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Published in:
Research in Developmental Disabilities

DOI:
[10.1016/j.ridd.2016.08.005](https://doi.org/10.1016/j.ridd.2016.08.005)

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version
Publisher's PDF, also known as Version of record

Publication date:
2016

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Timler, A., McIntyre, F., Cantell, M., Crawford, S., & Hands, B. (2016). Development and evaluation of the psychometric properties of the Adolescent Motor Competence Questionnaire (AMCQ) for Adolescents. *Research in Developmental Disabilities*, 59, 127-137. <https://doi.org/10.1016/j.ridd.2016.08.005>

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Development and evaluation of the psychometric properties of the Adolescent Motor Competence Questionnaire (AMCQ) for Adolescents

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ARTICLE INFO

Article history:

Received 26 June 2015

Received in revised form 15 July 2016

Accepted 9 August 2016

Available online 12 August 2016

Keywords:

Self report

Adolescence

Adolescents

Movement competence

Assessment

DCD

Developmental Coordination Disorder

ABSTRACT

Background: There are no valid and reliable self-report measures designed to identify level of motor competence and suspected motor difficulties among 12–18 year old adolescents. **Aim:** This paper reports the development and evaluation of a self-report questionnaire (Adolescent Motor Competence Questionnaire; AMCQ) to address this need.

Method: The project proceeded in 3 phases; (A) item development, (B) content evaluation, and (C) examination of reliability and validity of the final questionnaire. Each phase was informed by criteria A and B in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), comments from a sample of 10 adolescents aged between 12 and 18 years with a range of movement skills, key informants and international experts. A convenience sample of 38 adolescents completed the final version of the AMCQ. The McCarron Assessment of Neuromuscular Development (MAND) was used to investigate concurrent validity.

Results: The final version of the AMCQ comprised 26 items scored using a 4 point Likert scale with a maximum score of 104. Analyses revealed the questionnaire has an acceptable internal consistency (0.902) and 7 day test-retest reliability (0.956). A moderate positive correlation between the AMCQ and the MAND of 0.491 ($p < 0.002$) provides some evidence of concurrent validity.

Conclusion: The development of the AMCQ was exploratory in nature and has the potential to be a reliable and valid tool for measuring motor competence in Australian adolescents.

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What this paper adds

This paper reports the development of a new measure, the Adolescent Motor Competence Questionnaire (AMCQ), designed to identify suspected motor difficulties in adolescents aged between 12 and 18 years. The protocol used to develop the questionnaire allowed for a large pool of items to be developed and evaluated. The inclusion and exclusion of these

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items are discussed and the preliminary results presented. The evidence indicates that the AMCQ has the potential to be used to investigate the level of motor competence in adolescents. Further examination of the measure using data with a larger sample is required.

1. Introduction

Adolescents with Developmental Coordination Disorder (DCD) are unable to perform motor tasks with the same level of proficiency as most of their peers (Kirby, Edwards, & Sugden, 2011a). This impacts on the performance of many activities of daily living including self-care, and participation in recreation and sporting activities (Kirby, Edwards, & Sugden, 2011b). Common synonyms used in the literature for DCD include low motor competence (LMC), motor difficulties, motor impairment, poor coordination and suspected motor difficulties (SMD). For many years, it was thought that DCD was primarily evident during childhood with a prevalence between 5 and 10% (American Psychiatric Association [APA], 2013). However, a number of studies have reported that between 50 and 70% of those identified during childhood still experience motor difficulties into adolescence (Cantell, Smyth, & Ahonen, 2003; Losse et al., 1991) and adulthood (Kirby, Sugden, Beveridge, & Edwards, 2008). Consequently, for the first time the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5; APA, 2013) included central features and information about adolescents and adults with DCD.

