionnaire be used with children who have Attention Deficit and Hyperactivity Disorder (ADHD)?	The DCDQ can definitely be used with children who have other developmental conditions. The results, combined with other test results, may assist the professional in learning whether challenges in motor skills are the result of poor motor coordination or are due to poor attention to the task, or perhaps both. Scores for the DCDQ'07 were developed using logistic regression modelling, which took into account the factors of age, gender and the presence of ADHD. The presence of ADHD was *not* associated with the DCDQ'07 score, indicating that there is little bias when using this questionnaire with children who have ADHD. One unpublished study (Wilson, Crawford, & Green, 2009) found that children with both ADHD and DCD performed lowest on both the Movement Assessment Battery for Children (MABC) (Henderson & Sugden, 1992) and on the DCDQ, but children with ADHD alone performed much like typically developing children. However, children with ADHD – whether DCD is present or not – had overall low scores on the DCDQ Total Score. Children with ADHD alone scored within normal limits on the Control During Movement Factor. On the DCDQ, the overall score was unaffected by attention problems, but the profile of individual DCDQ factor scores showed that parent report could differentiate children with ADHD from the others on one factor: Control During Movement. This may help differentiate the attention issue from the coordination issue. Standardized assessment appears minimally affected by attention deficit alone: children with ADHD-only performed much like controls on the MABC. A multifaceted approach should be used to ascertain

	whether children's motor scores are related to true movement difficulties or to attention issues in order to determine the best intervention.

Scenarios Demonstrating the Use of the DCDQ'07

Use of the DCDQ'07 as a Screening Tool

Terry is a ten year old boy identified as having challenges with printing legibly, reduced participation in social activities at school, and poor coordination in his physical education program. He has been diagnosed with Asperger's syndrome as well as a learning disability. His verbal IQ is significantly higher than his performance IQ. He is a student who likes to please people. Therefore, building a strong working relationship with Terry was critical, as well as open communication with his parents.

The DCDQ'07 was given to the parents to complete prior to standardized testing to clarify the impact his motor incoordination had on his overall performance at school and within his community. His score was 49, which indicated possible DCD. Assessment results supported this finding:

- Movement Assessment Battery for Children (MABC): score at the 1st percentile
- Visual-Motor Integration (VMI): performance below average. Two supplemental tests identified visual perceptual skills that were average and motor coordination that was below average for a student his age.
- Sensory Profile – School Companion: definite differences with registration and seeking as well as processing visual and movement sensation.

A diagnosis of Asperger's syndrome alone did not identify the specific recommendations and accommodations that would support Terry in the classroom setting. Parents were encouraged to share the findings of this evaluation with his teacher to find appropriate accommodations at school. Parents were also encouraged to share the findings with their son's paediatrician to discuss the potential for further evaluation or diagnosis that might benefit Terry.

Use of the DCDQ as part of a Motor Assessment

Ian is a five year old attending a kindergarten program. He struggles with attention to tasks in the classroom and with participation in games and free play with other children. On referral to school therapy services, the following assessments were completed:

- MABC: decreased attention prevented administration of this test in the standardized format. Informal results suggested motor incoordination in several areas.
- VMI: very low overall performance score, with low performance on the visual perceptual supplemental test and very low performance on the motor coordination supplemental test.
- Sensory Profile – School Companion: challenges with processing all sensory information. His teachers assessed these challenges to negatively impact on his performance in the school setting.

The DCDQ'07 was then completed by Ian's parents to confirm that the observations made at school, within the testing environment, were consistent with the parent's observations in a non-structured day-to-day environment. Ian's score of 42 indicated possible DCD. In addition, the parents' experience of completing the DCDQ'07 gave them information that influenced their participation in following therapy recommendations at home and increased their confidence to advocate for their son at school. Standardized testing was inconclusive as Ian was found to be a complex student. Further evaluation was recommended when Ian's level of attention improved. Parents were encouraged to share this information with their paediatrician, as this student presently did not have a diagnosis of DCD.

<u>Interpretation of the DCDQ in relation to other test results</u>

Alison is a Grade 4 student who is considered by her teachers to be a very bright student in many areas. However, her handwriting and organization skills are poor, which interferes with her grades and her ability to fit into classroom routines. Lately, she has begun to have headaches and to avoid coming to school; teachers notice that she has few friends and prefers to hang out with children from the Grade 2 class. They supported the parents when a referral to a developmental clinic was made by Alison's physician. At the clinic, the following assessments were completed:

- MABC: Alison scored in the 10th percentile.
- VMI: Alison's scores on all 3 tests were in the low-average range; it was observed that she was very frustrated completing the test and had a creative variety of reasons why her drawings were not of better quality.
- WISC-IV: Alison's performance placed her in the gifted range. Verbal scores were somewhat higher than performance scores, but the spread was less than 15 points.
- DCDQ'07: The score of 32 on the DCDQ, completed jointly by Alison's parents, indicated possible DCDQ. The parents had researched DCD, and were quite certain that this condition was Alison's primary problem.

Because most of the scores in this comprehensive assessment were within average range, the developmental assessment team was initially reluctant to give

a diagnosis of DCD or learning difficulty (LD). However, physical and neurological examination did not reveal any other cause for her coordination difficulties, and the teachers' and parents' reports of her struggles at home and in school (despite her obvious intelligence) were significant. Alison was experiencing stress and high levels of anxiety at school. When standardized tests were interpreted in light of her high IQ scores, then a diagnosis of DCD was seen as appropriate by the paediatrician. This diagnosis enabled Alison's parents to advocate for accommodations in the classroom and to give Alison the emotional and practical support she needed to feel better about her abilities.

SECTION II

Developmental Coordination Disorder (DCD)

Developmental Coordination Disorder (DCD) is one of the most common disorders amongst school-aged children (Wann, 2007). The Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR)(American Psychiatric Association, 2000) provides four criteria to classify a child as having DCD:

A. Performance in daily activities that require motor coordination is substantially below given the person's chronologic age and measured intelligence. This may be manifested by marked delays in achieving motor milestones (e.g., walking, crawling, sitting) dropping things, "clumsiness," poor performance in sports, or poor handwriting.
B. The disturbance in criterion A significantly interferes with academic achievement or activities of daily living.
C. The disturbance is not due to a general medical condition (e.g., cerebral palsy, hemiplegia or muscular dystrophy) and does not meet criteria for a Pervasive Developmental Disorder.
D. If mental retardation is present, the motor difficulties are in excess of those usually associated with it.

Despite having been a recognized childhood condition for the better part of a century, researchers and clinicians are still developing a consensus on methods of identification and effective approaches for remediation (Leeds Consensus Statement) (Sugden, Chambers, & Utley, 2006).

Assessment of DCD and Comparison of the Performance of Different Measures

A number of tools have been developed which focus on identifying the presence, and extent, of a movement skill deficit tested under clinical and standardized conditions, in order to meet requirements for a motor impairment as stipulated under Criterion A of the DSM-IV-TR:

"Performance in daily activities that require motor coordination is substantially below given the person's chronologic age and measured intelligence. This may be manifested by marked delays in achieving motor milestones (e.g., walking, crawling, sitting) dropping things, "clumsiness," poor performance in sports, or poor handwriting." (page 58)

Tests commonly used in North America include the Movement Assessment Battery for Children (MABC) (Henderson & Sugden, 2007; Henderson & Sugden, 1992); the Bruininks-Oseretsky Test of Motor Proficiency (BOT) (Bruininks & Bruininks, 2005; Bruininks, 1978) and the Beery-Buktenica Developmental Test of

Visual Motor Integration (VMI) (Beery & Buktenica, 1997; Beery, Buktenica, & Beery, 2003). However, no one instrument is considered to be the `gold standard` for the identification of DCD.

In contrast, fewer standardized measures are available to ascertain the impact of these movement problems on functional everyday home and school tasks, to determine whether Criterion B has also been met. Criterion B requires evidence of poor performance of daily living and academic skills, which must be measured within the context of the situation. Interviews (Geuze, 2007) and information from qualitative studies (Missiuna, Moll, Law, King, & King, 2006; Summers, Larkin, & Dewey, 2008a; Summers, Larkin, & Dewey, 2008b) are available, and several instruments have been developed for the identification of DCD by teachers (Faught et al., 2008; Hay, Hawes, & Faught, 2004; Henderson & Sugden, 1992; Rosenblum, 2006; Schoemaker, Flapper, Reinders-Messelink, & Kloet, 2008). Parent report has been found to be useful in the process of identification of developmental and movement difficulties (Bois, Sarrazin, Brustad, Trouilloud, & Cury, 2005; Glascoe, 1999).