Given its impact on many aspects of an individual's health and well-being it is important to identify those with SMD as early as possible. Unfortunately, motor difficulties often go undetected and many children enter adolescence without any recognition of their condition. Adolescence is a particularly important phase of development for a number of reasons. Many health-related behaviours, such as participation in physical activity and sports are important social occasions (Cairney et al., 2010; Hands & Larkin, 2002; Okely, Booth, & Patterson, 2001; Raz-Silbiger et al., 2015), and for those with SMD, sedentary activities become preferred over physical activities (Cairney et al., 2010; Hands & Larkin, 2002; Raz-Silbiger et al., 2015). They avoid participating in physical activity opportunities, such as community sports, which reduces their opportunities to socialize which may impact their peer relationships (Fitzpatrick & Watkinson, 2003; Kirby, Edwards, Sugden, & Rosenblum, 2010) and lead to social isolation (Piek, Baynam, & Barrett, 2006; Poulsen, Ziviani, & Cuskelly, 2007). In addition, peer victimization or bullying may lead to increased anxiety and depression (Pratt & Hill, 2011). Many families, teachers and even health professionals are unaware of the condition, consequently many adolescents remain undiagnosed and do not access support networks that could provide information, advice and a sense of belonging (Lingam, Novak, Emond, & Coad, 2013). A timely identification of motor difficulties before adulthood is therefore important for minimising these negative consequences, gathering support, building self-confidence and assisting in negotiating future pursuits such as employment opportunities.

At present, clinical tests or parent questionnaires are primarily used to identify adolescents with SMD. The most common clinical tests for adolescents are the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2) which accommodates 4- to 21-year-olds (Bruininks & Bruininks, 2005), the Movement Assessment Battery for Children, Second Edition (MABC-2) designed for 3- to 16-year-olds (Henderson, Sugden, & Barnett, 2007) and the McCarron Assessment of Neuromuscular Development (MAND; McCarron, 1997) suitable for 3.5-year-olds to young adult. Given the cost to purchase test kits, train testers and implement the assessment (generally between 20 and 30 min) these tests are not suitable for large studies (Hands, Licari, & Piek, 2015). One alternative is to use a valid and reliable questionnaire which is cheaper to print or purchase, generally does not require tester training, is easier to administer to large groups, and may identify individuals in need of support and intervention (Clark, Thomas, Khattab, & Carr, 2013). The most widely used questionnaire is the Developmental Coordination Disorder Questionnaire (DCDQ-07; Wilson et al., 2009) which is designed for parents of children aged between 5 to 15 years. However, this is not ideal for adolescents as parents may try to report on aspects they may not fully understand nor be aware of. For example, adolescents may experience negative social interactions, such as bullying or teasing by peers but they refrain from telling parents as it may become worse once parents get involved (Missiuna et al., 2008b).

Self-report questionnaires enable adolescents to report on their own movement abilities (Missiuna, Gaines, Soucie, & McLean, 2006; Tal-Saban, Ornoy, Grotto, & Parush, 2012). To date, three questionnaires have been published for older adolescents and adults. The Adult Developmental Coordination Disorders/Dyspraxia Checklist (ADC) was based on the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV; American Psychiatric Association, 1994). It is a 40 item questionnaire designed for 17- to 42-year-olds (Kirby et al., 2010) and distinguishes between DCD, at risk DCD and no DCD (Kirby et al., 2010). It requires participants to report on current movement difficulties, as well as movement history. The psychometric properties of the ADC showed good internal consistency, construct and concurrent validity and discriminant validity. The Functional Difficulties Questionnaire-9 items (FDQ-9; Clark et al., 2013) is an adult questionnaire developed for 18–65 year-olds using the guidelines from the International Statistical Classification of Diseases and Related Health Problems 10 revision (ICD-10; World Health Organisation, 2007) and the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR; American Psychiatric Association [APA], 2000). The FDQ-9 used three different samples ranging from 257 to 30 participants to establish initial psychometric properties which reported an acceptable internal consistency, construct validity, diagnostic accuracy and an identified cut-off score. Finally, the Adolescents and Adults Coordination Questionnaire (AAC-Q; Tal-Saban et al., 2012) was based on criteria A and B from the DSM-IV-TR (APA, 2000). It is a 12 item questionnaire developed for 16- to 35-year-olds and had acceptable internal consistency, construct validity and discriminant validity. The development of the AAC-Q used data from a large sample of 2379 adolescents (aged between 19

Fig. 1. The inclusion and exclusion of items during the three phases undertaken to develop the AMCQ.

to 25-years) and identified diagnostic cutoff scores to identify DCD for both clinical and research use (5th–15th percentile, 1.00–1.65 SD). Evidence of concurrent validity was not reported for the FDQ-9 or the AAC-Q.