The DCDQ'07 was developed to screen for the presence of motor problems and as an adjunct to standardized tests. Over the past 10 years, it has also proven to be a valid measure of everyday functioning, as outlined in Criterion B. While the DCDQ'07 should not be used alone to diagnose DCD, it can be used in conjunction with standardized tests and an examination by a physician.

Development of the Original DCDQ

Why was the DCDQ developed?

As part of the Alberta Mental Health Research Unit Award to the Behavioural Research Unit at the Alberta Children's Hospital, a large, descriptive study of learning and attention problems, which included specific movement skills, was carried out from 1992 to 1997. During the course of this 5 year study, the limitations of current standardized tests of motor skills and the lack of a "gold standard" upon which to base a diagnosis of DCD was observed. Concurrently, the value of parent report in detecting developmental concerns was well recognised (Bodnarchuk & Eaton, 2004; Glascoe, 2000). A parent questionnaire, the Developmental Coordination Disorder Questionnaire (DCDQ), was therefore developed with this convenience sample, (children referred for learning and attention problems) as well as typically developing children and adolescents matched for age, gender, and socioeconomic status.

Summary of research on the original DCDQ

As part of this broad study, a 35-item research version of the DCDQ was given to all parents of participating children, aged 8 through 14 years. Item validity and discriminant ability were examined. Various analyses including analysis of

variance, correlations, and Cronbach's coefficient alpha were used to reduce the DCDQ to the strongest 17 items, and to develop cut-off scores for three categories: DCD, Suspect for DCD, and non-DCD.

At the time, the DCDQ was the only existing parent report of motor skills available for the eight to 14 year age group. The final version of the questionnaire contained 17 items, with each item scored on a 5 point Likert scale, which compared a child's motor performance to that of his or her peers.

As reported in Wilson, Kaplan, Crawford, Campbell, & Dewey (Wilson et al., 2000), the internal consistency of the DCDQ was high (coefficient alpha of .88). Results of a discriminant function analysis showed that the questionnaire accurately identified 86% of the children with DCD and 68% of the total sample. Its performance was stronger for the identification of children *with* DCD than those without a motor coordination problem: this is appropriate for a screening tool. A factor analysis identified four distinct factors (Control during Movement; Fine Motor/Handwriting; Gross/Motor Planning; General Coordination).

Other studies of the test which provide additional evidence for the validity of the DCDQ are summarized in Section III.

Rationale for Further Validation and Revision

Following publication of the DCDQ in 1999, further studies of test consistency and divergent validity were examined and compared with evidence from its use in two clinical European studies (Green et al., 2005; Schoemaker et al., 2006). It became evident that the specificity and sensitivity of the questionnaire differed across settings and with different ages of children. In addition to the examination of the psychometric properties of any measure, the assessment of its clinical validity occurs over time with the continued use of the test. Fletcher, Fletcher and Wagner (Fletcher, Fletcher, & Wagner, 1996) state that:

> "Not infrequently, a new diagnostic test is described in glowing terms when first introduced, only to be found wanting later when more experience with it has accumulated… This kind of confusion – initial enthusiasm followed by disappointment – arises not from any dishonesty on the part of early investigators or unfair skepticism by the medical community later. Rather it is related to limitations in the methods by which the properties of the test were established in the first place… selection of diseased and nondiseased patients can profoundly affect the determination of sensitivity and specificity… Difficulties many arise when patients used to describe the test's properties are different from those to whom the test will be applied in clinical practice." (pp. 53-54) (Fletcher et al., 1996).

The inclusion of children referred for learning and attention difficulties in the original reference sample, rather than only typically developing children, was

justifiable at the time because of the large degree of overlap between DCD and other developmental problems. However, it appears that their inclusion affected the performance of the questionnaire in clinical settings. "Spectrum bias" occurred because the original sample differed from that of the population to which we wanted to generalize the results of the questionnaire. It became imperative to re-examine the validity and reliability of this test using a reference sample with a higher proportion of typically developing children. This would allow for examination of the test's sensitivity and specificity without the bias of over-inclusion of children with DCD.

Although it is sometimes thought that sensitivity and specificity are not affected by the prevalence of the condition, Goodman (Goodman, 1997) provides a wonderful working example of how these calculations are affected:

> Study X involves 100 children from a high-risk population with a true rate of psychiatric disorder of 50%; if the screening questionnaire has a sensitivity of .8 and a specificity of .8 when using the standard cut-off, the questionnaire will identify 40 true positives and 10 false positives. Study Y involves 100 children from a low-risk population with a true rate of disorder of 10%; even with the same sensitivity and specificity, the questionnaire will identify 8 true positives and 18 false positives. Despite using the same questionnaire and the same cut-off, a comparison of "cases" from studies X and Y will primarily be a comparison of true positives from study X with false positives from study Y. (Goodman, 1997)

In other words, the predictive value of any test is determined not only by its sensitivity and specificity but also by the prevalence of the condition, which may change from setting to setting. (Fletcher et al., 1996) The variable range of prevalence of DCD in the different samples that have been studied can affect sensitivity and specificity when classical measurement models are used. This could explain the low prevalence found for non-DCD children in the two studies done outside of Canada and could also explain why the sensitivity and specificity values they obtained differed from the original analysis, which had no children who were referred specifically for motor problems. Again, the use of a population-based reference sample was necessary to insure that the prevalence of DCD in the test development was closer to that in the general population.

These above factors provided the rationale for further study of the DCDQ, and for the incorporation of a typically developing reference sample for children, aged 5 to 15 years.

Revision of the DCDQ

Summary of Revision

A full report of the revision of the DCDQ is available on the DCDQ website (www.dcdq.ca) and is published in the journal "Physical and Occupational Therapy in Pediatrics":

Wilson, B.N., Crawford, S.G., Green, D., Roberts, G., Aylott, A., & Kaplan, B. (2009). Psychometric Properties of the Revised Developmental Coordination Disorder Questionnaire. ***Physical & Occupational Therapy in Pediatrics, 29(2):182-202.***

The purpose of the above study was to revise the DCDQ, which was originally developed for children aged 8 to 14.6 years, to accommodate a lower age group of children aged 5 to 7 years. The study aimed to clarify existing items and produce new items to enable the tool to be used by children across a larger age range. This was done by assessing the revised questionnaire and testing it with a group of children who had not been previously identified with developmental disorders. Cut-off scores which took into account age, gender, and attention problems were established. Internal consistency, construct validity and concurrent validity of the revised version were analyzed with a clinically referred population of children.

Rewording, addition and revision of items was undertaken by a clinical advisory committee consisting of five occupational therapists with experience with DCD. A 24-item version was then completed by 287 parents, of which 283 were used for analysis. Cronbach's alpha coefficient for the 24-item version was 0.90. After examination, the questionnaire was revised to include only 15 items. Cronbach's alpha coefficient was 0.89. To determine predictive validity and cut-off scores, the sample was extended to include the original population based sample, a second sample in Calgary and a clinical sample from England. Cut-off scores were determined for "DCD or Suspect DCD" and "No DCD". Strong internal consistency, construct validity and concurrent validity were demonstrated, confirming that the revised DCDQ'07 is an appropriate clinical screening tool for DCD in children aged 5-15 years.

Factor Analysis

Using varimax rotation, three factors emerged with Eigen values > 1.0. These factors accounted for 79% of the variance of the test score. The first factor had

items related to motor control while the child was moving, or while an object was in motion; it was labelled "Control during Movement". The second factor contained fine motor and handwriting/printing items. The third factor contained items related to general coordination. "Planning an activity" was the only item loading at > 0.50 on more than one factor, and it was placed with the factor labelled "Control during Movement".

Questionnaire Item	Component		
	Control During Movement	Fine Motor / Handwriting	General Coordination
1: Throw	.85		
2: Catches	.85		
3: Hits	.81		
4: Jumps	.81	.31	
5: Runs	.73	.38	
6: Plans	.62	.51	
7: Writes fast		.85	
8. Writes legibly	.30	.83	
9. Effort/pressure	.38	.77	
10. Cuts	.42	.75	
11. Like sports		.36	.78
12. Learning new			.77
13. Quick/competent		.35	.75
14. "Bull"			.77
15. Not Fatigue	.33		.73

Strengths of the Revised DCDQ'07

The DCDQ`07 presented here is considered to have stronger psychometric properties than the original 2000 version (Wilson et al., 2000) because it was developed with a population-based sample and has a larger age range. However, in order to develop scores for the younger children and to account for differences across the age ranges, the scores indicate two possibilities: either ``indication of DCD or Suspect DCD`` or ``Probably not DCD``. It was not possible to divide these two categories into the three categories of the original version. The decision of whether to use the original or the revised DCDQ'07 depends on the importance attached to having a `Suspect`` category rather than having scores that are more sensitive to age and gender differences, and the presence of DCD.

Comparison of the performance of the DCDQ to other measures of DCD

The American Psychological Association (APA) (American Psychiatric Association, 2000) sets standards for acceptable reliability and validity of psychometric instruments. Research on the DCDQ and this revision has been done to meet those standards of excellence. While some properties of the DCDQ are very strong (test consistency and the stability of the factors), some do not

meet the current standards. One of the reasons for this disparity is the heterogeneous nature of DCD; diagnosis of the condition is not as straight forward as a medical diagnosis of, for example, high blood pressure.

Study of the concurrent validity of the DCDQ'07 revealed only moderate but significant correlations with tests of motor skills: $r = -.55$ ($p < .001$) with the total impairment scores of the MABC and $r = .42$ ($p < .001$) with the VMI Standard Score. (The correlation with the MABC is appropriately negative as the two tests are scaled in opposite directions: high MABC impairment scores reflect poor performance.) Although these correlations are moderate, they are consistent with the range of correlations of .40 to .60 between other standardized tests of DCD (Barnett & Peters, 2004; Croce, Horvat, & McCarthy, 2001; Henderson & Sugden, 1992). Another area of concern is the relatively low specificity of the DCDQ. Sensitivity refers to the percentage of children who are correctly identified as meeting the criteria for DCD. According to the generally accepted standards for diagnostic tests, 80 percent sensitivity is preferable. Specificity is the percentage of children without problems who are correctly identified as such by a screening test, and 90% is preferable. These two values vary according to the type of sample and the criterion used to define the condition (Hunsley & Meyer, 2003). In addition, there is always a "trade-off" between sensitivity and specificity (Fletcher et al., 1996); unless a test has 100% sensitivity and specificity, the increase of one value will lead to a decrease in the other. For a screening test in which early diagnosis is beneficial and when it is desirable to identify all those at risk for having DCD, high sensitivity is preferable to higher specificity. Schoemaker et al. (Schoemaker, Smits-Engelsman, & Jongmans, 2003) state that screening instruments should function as a "coarse sieve" to identify all children who really have DCD, even if children without the condition are falsely identified. The risk of screening positively for a condition erroneously (i.e., a false positive diagnosis) would be corrected by confirmatory testing with a norm referenced standardized test, which is always recommended when using the DCDQ. Schoemaker et al. (Schoemaker et al., 2008) also believe it is ethically more responsible to identify more children than to miss identifying and supporting children who need services.

The overall sensitivity of the Revised DCDQ'07, when age-specific cut-off scores are used, exceeds 84%. Specificity is lower at 71%. Other measures of DCD report specificity values which range from 62% to 66% (Chambers & Sugden, 2002; Faught et al., 2008; Schoemaker et al., 2003; Schoemaker et al., 2008).

Summary of psychometric properties of the DCDQ '07

Reliability

Item Consistency: Cronbach's alpha is .89. Corrected item-total correlations ranged from .42 to .67.

Test-Retest Reliability: Although the studies with the Canadian version of the DCDQ have not included a measure of test-retest reliability, other translated versions have found high reliability: 0.94 (Tseng et al., 2010) and 0.97 (Prado et al., 2009).

Inter-rater Reliability: No between-rater assessment has been done.

Validity

Construct Validity: A group of children who had DCD or were suspected of having DCD (n = 136) scored significantly lower on the DCDQ'07 than a group of 96 children without evidence of DCD ($F(1,230) = 81.7$, $p < .001$)

Concurrent Validity: The DCDQ'07 significantly correlates with the MABC ($r = -.55$, $p < .001$) and the VMI ($r = .42$, $p < .001$).

The presence or absence of ADHD is not correlated with the scores of the DCDQ ($r = -.11$, $p = .12$).

The DCDQ scores do not differ significantly between boys and girls ($F(1,284) = .8$, $p = .37$).

The DCDQ score is not correlated with children's ages ($r = .09$, $p = .37$).

Stability of Factors:

The three factors found in the DCDQ'07 have been confirmed by other studies (Cairney, Missiuna, Veldhuizen, & Wilson, 2008; Tseng et al., 2010), which indicates that these factors are stable and that a similar factor structure is evident in different populations and in different cultures.

Sensitivity and Specificity

Overall sensitivity is 84.6%and specificity is 70.8% when using age related cut-off scores which are adjusted for the 3 age groups.

SECTION III

This section outlines some of the research that has been conducted on, or has used, the DCDQ in order to present the empirical evidence available concerning validity and reliability. We recommend that the complete studies and/or published reports be reviewed in their entirety.

Summaries of research on the original DCDQ

Assessment tools used today have often been developed over extended periods of time during which these instruments have been refined and modified. An example of this development can be seen in the recent publication of the MABC-2 (Henderson & Sugden, 2007) which is the fruit of the first edition of the MABC (Henderson & Sugden, 1992), which in turn was developed from the TOMI (Test of Motor Impairment) (Stott, Moyes, & Henderson, 1972) in 1972. The DCDQ was first published in 2000 and in 2007 underwent its first revision, with possibly other revisions to come. Much of the research on the original DCDQ can be applied to the revision.

Crawford, S.G., Wilson, B.N & Dewey D. (2001). Identifying Developmental Coordination Disorder: Consistency Between Tests. ***Physical & Occupational Therapy in Paediatrics, 20 (2/3)***, 29-50.

The aim of this paper was to assess the level of consistency between tools when identifying children with DCD. The study included 379 participants ranging from 8 to 17 years. The final sample included 101 children with DCD and 101 children who were matched from the non-DCD group. The children were matched for age, sex and the presence of ADHD and/or reading disability. The Bruininks-Oseretsky Test of Motor Proficiency (BOT) was administered and compared to the results of the Movement Assessment Battery for Children (MABC) and the Developmental Coordination Questionnaire (DCDQ).

The analyses was divided into three phases: phase one - demographic comparisons and comparisons of motor skills; phase two - agreement between scores on the BOT and the MABC and confirmed DCD; phase three - agreement between scores on the BOT and the DCDQ and confirmed DCD. The study found that there was less than 80% agreement between the BOT, the MABC and the DCDQ. When the DCDQ and the BOT were compared it was found that the agreement between them was very high when identifying children who were non-DCD, but low when identifying those with DCD. The study highlighted the importance of using multiple tools when assessing children for DCD due to the variations observed in administration and inconsistency of the currently available tests for DCD.

Green, D., Bishop, T., Wilson, B.N., Crawford S., Hooper R., Kaplan, B., & Baird, G. (2005). Is Questionnaire-Based Screening Part of the Solution to Waiting Lists for Children with Developmental Coordination Disorder? ***British Journal of Occupational Therapy, 68,*** **2-10.**

This study was designed to determine whether questionnaire-based screening could be part of the solution to a long waiting list of referrals for occupational therapy assessment for children with suspected DCD. The questionnaires used were the original version of the DCDQ that was completed by parents, and the Checklist of the Movement Assessment Battery for Children (C-ABC) completed by teachers. The results of the questionnaire screening were compared to the traditional clinical assessment of children. If questionnaire based screening could identify children at risk of DCD, these children could be given priority for clinical assessment. In addition, the families of children without DCD could avoid unnecessary time and money spent while waiting for a referral for an assessment.