None of these questionnaires have been specifically developed for adolescents aged between 12 and 18 years. An important time for motor difficulties to be recognised as they experience many social, behavioural and emotional challenges during this time. In addition, activities of daily living and sports participation are often different from those undertaken by older adults. These issues have been noted in the DSM-5 (APA, 2013). For example, during adolescence a high importance is placed on self-image (e.g. getting ready to go out, putting on make-up) and participation in after school and weekend sporting opportunities. Criterion B also mentions daily activities such as dressing, engaging in new games and using classroom tools (scissors or rulers) that may impact differently on an adolescent (APA, 2013).

The purpose of this paper is to report on the development and evaluation of a self-report questionnaire, the Adolescent Motor Competence Questionnaire (AMCQ; Timler, McIntyre, Cantell, Crawford, & Hands, 2015) to identify SMD in 12- to 18-year-olds. It is not considered to be an exclusive diagnostic tool for DCD as it was not possible to include items relating to criteria C and D from the DSM-5 which refer to intellectual disabilities or visual impairments. Although this questionnaire can contribute to a diagnosis, a clinical test and expert advice is also needed. A range of items involving age-appropriate functional tasks, activities of daily living, common motor skills and informed by the DSM-5 were considered (APA, 2013; Kwan, Cairney, Hay, & Faught, 2013).

2. Methods and results

The development of the questionnaire proceeded in three phases. An overview of the steps taken to develop the AMCQ and the number of items included or excluded in each phase is shown in Fig. 1. This project was approved by the Human Research Ethics Committee of the University of Notre Dame in Perth, Western Australia.

2.1. Phase 1: AMCQ content development

Item development of the AMCQ used a mixed method approach to maximise ecological and content validity (Onwuegbuzie, Bustamante, & Nelson, 2010; Polit & Beck, 2006; Wilson, Emslie, Hazel, Alderman, & Burgess, 2010). Poten-

Table 1

Sample items from the AMCQ.

Questions	Never	sometimes	frequently	always
I PREFER TO PARTICIPATE IN INDIVIDUAL SPORTS (SUCH AS SWIMMING, MARTIAL ARTS, ATHLETICS) RATHER THAN TEAM SPORTS (SUCH AS FOOTBALL AND NETBALL)				
(+)				
I CAN RIDE A BICYCLE				
I FIND IT HARD TO USE A FORK OR A KNIFE WHEN EATING A MEAL (+)				
MY HAND WRITING IS FAST ENOUGH TO KEEP UP WITH THE REST OF THE CLASS				
I BREAK OBJECTS ACCIDENTLY MORE OFTEN THAN MY FRIENDS (+)				
I HAVE TROUBLE LEARNING NEW OUTDOOR GAMES (+)				
I CAN CATCH A BALL CONSISTENTLY				
I WOULD RATHER BE A SPECTATOR THAN PARTICIPATE IN THE SPORTS GAME (+)				
I CAN EASILY FLOSS BETWEEN MY TEETH				
I HAVE TROUBLE LEARNING NEW OUTDOOR GAMES (+)				
I CAN USE SCISSORS TO NEATLY CUT OUT A PICTURE FROM A MAGASINE				

(+) means that the items is positively worded, and has been reverse scored.