It was found that there was little cost benefit to using either questionnaire to screen children already referred to a clinical service. The C-ABC performed particularly poorly. Several confounding variables, including an unequal proportion of children with DCD in the sample and the inclusion of children who were younger than the age range of the DCDQ, may have influenced the performance of the DCDQ. A strong relationship was found, however, between parent report on the DCDQ and therapists' identification of the child having DCD or being at risk of having DCD. While it is suggested that questionnaires cannot be used to replace a detailed clinical assessment, parent report may be effective prior to clinical assessment in the identification and management of DCD.

Green, D., & Wilson, B. N. The Importance of Parent and Child Opinion in Detecting Change in Movement Capabilities. (2008). ***Canadian Journal of Occupational Therapy. 74(5),*** **208-218.**

This study evaluated the value of parent and child report in recording change in the movement performance of 5 to 11 year old children. Forty-three children (37 males, 6 females) with DCD and their families completed surveys five times over a period of 2.25 years to determine progress in movement tasks. In addition clinical tests were carried out. The parents completed the DCDQ and the children used the Coordination Skills Questionnaire (CSQ), which allowed them to rank their perceived skill level in performing a variety of movement tasks and their satisfaction with their performance level. An occupational therapy intervention program was provided to children in age-based groups at different time blocks throughout the study period. The MABC was used as a clinical measure for determining motor function.

The DCDQ proved to be a useful adjunct for monitoring change in the children. It demonstrated the ability to measure differences in the extent of movement difficulties over time within this relatively small DCD population. It was sensitive to change approximately 6 months to one year after the MABC documented progress. Parent perception of their child's motor function, as measured by the DCDQ, significantly correlated with the scores on the MABC. There was a less clear relationship between the degree of a child's movement problems, as measured by clinical assessment, and his/her perception of skill. Correlations between the child's perception of motor performance and the clinical assessment were not significant. The CSQ has not been validated outside of this study, which could have affected the results seen.

Parent and child report correlated only at the third testing point but not at the other four time points. The low agreement between parent and child perceptions of progress is consistent with other studies (Cairney et al., 2008; Dunford, Missiuna, Street, & Sibert, 2005). It is apparent that neither parents nor children rate progress in motor capabilities in the same terms as clinical measures. However, parents and children have an important role to play in the identification of movement difficulties, particularly with respect to the impact any problems may have on occupational performance, and both opinions are integral to the process of intervention and the evaluation of outcome.

Schoemaker, M. M., Flapper, B., Verheij, N. P., Wilson, B. N., Reinders-Messelink, H. A., & de Kloet, A. (2006). Evaluation of the Developmental Coordination Disorder Questionnaire as a screening instrument. Developmental Medicine & Child Neurology, 48, 668-673.

This paper reports the reliability and validity of the DCDQ, a parent report measure developed for 8 to14 year olds. Participants in this study included a Dutch population-based sample of 608 children (mean age 7.8 (SD 2.4), 311 males, 297 females), a sample of 55 children with DCD referred to a rehabilitation clinic, and a control sample of 55 children, matched for age and gender to the children with DCD (mean age 8.3 (SD 2.0), 48 males, 7 females in each sample). Another aim of the study was to evaluate the usefulness of the DCDQ in identifying DCD in children younger than those for which the DCDQ was developed. Its use with children as young as 4 years of age was seen as clinically relevant, since DCD has been found to lead to social-emotional problems in children as young as 6 years of age.

Reliability and validity of the DCD were examined using the MABC as the gold standard for identification of DCD. Internal consistency was determined in the population-based sample using Cronbach's alpha. Construct validity was investigated in the population-based samples. Discriminant validity was determined and compared for both the clinic-referred sample and the matched

control sample. Concurrent validity was calculated for all samples using the MABC for comparison.

The DCDQ proved to be a reliable and valid tool for both the age range for which the questionnaire was developed and for the younger age range (4-8 years). There was no influence of age and sex on scores in the intended age range, although there was a significant gender effect on score in the younger population, with males scoring significantly worse. The effects of age also approached significance ($p = 0.12$) in this age group. In the 8-12 year range, the four factors which were found to explain 70% of the variance were: 1) control during movement. 2) fine motor/handwriting. 3) general coordination. 4) gross motor control/planning. The factors explaining the variance in the younger age group were found to be slightly different.

The DCDQ met the standard for sensitivity (80%) in the clinic-referred sample (81.6%), but not in the population-based sample (28.9%). The authors theorize that the low sensitivity in the population-based sample may have been influenced by the use of the MABC as the gold standard, since it tends to identify more children with DCD when compared with other tests of motor skills. Specificity almost reached the standard of 90%: it was 89% in the population-based sample, and 84% in the clinic-referred sample.

Schoemaker, M. M., Flapper, B. C. T., Reinders-Messelink, H.A., & de Kloet, A. (2008). Validity of the motor observation questionnaire for teachers as a screening instrument for children at risk for developmental coordination disorder. ***Human Movement Science,*** **27, 190-199.**

This study was undertaken to determine whether the Motor Observation Questionnaire for Teachers (MOQ-T) was an appropriate tool to use in the identification of children at risk for DCD. The MOQ-T was designed to take into account fine and gross motor functioning to identify clumsiness or DCD in children aged 5-11 years. The 18 item MOQ-T was assessed for its ability to be able to categorize children as DCD or non-DCD when compared to the results from the MABC; its ability to be able to distinguish between children with motor problems and those without motor problems and its performance when results were compared to the DCDQ.

There were 182 study participants, consisting of 91 children who had been referred to one of three rehabilitation clinics whose mean age was 7.7 years and a comparison group consisting of 91 children from a population-based sample with a mean age of 7.6 years. The children were matched for age and gender. The questionnaire (MOQ-T) was reported to have high internal consistency of items (α=.95), and, when using the MABC as the gold standard, sensitivity of 80.5% and specificity 62% was reported. Significant correlations resulted when the questionnaire was compared to the DCDQ (r=-.63) and the MABC (r=.57).

The use of the DCDQ in this study supported the validity of the MOQ-T. The significance of the agreement between the scores obtained on the DCDQ and the MOQ-T showed that those children that have problems with motor skills on a daily basis in the home, have similar problems at school. The study demonstrated that the MOQ-T is a valid tool that can be used by teachers to screen children at risk for DCD.

Civetta, L.R. & Hillier, S.L. (2008). The Developmental Coordination Disorder Questionnaire and Movement Assessment Battery for Children as a Diagnostic Method in Australian Children. ***Pediatric Physical Therapy, 20(1),*** **39-46.**

This two part study aimed to diagnose children with DCD utilizing the DCDQ and the MABC. Australian students from 10 primary schools, aged 7 to 8 years of age were invited to participate. Of the 460 children who were sent the DCDQ, 185 questionnaires were completed and returned. There were 57 children in the study population who were identified by the DCDQ as either DCD or suspect DCD. These 57 children were then asked to complete the MABC physical assessment and results were compared to a control group of children who were matched for school, age and sex.

High internal consistency of the DCDQ was confirmed by this study, however, the internal consistency of the MABC did not reach an acceptable level for research purposes. It was determined that there is a significant relationship between the DCDQ and the MABC, however the strength of this relationship was only 'fair'. Concerns were raised regarding false positives and negatives when existing cut off scores for both instruments were used. When used in combination, the DCDQ and the MABC are reported to be a fairly valid method for the recognition of DCD. Further examination of current cut-off scores for the tools is recommended, as is revision of the MABC and/or the DCDQ to improve their reliability as screening instruments.

Note: *Since this study was completed, both the MABC and the DCDQ have undergone revisions.*

Davies, R., & Jackson, M. A Randomised Controlled Trial Study of the Effectiveness of Occupational Therapy Provision in Mainstream Schools for Children with Signs of Developmental Co-ordination Disorder. Unpublished Report.

This study was undertaken to evaluate the effectiveness of a school-based occupational therapy program for children with signs of DCD. The original DCDQ was used as the initial screening tool in Stage 1 of a three-stage referral and intervention care pathway. Teachers identified children in their classes who had motor coordination difficulties, and the DCDQ was completed by both

parents and teachers, either together or individually. Children scoring at or below the 10th percentile were considered to have met Criterion A and B for DCD and proceeded for further testing. The DCDQ correlated significantly with a gross motor skills subsection of a general teacher questionnaire (r=0.486 to 0.749).

Ten schools participated in the study and were randomly assigned to the intervention group (n=5) or the control group (n=5). Eighty-five children, ages 4 to 11 years, were identified as DCD and participated in an intervention program for 10 weeks. Two groups were poorly matched for age, with the mean age of the control group being 2.5 years older than the intervention group: this confounded the interpretation of the results. Gross motor skills, as assessed by the teachers, improved significantly more in the intervention group than in the control group (p = 0.012). The same pattern was noted in the teacher assessment of visual skills (p = 0.030). Parents reported improvements in their children's motor skills, self-esteem and confidence among other noted improvements post-intervention. The study provides evidence to show that participation in programs can help improve gross motor skills in children showing signs of DCD.

Schoemaker, M.M, Flapper, B., Wilson, B.N, Reinders-Messelink, H.A., & de Kloet, A. Identification of Children with Developmental Coordination Disorder. Under revision.

This study aimed to assess if those children who met criterion A of the DCD diagnostic criteria also met criterion B, and to examine the influence of different cut-off scores. A total of 493 children, aged 5 to 11 years, from 14 schools in the Netherlands were selected to participate in the study. The final study population included 223 children with a mean age of 8 years, consisting of 126 boys and 107 girls.

The study utilized a multiple assessment procedure to identify children with DCD. Parents of the participants were asked to complete the DCDQ, teachers were asked to complete the MOQ-T and research assistants administered the MABC. Two different cut-off scores were used in the analyses. The 15th percentile was used as a criterion for DCD identification when using the DCDQ and the MOQ-T and the 15th or 5th percentile was used for the MABC. When the MABC was administered 19.3% scored below the 15th percentile and 6% scored below the 5th percentile. The study found that 15.9% scored below the 15th percentile on the DDCQ and 16.3% scored below the 15th fifteenth percentile on the MOQ-T.

It was found that the correlation between subscales of the MABC and the subscales of the MOQ-T and DCDQ ranged from 0.007 to 0.27. Correlations between subscales of the MOQ-T were 0.05 to 0.71. The study confirmed that when the 15th or 5th percentile are used as cut-off criterion for the MABC, the incidence of children with DCD was 9% and 3.7% respectively. The study highlighted that motor tests such as the MABC measure skills performed at one

particular point in time, and that performance could have been influenced by variables such as anxiety or fatigue. Questionnaires, on the other hand, had the ability to measure performance over a longer period of time. It is recommended that careful consideration be given to DCD diagnoses which are based on criterion A alone; an assessment of motor skills in daily life should be included when making a DCD diagnosis.

Loh, P.K., Piek, J.P., & Barrett N.C. (2009). The Use of the Developmental Coordination Disorder Questionnaire in Australian Children. Adapted Physical Activity Quarterly, 26, 38-53.

In this study, the DCDQ and the McCarron Assessment of Neuromuscular Development (MAND) were investigated for concurrent validity in a sample of Australian children. The sample consisted of 129 children (38 girls and 91 boys) aged 9-12 years (mean age 11.15). Scores were obtained for all children for the DCDQ and the MAND.

Motor impairment (MI) was identified as mild in 30 children, moderate in 9 children and severe in 5 children according to the MAND. Mild MI was identified in 12 children, moderate MI was identified in 9 children and severe MI in 5 children by the DCDQ. In total, the DCDQ identified 46 cases of MI and the MAND identified 44. The study found that the degree of association was low (kappa = 0.284) between the DCDQ and the MAND. A decision agreement analysis confirmed that both tests identified 24 of the same cases, but 44 cases were mismatched, resulting in an overall decision agreement of 67% [(24+63)/129) x 100], and a proportion of agreement of 0.55. The two tools did not reach the satisfactory decision agreement level of 80% for concurrent validity, indicating that different aspects of motor performance are being measured by each tool.

Note: *Since this research was completed, a further study has suggested that the MAND itself can be problematic, lacking in discrimination accuracy. The MABC is preferred over the MAND for identifying children with DCD.* (Brantner, Piek, & Smith, 2009)

Summaries of Research on the Revised DCDQ'07

Cairney, J., Missiuna, C., Veldhuizen, S, and Wilson, B.N. (2008) Evaluation of the psychometric properties of the developmental coordination disorder questionnaire (DCD-Q): Results from a community based study of school-aged children. Human Movement Science, 27:932-940.

This study reports the evaluation of the psychometric properties of the revised version of the Developmental Coordination Disorder Questionnaire (DCDQ'07) in a school based sample of 523 children (253 male, 270 female). The study of 9 to 14 year olds was part of a pilot project for a larger study (Missiuna et al., 2006). Participants were recruited from grade 4 to 8 classes in 3 schools. The Children's Self-perceptions of Adequacy in and Predilection toward Physical Activity (CSAPPA), a child self-report measure of self-efficacy in physical activity was also administered. Parents were sent home a copy of the DCDQ'07 and the

CSAPPA was administered in a class setting to those students who consented to participate in the study.

The internal consistency of the DCDQ'07 was found to be high; Cronbach's alpha for the complete scale was 0.94; 'control during movement' factor was 0.91; 'fine motor/handwriting' 0.91 and 'general coordination' subscale 0.91. Construct validity was determined by confirmatory factor analysis (CFA) to evaluate the hypothetical three factor structure of the DCDQ'07, using the Comparative Fit Index (CFI) as a measure. A modest fit of the factor structure was found, with a CFI score of 0.96, which met the acceptable standard of 0.95. However, the RMSEA (root mean square error of approximation) of 0.095 did not an acceptable standard (adequate threshold below 0.05). A redundancy test was performed, based on the fit data, and confirmed that the three factor structure was better than a unifactorial structure for the DCDQ.

The self-report CSAPPA was used as the standard against which the concurrent validity of the parent report DCDQ'07 was measured. A moderate correlation ($r = 0.38$, $p<0.001$) was found between the DCDQ'07 and the CSAPPA. The strongest correlation, however, was found between the control during movement subscale of the DCDQ'07 and the perceived adequacy and the predilection scales of the CSAPPA ($r=0.47$, $p<0.001$, and $r=0.41$, $p<0.001$). The correlation between the parent and child report found in this study suggests that both parents and children have a role to play in the identification of coordination problems. The discrepancies found between the results of the two questionnaires may be due to the measurement of different areas of motor coordination.

Keijsers, E.D.A., Frijters, M. C.T. & Smits-Engelsman, B. C.M. (2009) Psychometric properties of the new version of the Developmental Coordination Disorder Questionnaire, used by teachers and parents. ***Unpublished MSPT Research Report***

This study aimed to investigate the use of the DCDQ '07 with a study sample of 221 Dutch primary school children (119 male and 102 female). One half of the children (112) were in a random group and 109 were in a 'traffic light' group (defined by the teacher as red for children with poor motor performance, orange for performance below the mean and green for normal performance).

Concurrent validity of the DCDQ'07 was examined by correlating the score with the MABC-2 (Henderson & Sugden, 2007) and examining the correlation of scores when the DCDQ '07 was completed by parents and teachers. The study also examined the sensitivity, specificity, positive predictive value and accuracy of the DCDQ'07 scores when completed by teachers and parents.

When completed by the teachers, significant correlations were reported between the DCDQ'07 and the MABC-2: $r=0.44$, $p<0.001$ (total group), $r=0.50$, $p<0.001$

(traffic light) and r=0.32, p<0.05 (at random). When completed by parents, the correlations for the total group were r=0.43, p<0.001 (total), r=0.58, p<0.001 (traffic light) and r=0.21, p<0.05 (random).

Limitations of the study include the lack of a gold standard for the identification of DCD and the use of the MABC-2 as a criterion standard. The use of Canadian norms in a Dutch population and Canadian item development, including specific daily sports, which may not be applicable to Dutch children, were also cited as limitations.