tial test items were initially identified by an extensive literature search using the search terms; DCD, motor competence, motor difficulties, adolescents and adults. Both qualitative and quantitative studies were examined to identify questionnaires related to motor competence (Clark et al., 2013; Kirby et al., 2011b; Tal-Saban et al., 2012; Wilson et al., 2009), and the language and terminology typically used by adolescents (Barnett, Dawes, & Wilmut, 2013; Fitzpatrick & Watkinson, 2003; Kirby et al., 2011b). Given the diagnostic criteria of DCD described in the DSM-5 (APA, 2013), items were included that reflected a range of skills involving aspects of sports, schooling, self-care, activities of daily living, and fine or gross motor tasks typical of adolescents (APA, 2013; Cousins & Smyth, 2003; Fitzpatrick & Watkinson, 2003; Kirby et al., 2011b; Losse et al., 1991; Missiuna et al., 2008a). An initial 29 items were developed (see Fig. 1) using a Likert scale response format of Never (1), Sometimes (2), Frequently (3), and Always (4; see Table 1). In order to avoid response bias, fourteen of the 29 items were reverse scored. The four point Likert scale was chosen rather than an odd numbered response (such as 5 points) to avoid a neutral, undecided midpoint (Lynn, 1986; Polit & Beck, 2006).

Three key informants (2 adults and an older adolescent) who had been diagnosed with DCD, reviewed each item using personal insight based on their lived experience. Consequently, another six items were added and additional examples for some items included, such as, putting on makeup, doing up zip-lock bags, and using a can opener (see Fig. 1). These 35 items were subsequently reviewed by nine experts (psychologists, academics, and members of Western Australian DCD research collaboration team [move.grow.engage](http://movegrowengage.com.au) who have all specialised in the area of DCD) for language, terminology, user-friendliness, ecological and content validity and to ensure a balance of tasks that represented both Criteria A and B from the DSM-5 (APA, 2013). A further 13 items were subsequently included resulting in 48 items. These included items involving social elements like shying away from social events such as dances, feeling neat and tidy on social occasions, keeping up with friends while walking or running and preferring not to participate in physical education classes.

2.2. Phase 2: content validation and item assessment

Content validation of the 48 items was undertaken by an international panel of 10 experts (psychologists, epidemiologists, physiotherapists and academics who specialised in the area of DCD) from Australia, the Netherlands and Canada. Each rated the relevance of each item on a scale of 1 (not relevant) to 4 (highly relevant) to derive a Content Validity Index (CVI) for each item. This was calculated by dichotomizing the items into relevant and not relevant (Polit & Beck, 2006) by grouping those that scored a 3 or 4, and those that scored a 2 or 1. The number of experts who rated an item as relevant was divided by the total number of experts to create a CVI for each item ranging from 0.01 to 1.0. Eight items scored total agreement (CVI = 1.0) and 14 items received 9 out of 10 agreement (CVI = 0.9). Twelve items with a CVI of 0.6 or below were eliminated (Polit & Beck, 2006) resulting in 36 items (see Fig. 1). The eliminated items included: feeling uncomfortable when running, using a computer rather than a pen and a paper to write, running as fast as friends, facing challenges when multitasking, participating in recreational verse competitive sports, feeling neat and tidy on social occasions, keeping the bedroom organised and tidy, naming right and left sides, shying away from social events like school dances, avoiding compulsory school activities like sports carnivals, spending leisure time on their own rather than with friends, and flinching when a hard or fast ball is thrown.

Informal, one-on-one interviews and small group discussions to consider these 36 items were undertaken with 10 adolescents (6 boys and 4 girls) diagnosed with DCD and aged between 12 and 18 years (mean age = 14.89 years). They were recruited through AMPitup, a physical fitness program for adolescents with DCD (<http://movegrowengage.com.au/>). The participants sat with the primary researcher and discussed each item considering comprehensibility and age-appropriateness. They provided further suggestions for items and in some cases rephrased them to be more age-appropriate (e.g. *I can walk as fast as my friends* changed to *I can keep up with my friends when walking*).

Table 2

Descriptive statistics [M,(SD)] of the participants involved in Phase 2 of AMCQ development.