SECTION IV

Cross-cultural adaptation of the DCDQ and the DCDQ'07

Process of cross cultural adaptation

In multi-cultural countries, it is important to have valid and reliable assessment tools which can be used for children and families whose first language is not English. The World Health Organization recommends the cross-cultural translation of existing instruments, because this process is less expensive and faster than the creation of new instruments. In addition, the cross-cultural translation can facilitate collaboration, exchange of information and comparison between different populations of children. The availability of instruments in several languages enables therapists to use validated tools with non-English speaking clients, as well as facilitating multi-national collaboration.

The DCDQ has been translated into several languages and is in use internationally. Cross-cultural adaptation is a process involving translation and adjustment of cultural words, idioms and (if necessary) complete transformation of some items, in order to capture the same concept in the target culture as in the original source (Guillemim, 1995). Adhering to this process of adaptation ensures greater comparability of responses across international populations. The process involves working in close contact with the primary developer and having an expert committee involved in decisions about specific wording. Following establishment of the face validity of an adapted instrument, a scoring system specific to the country may be developed (if sample size is adequate), or the original scoring may be tested for validity in the new county.

Cross cultural adaptations which followed the guidelines developed by Beaton, Bomardier, Guillemin, and Feraz (Beaton, Bombardier, Guillemin, & Ferraz, 2000), or follow a similar process, are reported here; there are no doubt other translations done with less rigor which are not known to the authors. The translations reported here have been done with rigor and care, and their use can be recommended.

Summaries of cross cultural adaptation

In addition to the Dutch, Hebrew, Chinese, Portuguese and Greek translations reported below, other adaptations which are in progress and are being researched include Canadian French, German, Spanish, Danish, Japanese, Iranian, and Norwegian.

Traub RBI, Levi AW, Parush S. (2005) Validity and reliability of the Developmental Coordination Disorder Questionnaire for school-aged

children in Israel. ***Israel Journal of Occupational Therapy*** **14(4): E181 (Abstract)**

The purpose of the current study was to investigate the validity and reliability of the Hebrew translation of the DCDQ for use with Israeli children. Fifty-six children between the ages 6.11 and 12.9 years participated in the study; 28 were suspected of having DCD. The control group consisted of 28 non-DCD children matched for age and gender. The questionnaires were completed by parents and were analyzed for content validity, construct validity and internal validity.

The groups differed significantly on the total DCDQ score, supporting the construct validity of the questionnaire as adapted for use in Israel. Cronbach's coefficient alpha for the total DCDQ score, and correlations between the total score and each of the questionnaire sub-scores, were calculated and supported the internal validity of the questionnaire (α= .88 for the total assessment; r=.67 - .91, p<.001). These analyses indicate that scores on the DCDQ are not influenced by a child's age or gender, confirming the rationale for using the questionnaire as a tool for assessing motor function regardless of the age or gender of the child.

These findings indicate that the Hebrew version of the DCDQ is a reliable and valid screening tool for use with Israeli children, based on its psychometric properties

Prado, M.S., Magalhaes, L.C. & Wilson, B.N. (2009). Cross-cultural adaptation of the developmental coordination disorder questionnaire for Brazilian children. Brazilian Physical Therapy, 13(3):236-243.

Cross-cultural translation of the DCDQ'07 into Portuguese was conducted according to current guidelines for cross-cultural translation of instruments. The translated questionnaire was completed by 45 parents; parents of 15 children (14 males, one female; mean age 8 years 10 months) with motor coordination problems and by the parents of a control sample of 30 children with typical development. This latter group was matched for age with the sample of children with motor coordination problems (15 males mean age 9y; 15 females, mean age 9y 2mon). Five parents from each group completed the questionnaire twice, 14 days apart, to examine test-rest reliability.

The parent's opinion regarding the quality of the questionnaire was also recorded. The results indicated that 91% of Brazilian parents reported no difficulty in completing the DCDQ. Regarding psychometric properties, two items showed some limitations due to cultural differences. After item substitution, sensitivity increased from 0.66 to 0.73 and test-retest reliability from 0.95 to 0.97. Internal consistency also increased from 0.91 to 0.92.

The small sample size and the informal identification of children with DCD in the clinical sample are listed as limitations of this study. The final instrument shows good potential to be used as a screening tool for DCD in Brazil. However, further research with a larger sample is needed in order to define cut-off scores and verify the instrument's clinical utility; this study is underway.

Tseng, M-H, Fu, C-P, Wilson, B.N. and Hu, F-C. (2010) Psychometric properties of a Chinese version of the Developmental Coordination Disorder Questionnaire in community-based children. Research in Developmental Disabilities. 31:33-45.

The purpose of this study was to describe the cross-cultural adaptation of the Developmental Coordination Disorder Questionnaire (DCDQ'07) for a Chinese population, and to further evaluate the applicability and construct validity of the questionnaire for use with a community-based population of children in Taiwan. Parents of 1082 children from five primary schools in the greater Taipei area completed a Chinese adaptation of the questionnaire. Thirty-five parents completed the questionnaire twice, 2 weeks apart, to examine test-rest reliability.

Analysis showed that Cronbach's alpha for the total test was 0.84 and the test-retest reliability, 0.93. The results of the item-total correlation and the frequency distribution led to the deletion of two items. The results of the exploratory factor analysis identified three distinct factors which were compatible with the four factors of the original DCDQ, the three factors of a recently revised DCDQ'07, and the factor pattern of a Dutch Adaptation of the DCDQ'07.

The similarity in the factor structure between the Chinese version of the DCDQ-15 in Taiwan and the DCDQ'07 in Canada and the Netherlands suggests that considerable similarity exists in the motor disorders in children across cultures. The Chinese adaptation of the DCDQ'07 is reliable and appropriate for identifying motor coordination problems in a community-based population of children in Chinese-speaking societies.

The sample of children were limited to 6-9 year olds; this is a limitation of the study and it is suggested that studies utilizing participants from the full age group be investigated. It is also suggested that factor structure be further verified by confirmatory factor analysis in other studies.

Chen, Y-W., Tseng, M-H., Hu, F-C., & Cermak, S-A. (2009/11). Psychosocial adjustment and attention in children with developmental coordination disorder using different motor tests. Research in Developmental Disabilities.30(6),1367-1377.

Wang, T-N., Tseng, M-H., Wilson, B-N., & Hu, F-C.(2009/03). Functional performance at home and school of children with developmental

coordination disorder. Developmental Medicine and Child Neurology.51(10), 817-825.

Martini, R., St-Pierre, M., Wilson, B. N. (2011). French Canadian crosscultural adaptation of the Developmental Coordination Disorder Questionnaire '07: DCDQ-FC. *Canadian Journal of Occupational Therapy, 78*, 318-327.

The aim of this study was to undertake a formal translation of the English DCDQ'07 and begin to examine its psychometric properties. The translation was done using Beaton et al. (2000)'s guidelines for cross-cultural adaptation. Methodologies described by Haccoun (1987) and Vallerand (1989) were used to address the psychometric qualities of the translation. The DCDQ'07 and its French translation (DCDQ-FC) are equivalent, with excellent internal consistency and test-retest reliability. Concurrent and construct validity were adequate for a screening measure; however, low sensitivity was obtained with both measures. The DCDQ-FC is a valid translation for use with a French Canadian population.

Monteiro, M., Koutsouki, D., Karageorgi, N., Hatzinikolaou, K., Skordilis, E. Psychometric properties of cross-culturally adapted versions of the DCDQ for Parents and Teachers: a preliminary study with 8 – 10 year old Greek children. Under revision.

This study investigated the psychometric properties of a cross-culturally adapted version of the DCDQ'07 for parents and teachers, consisting of 220 Greek children aged 8-10 years old, 10 teachers and 89 parents. The DCDQ'07 underwent an extensive translation process including back and forward translation to ensure grammatical and culturally appropriate language was used, in consultation with Greek and English speaking professionals. A teacher's version of the DCDQ'07 /T was also adapted for this study. The MABC was used to assess the children's motor skills.

Factor analyses identified that four factors in the parent questionnaires were responsible for 63.62% of data variance and three factors in the teacher questionnaires were responsible for 71.9% of data variance. Pearson's correlation between the MABC total score and the DCDQ/T were significant (-0,470, *df* 36, $p < 0.05$), but was non-significant between MABC and the parent version (DCDQ/P ; Spearman rho = -0,130, *df* 47, n.s.). Total scores of the DCDQ/P and DCDQ/T showed a trend towards significance and positive correlation (Spearman Rho = 0.254, *df* 84, $p < 0.056$).

The study found that the DCDQ/Teachers version had a higher coefficient of internal consistency and better item-total score correlation when it was compared to the DCDQ/Parents. However, both scales were found to have good reliability.

Monteiro, M. V., Hatzinikolaou, K., Karageorgi, N., Wilson, B. N., Koutsouki, D. Comparison of parents' and teachers' ratings on the DCDQ of children's motor performance. Under revision.

This two-part study investigated the level of agreement between parents and teachers when they assess the motor behaviour of children. The first study compared the scores of individual items obtained by parents and teachers when they completed the DCDQ. The second study involved parents and teachers rating motor performance of children based on observation of recorded images of children performing motor tasks.

In Study 1, parents and teachers of 72 children, aged 8 and 9 years old, participated. Absolute agreement (54% to 21%) was identified between parents and teachers for six individual items of the scale (jumping, running, motor learning, writing legibly, sports and clumsiness). Items related to catching, hitting, writing fast and fatigue had absolute agreement levels of 27% to 37%. The frequencies of relative to absolute agreement was more than 81% for 11 items, and 50% of absolute agreement was found for approximately one third of the items.

In order to judge the differences in ratings, the teacher and parent ratings for each item was subtracted from the best performance rating and the distances of ratings from the best performance rating (DBPR) were then pooled for each of the DCDQ'07 subscales. Intra-class correlation between the parents DBPR and teachers DBPR was carried out and a moderate correlation of r= 0.48 was found for fine motor/writing coordination, r=0.36 for general coordination and r= 0.13 for control of movement. The frequency of the difference in ratings between parents and teachers showed normal distribution with observable tendency towards lower ratings for parents.

In summary, Study 1 found frequency of absolute agreement between parents and teachers to be moderate and frequency of relative agreement to be high when scoring motor behaviour. It is recommended that raters bias and the situations in which children's performances are observed be considered as sources of difference when assessing motor skills, and that parents and teachers assessments should be used in conjunction with each other, rather than separately.

Other Adaptations of the DCDQ

The DCDQ has been adapted for adolescents, young adults and adults for use in qualitative and exploratory studies. No scoring system has been developed for these versions, but they provide direction for future research. Dr. Marja Cantell adapted the 17 items of the DCDQ and added several items to assess adults who

identified themselves as DCD. The questionnaire was also adapted into two versions for adolescents and used in a small student project under the direction of the Brenda Wilson. One version was worded in the first person while the other described scenarios and asked the teenager to identify whether the person in the item was "a lot like them" or "not like them". Their ratings on these two versions were compared to their parent's assessment of their motor skills using the original DCDQ. Correlation between parent report and the first person version was low but was higher between parent report and the scenarios version. The adolescent versions were then adapted by Dr. Cheryl Missiuna and used in a qualitative study of young adults who identified themselves as DCD (C. Missiuna, Moll, King, Stewart, & Macdonald, 2008).

Most recently, the DCDQ has been adapted for use with preschool children. Tanya Rihtman and Shula Parush (Rhitman et al., 2011) have adapted the DCDQ'07 into Hebrew according to guidelines for cross-cultural adaptation of instruments including a back-translation into English. The suitability of each item was assessed for 3 and 4 year olds, and 22 additional items were devised based on expert opinion. All items were rated by 15 child development experts, using three criteria of appropriateness and a 4-point scale to establish content validity. Nineteen items had 80 percent agreement among the experts; 15 of these 19 items were similar to areas of skills in the school-age DCDQ and were therefore included in the pilot version and categorized into three sub-scales. The 15-item questionnaire was then translated into English and was reviewed with the developer of the DCDQ and other experts for intent and clarity of wording. It was back-translated into Hebrew and the pilot version, called the Little DCDQ, was administered to the parents of 28 children in Israel, ages 3 and 4 years. Test-retest reliability for the total score and subscale scores ranged from r = 0.73-0.87. Further studies in Canada and Israel, as well as an international collaboration, are underway to further evaluate the reliability of the questionnaire and to establish construct and concurrent validity of the Little DCDQ.

References

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders (DSM IV-TR)* (4th ed.). Washington, DC: American Psychiatric Association.

Barnett, A., & Peters, J. (2004). Motor proficiency assessment batteries. In D. Dewey, & D. E. Tupper (Eds.), *Developmental motor disorders: A neuropsychological perspective, the science and practice of neuropsychology* (pp. 66-109). New York, NY, US: Guilford Press.

Beaton, D. E., Bombardier, C., Guillemin, F., & Ferraz, M. B. (2000). Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine, 25*(24), 3186-3191.

Beery, K., & Buktenica, N. (1997). *The beery-buktenica developmental test of visual-motor integration*. Minneapolis, MN: Pearson Assessments.

Beery, K., Buktenica, N., & Beery, N. (2003). *Beery-buktenica test of visual motor integration*. Canton, OH: Achievement Products for Children.

Bodnarchuk, J. L., & Eaton, W. O. (2004). Can parent reports be trusted? validity of daily checklists of gross motor milestone attainment. *Journal of Applied Developmental Psychology, 25*(4), 481-40.

Bois, J. E., Sarrazin, P. G., Brustad, R. J., Trouilloud, D. O., & Cury, F. (2005). Elementary school children's perceived competence and physical activity involvement: The influence of parents' role modelling behaviours and perceptions of their child's competence. *Psychology of Sport and Exercise, 6*(4), 381-397.

Brantner, S., Piek, J. P., & Smith, L. M. (2009). Evaluation of the validity of the MAND in assessing motor impairment in young children. *Rehabilitation Psychology, 54*(4), 413-421. doi:10.1037/a0017315

Bruininks, R., & Bruininks, B. (2005). *Bruininks-Oseretsky test of motor proficiency* (2nd Edition ed.). Circle Pines, Minnesota: AGS Publishing (American Guidance Services).

Bruininks, R. H. (1978). *Bruininks-Oseretsky test of motor proficiency: Examiner's manual*. Circle Pines, MN: American Guideline Service.

Cairney, J., Missiuna, C., Veldhuizen, S., & Wilson, B. (2008). Evaluation of the psychometric properties of the developmental coordination disorder questionnaire for parents (DCD-Q): Results from a community based study

of school-aged children. *Human Movement Science, 27*(6), 932-940. doi:10.1016/j.humov.2008.04.002

Chambers, M. E., & Sugden, D. A. (2002). The identification and assessment of young children with movement difficulties. *International Journal of Early Years Education, 10*(3), 157-175.

Chen, Y-W., Tseng, M-H., Hu, F-C., & Cermak, S-A. (2009). Psychosocial adjustment and attention in children with developmental coordination disorder using different motor tests. *Research in Developmental Disabilities.*30(6),1367-1377.

Civetta, L. R., & Hillier, S. L. (2008). The developmental coordination disorder questionnaire and movement assessment battery for children as a diagnostic method in australian children. *Pediatric Physical Therapy, 20*(1), 39-46.

Crawford, S. G., Wilson, B. N., & Dewey, D. (2001). Identifying developmental coordination disorder: Consistency between tests. *Physical Occupational Therapy in Pediatrics, 20*(2-3), 29-50.

Croce, R. V., Horvat, M., & McCarthy, E. (2001). Reliability and concurrent validity of the movement assessment battery for children. *Percept.Mot.Skills, 93*(1), 275-280.

Davies, R., & Jackson, M. A. *Randomised controlled trial study of the effectiveness of occupational therapy provision in mainstream schools for children with signs of developmental co-ordination disorder.* Unpublished manuscript.

Dunford, C., Missiuna, C., Street, E., & Sibert, J. (2005). Children's perceptions of the impact of developmental coordination disorder on activities of daily living. *British Journal of Occupational Therapy, 68*(5), 207-214.

Faught, B. E., Cairney, J., Hay, J., Veldhuizen, S., Missiuna, C., & Spironello, C. A. (2008). Screening for motor coordination challenges in children using teacher ratings of physical ability and activity. *Human Movement Science, 27*(2), 177-189.