	Total N = 38 (28 males) M, (SD)	SMD (≤ 85) n = 23 (16 males) M, (SD)	TD (> 85) n = 15 (12 males) n = 3 females) M, (SD)	Group Difference (p)
Age (yrs)	14.18, (1.43)	13.87, (1.18)	14.67, (1.67)	0.093
NDI	96.92, (24.91)	114.36, (14.30)	71.33, (10.46)	0.001
AMCQ	82.71, (11.62)	87.39, (8.77)	75.53, (12.04)	0.001

SMD—Suspected motor difficulties; TD—typically developing; NDI—Neuromuscular Developmental Index (M = 100, SD = 15); AMCQ – Adolescent Motor Competence Questionnaire (total score = 104).

2.3. Phase 3: reliability and validity of the AMCQ

In this phase the internal consistency, test-retest reliability, and concurrent validity of the 36-item AMCQ was examined and a preliminary cut score for the identification of SMD identified. A convenience sample of 38 Australian adolescents with a range of motor competence was recruited (Table 2). To ensure some experienced motor difficulties, 15 diagnosed with DCD were recruited from AMPitup, others were children of university staff members (n = 12); of unknown motor competence ability, and a local basketball sporting club (n = 11) considered to have higher motor competence skills. Ages ranged from 12- to 17- years, ($M_{age} = 14.18$ years, $SD = 1.43$; 74% male, 26% female). The inclusion criteria also specified English as the first language and no other diagnosed movement-related disability such as autism spectrum disorder (ASD), cerebral palsy, learning difficulties or muscular dystrophy.

Participants completed the 36 item AMCQ and the MAND at the same test occasion (McCarron, 1997). The time of completion for the AMCQ was less than 10 min (average 4.53 min). The MAND was administered by Exercise and Sports Science professionals with over 10 years' experience in identifying motor difficulties. The MAND is a standardised assessment tool that is widely used to identify mild to severe motor disability (McCarron, 1997). It comprises five fine and five gross motor items, which involve both qualitative and quantitative components, and takes about 25 min to administer. Raw scores are standardised and summed to derive a Neuromuscular Development Index (NDI; $M = 100$, $SD = 15$). NDI scores between 85 and 70 indicate mild motor disability and below 70 indicates a severe motor disability. Evidence of reliability, and content, construct, predictive and concurrent validity is provided by McCarron (1997). Its concurrent validity, as indicated by sensitivity and positive predictive value for identifying 5- to 11-year-olds with SMD, was assessed as good when compared with BOTMP-SF (Bruininks, 1978) by Tan, Parker and Larkin (2001). McCarron (1997) has reported test-retest reliability coefficients of 0.99. In Australia, the MAND has been used as a measure of motor coordination in children (Brantner, Piek, & Smith, 2009; Hands, Kendall, Larkin, & Parker, 2009a), and adolescents (Hands, Kendall, Larkin, & Parker, 2009a; Hands et al., 2009b; Hands, Larkin, & Rose, 2013; Hands, Parker, Rose, & Larkin, 2015b; Hands et al., 2015a; McIntyre, Chivers, Rose & Hands, 2015; Rose, Larkin, Parker, & Hands, 2015). To date, however, no studies have reported evidence of validity with an adult sample.

In the current study, based on the MAND NDI scores, the sample comprised a broad range of motor competence; 23 (61%) had no motor disability (> 85), 10 (26%) had a mild disability (85–70) and five (13%) had a severe motor disability (< 70). The total scores of the AMCQ ranged between 62 and 102 (total possible score 26–104). Significant group differences for both the NDI and AMCQ scores were found between the adolescents identified not to have SMD (typically developing group; TD; > 85) and the SMD group (≤ 85 ; Table 2).

2.3.1. Test-retest reliability

Eighteen of the 38 participants completed the 36-item AMCQ version seven days after the initial administration. A 7 day test-retest interval was used as this time frame is most commonly used by others (Polit, 2014). Unfortunately, due to missing responses and non-applicable options for some items, only 26 of the 36 items in the final version of the AMCQ were able to be included in the analysis. The intra-class correlation coefficient (ICC; two-way mixed model, absolute-agreement) between the total scores for these items was 0.956 (95% confidence interval: 0.888–0.983; $p < 0.001$), which is above the recommended minimum standard of 0.7 (Terwee et al., 2007). A Kappa coefficient for each item ranged between 0.90–0.17. The item with the lowest score related to flossing between teeth. There was no significant difference between the total AMCQ scores between Occasion 1 ($M = 87.94$, $SD = 10.34$) and Occasion 2 scores ($M = 88.82$, $SD = 10.05$; $t(16) = -1.22$, $p < 0.001$).

2.3.2. Internal consistency

Cronbach's alpha was calculated to examine the internal consistency of the 36-item AMCQ. The best fit was determined through the inclusion and exclusion of test items to achieve an acceptable alpha of > 0.7 (Cronbach & Meehl, 1955). Ten items with a corrected item-total correlation of less than 0.3 (Pallant, 2013) were removed resulting in 26 items (see Table 1 for a sample of items) with a high internal consistency ($\alpha = 0.902$). The removed items related to movement skills such as driving a manual car, being tired when physically active, food preparation skills and self-care skills such as shaving.

Table 3

Table of derived cut scores, sensitivity and specificity.

Cut score	C-value	Sensitivity	Specificity
80	68%	53%	78%
81	69%	60%	74%
82	71%	73%	72%
83	74%	80%	70%
84	71%	80%	65%
85	68%	87%	56%

C-Value represents the total proportion of agreement between the AMCQ and the NDI score from the MAND.

Table 4

The decision of agreement between the Adolescent Motor Competence Questionnaire (AMCQ) and the McCarron Assessment of Neuromuscular Development (MAND).

AMCQ (cut score = 83)	MAND (criterion measure)		
	NDI ≤ 85	NDI > 85	Total
AMCQ score ≤ 83	12 (a)	7 (b)	19
AMCQ score > 83	3 (c)	16 (d)	19
Total	15	23	38
Proportion of agreement = 0.74			

a = classification agreement, b = classification disagreement against MAND, c = classification disagreement against AMCQ, d = classification agreement.
 Proportion of agreement = $\{[(a + d)/\text{total sample}] \times 100\}$.

2.3.3. Preliminary cut score for identifying suspected motor difficulties

A potential cut point to identify adolescents with SMD was derived based on the total score for the final 26-item AMCQ version (Crawford, Wilson, & Dewey, 2001; Riggen, Ulrich, & Ozmun, 1990). Using the NDI from the MAND (McCarron, 1997) as the criterion measure, the decision of agreement proportion (represented as a C-value in Table 3) was calculated for a range of cut scores from the AMCQ (80–85). The average total score (out of 104) for those participants with an NDI of ≤ 85 was used to inform this range of cut scores. A relatively conservative preliminary score of 83 was identified as the most valid cutoff score (Table 3), as it showed the highest discrimination accuracy based on the sensitivity (true-positive rate) and specificity (true-negative rate) data (Safrit & Wood, 1995). The sensitivity of the AMCQ was consistent in classifying 80% $[a/(a + c)]$ of adolescents identified with SMD by the MAND (see Table 3). The specificity of the AMCQ was lower with 70% $[d/(b + d)]$ of adolescents identified as TD by the MAND, and classified as TD by the AMCQ (see Table 3). Nineteen of the 38 participants ($a + b$; 50%) scored ≤ 83 on the AMCQ (Table 4). The overall proportion of agreement between the two tests was 74% $\{[(a + d)/\text{total sample}] \times 100\}$. Of the 38 adolescents, 15 ($a + c$) were classified as having SMD based on the NDI (score ≤ 85), and 12 of those cases were also identified by the AMCQ (AMCQ score ≤ 83). Three adolescents were classified with SMD by the MAND and not by the AMCQ. Seven adolescents were classified with SMD by the AMCQ and not by the MAND.