Fletcher, R. H., Fletcher, S. W., & Wagner, E. H. (1996). *Clinical epidemiology: The essentials* (Third ed.). Baltimore: Williams & Wilkins.

Geuze, R. H. (Ed.). (2007). *Developmental motor coordination: A review of current approaches.* Marseilles, France: Solal.

Glascoe, F. P. (1999). Using parents' concerns to detect and address developmental and behavioral problems. *J.Soc.Pediatr.Nurs., 4*(1), 24-35.

Glascoe, F. P. (2000). Evidence-based approach to developmental and behavioural surveillance using parents' concerns. *Child Care Health Dev., 26*(2), 137-149.

Goodman, R. (1997). The strengths and difficulties questionnaire: A research note. *Journal of Child Psychology and Psychiatry, and Allied Disciplines, 38*(5), 581-586.

Green, D., Bishop, T., Wilson, B. N., Crawford, S., Hooper, R., Kaplan, B. J., et al. (2005). Is question-based screening part of the solution to waiting lists for children with developmental coordination disorder? *British Journal of Occupational Therapy, 68*(1), 1-9.

Green, D., & Wilson, B. N. (2008). The importance of parent and child opinion in detecting change in movement capabilities. *Canadian Journal of Occupational Therapy.Revue Canadienne d'Ergotherapie, 75*(4), 208-219.

Guillemim, F. (1995). Cross-cultural adaptation and validation of health status measures. *Scandinavian Journal of Rheumatology, 24*(2), 61-63.

Hay, J. A., Hawes, R., & Faught, B. E. (2004). Evaluation of a screening instrument for developmental coordination disorder. *J.Adolesc.Health, 34*(4), 308-313.

Henderson, S., & Sugden, D. (2007). *The movement assessment battery for children.* (2nd ed.). London: Pearson Assessment.

Henderson, S., & Sugden, D. A. (1992). *Movement assessment battery for children*. San Antonio, TX: Psychological Corporation.

Hunsley, J., & Meyer, G. J. (2003). The incremental validity of psychological testing and assessment: Conceptual, methodological, and statistical issues. *Psychological Assessment, 15*(4), 446-455.

Keijsers, E. D. A., Frijters, M. C. T., & Smits-Engelsman, B. C. M. (2009). *Psychometric properties of the new version of the developmental coordination disorder questionnaire, used by teachers and parents.* (Unpublished MSPT Research Report

Loh, P.K., Piek, J.P., & Barrett N.C. (2009). The Use of the Developmental Coordination Disorder Questionnaire in Australian Children. Adapted Physical Activity Quarterly, 26, 38-53.

Martini, R., St-Pierre, M., Wilson, B. N. (2011). French Canadian crosscultural adaptation of the Developmental Coordination Disorder Questionnaire '07: DCDQ-FC. *Canadian Journal of Occupational Therapy, 78*, 318-327.

Missiuna, C., Cairney, J., Hanna, S., Russell, D., Heath, N., Pollock, N., et al. (2006). *Examining the co-occurence of psychological problems in a population-based sample of children with developmental coordination disorder*. Ontario/Canada:

Missiuna, C., Moll, S., King, G., Stewart, D., & Macdonald, K. (2008). Life experiences of young adults who have coordination difficulties. *Canadian Journal of Occupational Therapy.Revue Canadienne d'Ergotherapie, 75*(3), 157-166.

Missiuna, C., Moll, S., Law, M., King, S., & King, G. (2006). Mysteries and mazes: Parents' experiences of children with developmental coordination disorder. *Canadian Journal of Occupational Therapy, 73*(1), 7-17.

Missiuna, C., Pollock, N., Egan, M., DeLaat, D., Gaines, R., & Soucie, H. (2008). Enabling occupation through facilitating the diagnosis of developmental coordination disorder. *Canadian Journal of Occupational Therapy, 75*(1), 26-34.

Monteiro, M. V., Hatzinikolaou, K., Karageorgi, N., Wilson, B. N., & Koutsouki, D. (Under revision). Comparison of parents' and teachers' ratings on the DCDQ of children's motor performance.

Monteiro, M., Koutsouki, D., Karageorgi, N., Hatzinikolaou, K., & Skordilis, E. (Submitted). Psychometric properties of cross-culturally adapted versions of the DCDQ for parents and teachers: A preliminary study with 8 – 10 year old greek children.

Prado, M., Magalhães, L., & Wilson, B. (2009). Cross-cultural adaptation of the developmental coordination disorder questionnaire for brazilian children. *Revista Brasileira De Fisioterapia, 13*(3), 236-243.

Rihtman, T., Wilson, B.N., Parush, S. (2011) Development of the Little Developmental Coordination Disorder Questionnaire for Preschoolers and Preliminary Evidence of its Psychometric Properties in Israel. *Research in Developmental Disabilities*. 32(4):1378-1387.

Rosenblum, S. (2006). The development and standardization of the children activity scales (ChAS-P/T) for the early identification of children with developmental coordination disorders. *Child: Care, Health and Development, 32*(6), 619-632.

Schoemaker, M., Flapper, B., Wilson, B. N., Reinder-Messelink, H., & de Kloet, A. (Under revision). Identification of children with developmental coordination disorder.

Schoemaker, M. M., Flapper, B., Verheij, N. P., Wilson, B. N., Reinders-Messelink, H. A., & de Kloet, A. (2006). Evaluation of the developmental coordination disorder questionnaire as a screening instrument. *Developmental Medicine & Child Neurology, 48*(8), 668-673.

Schoemaker, M. M., Flapper, B. C., Reinders-Messelink, H. A., & Kloet, A. (2008). Validity of the motor observation questionnaire for teachers as a screening instrument for children at risk for developmental coordination disorder. *Human Movement Science, 27*(2), 190-199.

Schoemaker, M. M., Smits-Engelsman, B. C., & Jongmans, M. J. (2003). Psychometric properties of the movement assessment battery for children-checklist as a screening instrument for children with a developmental co-ordination disorder. *Br.J.Educ.Psychol., 73*(Pt 3), 425-441.

Stott, D. H., Moyes, F. A., & Henderson, S. E. (1972). *The test of motor impairment*. Ontario: Brook Educational Publishing.

Sugden, D. A., Chambers, M. & Utley, A. (2006). *Leeds consensus statement 2006.* Retrieved January 4, 2008, from www.dcd-uk.org/consensus.html

Summers, J., Larkin, D., & Dewey, D. (2008a). Activities of daily living in children with developmental coordination disorder: Dressing, personal hygiene, and eating skills. *Human Movement Science, 27*(2), 215-229.

Summers, J., Larkin, D., & Dewey, D. (2008b). What impact does developmental coordination disorder have on daily routines? *International Journal of Disability, Development and Education, 55*(2), 131.

Traub, R. B. I., Levi, A. W., & Parush, S. (2005). Validity and reliability of the developmental coordination disorder questionnaire for school-aged children in israel. *The Israel Journal of Occupational Therapy, 1*4(4), E181.

Tseng, M. H., Fu, C. P., Wilson, B. N., & Hu, F. C. (2010). Psychometric properties of a chinese version of the developmental coordination disorder questionnaire in community-based children. *Research in Developmental Disabilities, 31*(1), 33-45.

Wang, T-N., Tseng, M-H., Wilson, B-N., & Hu, F-C.(2009). Functional performance at home and school of children with developmental coordination disorder. *Developmental Medicine and Child Neurology*.51(10), 817-825.

Wann, J. (2007). Current approaches to intervention in children with developmental coordination disorder. *Dev.Med.Child Neurol., 49*(6), 405.

Wilson, B. N., Crawford, S. G., & Green, D. (2009). The effects of attention on motor screening and testing. *Poster Presentation at the DCD VIII International Conference,* Baltimore, MD, USA.

Wilson, B. N., Crawford, S. G., Green, D., Roberts, G., Aylott, A., & Kaplan, B. J. (2009). Psychometric properties of the revised developmental coordination disorder questionnaire. *Physical & Occupational Therapy in Pediatrics, 29*(2), 184-204.

Wilson, B. N., Kaplan, B. J., Crawford, S. G., Campbell, A., & Dewey, D. (2000). Reliability and validity of a parent questionnaire on childhood motor skills. *The American Journal of Occupational Therapy, 54*(5), 484-493.