2.3.4. Concurrent validity

The total score for the AMCQ was compared with the NDI from the MAND to examine concurrent validity. The MAND is a widely used standardised test designed to assess motor competence. Fig. 2 depicts the line of best fit and the 95% confidence limits between the scores for these two measures. It reveals a moderate positive correlation ($r = 0.491$, $p < 0.002$) between the two scores, with only the score for one participant slightly outside the lower limit of 95. The positive correlation demonstrates that the higher the NDI ($> 85 = \text{TD}$), the higher the total score on the AMCQ ($> 83 = \text{TD}$). The TD group had a significantly higher AMCQ score ($M = 87.39$, $SD = 8.77$) than the SMD group ($M = 75.53$, $SD = 12.04$; $t(36) = -3.5$, $p < 0.001$).

To further investigate the ability of the items to discriminate between levels of motor competence, the mean scores for each item were ranked based on the mean score differences between the TD group and SMD group (Fig. 3). These ranged from -0.23 (item 18) to $+0.96$ (item 20). The three items that were significantly different between the TD and SMD groups related to individual over team sports (item 2, $p = 0.008$), speed of writing (item 17; $p = 0.002$) and flossing teeth (item 20; $p = 0.002$).

3. Discussion

The development of the AMCQ was exploratory in nature and followed a robust process. It was undertaken over three phases and the results indicate that the 26 item questionnaire has the potential to be a valid and reliable measure for adolescents to self-report on their level of motor competence. The development of the AMCQ was examined in a number of ways to ensure the ecological presence of the condition was captured (Wilson et al., 2010) and that the criteria for the diagnosis of DCD were considered. The time to complete the questionnaire was acceptable. It took adolescents less than 10 min to complete thereby minimising response fatigue that may cause poor motivation or loss of attention (Moser & Kalton, 1971). Other adult and older adolescent questionnaires also reported similar completion times of up to 10 min (Kirby et al., 2010; Tal-Saban et al., 2012).

Fig. 2. The distribution of the total scores on the AMCQ (total score = 104) and the NDI (≤ 85 mild to severe difficulty > 85 no motor difficulty) score from the MAND, based on the line of best fit and 95% confidence intervals.

Fig. 3. Mean AMCQ scores for the suspected motor difficulty (SMD; $\text{NDI} \leq 85$) and the typically developing (TD; $\text{NDI} > 85$) groups. Items are sequenced based on the mean difference between the TD group. 1 = never and 4 = always.

The items considered for inclusion were drawn from a number of sources. These included the range of motor skills used as exemplars in the DSM-5 (APA, 2013), suggestions from adolescents with SMD, and experts from the field. The consultation process to validate the content was similar to that followed by other developers of motor difficulty questionnaires (Kirby et al., 2010; Tal-Saban et al., 2012). Consequently, items relating to sport, academics, fine and gross motor skills and activities of daily living, personal care, peer comparisons and co-occurring characteristics were included. Assumptions are often made that items measuring motor competence in children can simply be modified in a variety of ways to accommodate an older age group (Hands et al., 2015a,b). However, during the validation process we found this was not the case and the inclusion or exclusion of items are discussed below. The final version of the AMCQ is able to discriminate between adolescents with and without SMD as evidenced by the significant difference between both NDI and AMCQ scores for the SMD and TD groups (Table 2).

Physical activities such as kicking, catching and throwing a ball (Clark et al., 2013; Tal-Saban et al., 2012; Wilson et al., 2009; van der Linde et al., 2014), jumping (Wilson et al., 2009), participating in extreme sports, dancing, riding a bicycle (Tal-Saban et al., 2012), or participating in team games (Clark et al., 2013; Kirby et al., 2010) have been included in other questionnaires as they are considered to be difficult for those with SMD. Therefore, the AMCQ also includes items involving ball skills such as kicking (item 4), catching (item 8) and throwing (item 1) as well as static (on one foot; item 24) and dynamic balance (walking on a narrow straight line; item 25). Such tasks are important for both younger children and adolescents (APA, 2013). The mean scores for all of these items in the AMCQ clearly distinguish between the SMD group and the TD group (Fig. 3). On the other hand, items more relevant to adolescence and not childhood related to playing ball games like team sports (APA, 2013).

Difficulties with fine motor skills such as utensil or scissor use, learning a musical instrument, threading a needle or hammering a nail (Clark et al., 2013; Kirby et al., 2010; Wilson et al., 2009; van der Linde et al., 2014) are also common for individuals with motor difficulties. Consequently, most motor assessment questionnaires include items related to handwriting (van der Linde et al., 2014), fast or legible writing (Kirby et al., 2010; Tal-Saban et al., 2012; Wilson et al., 2009), quality of the hand writing (Clark et al., 2013) and appropriate tension while writing (Wilson et al., 2009). Such items are very relevant given slowness or inaccuracy of handwriting may be experienced throughout the lifespan (Bo et al., 2014; Kirby et al., 2008; Prunty, Barnett, Wilmut, & Plumb, 2014), and may impact on academic productivity and achievement of future goals (APA, 2013). Therefore, The AMCQ also included handwriting items about ease of reading (item 12) and speed of writing (item 17) as well as the use of scissors (item 11) and flossing between teeth (item 20). These latter two items attracted some of the largest mean differences in scores between the SMD and TD groups and may be of particular relevance among adolescents (Fig. 3).

Personal and self-care is a central feature of criterion B of the DSM-5 (APA, 2013) and need to be considered when assessing motor difficulties. For example, one parent report questionnaire included items related to washing hands, drying after a shower, and putting on socks (DCDDaily-Q; van der Linde et al., 2014) while another designed for adults included difficulty tying shoelaces, fastening buttons, doing zips, and shaving or putting on make-up (ADC; Kirby et al., 2010). The AMCQ included items about getting ready to go out (item 7) and speed of changing clothes (item 22). These items were suggested by the target group so are probably more age-appropriate in content and wording than the wording in other questionnaires.

DCD is often diagnosed concurrently with other developmental disorders such as Autism Spectrum Disorder, learning difficulties or Attention Deficit Hyperactivity Disorder (ADHD; Loh, Piek, & Barrett, 2011; van Damme, Sabbe, van West, & Simons, 2015). When examining item content of other questionnaires used with this age group, it appeared some items related to symptoms associated with these co-occurring conditions rather than DCD. Examples include organizational skills (Clark et al., 2013; Tal-Saban et al., 2012), finding new buildings or things in the bedroom, ability to sit still (Kirby et al., 2010), not fatigue, and slouching (Wilson et al., 2009). In the first phase, items that strongly related to possible co-occurring disorders (facing challenges while multitasking, keeping the bedroom neat and tidy), were included however the only item that remained in the final version related to confusion between right and left sides (item 16). This highlights the value of discussing and validating the content of questionnaire items with the target audience rather than only parents or academics. For example, in this study, the adolescents advised that they did not value neat and tidy bedrooms as it was a space for personal expression.

The AMCQ has several unique features. It includes items about perceptions of sports participation as many adolescents avoid participating in activities that expose their weaknesses and highlight their difficulties, even from a young age (Cairney et al., 2010; Fitzpatrick & Watkinson, 2003; Kwan et al., 2013; Raz-Silbiger et al., 2015). For example, being a spectator (item 10), learning new games (item 26) and the preference for participation in individual sports over team sports (item 2) are coping strategies adopted by adolescents with motor difficulties. Fitzpatrick and Watkinson (2003) found adolescents with motor difficulties still wanted to participate in physical activities for social reasons so they often volunteered for jobs such as organizer or team manager. Adolescents with motor difficulties reflecting on their childhood reported that learning new motor tasks was difficult (Missiuna et al., 2008a) and that fear of failure was the greatest barrier to participating in new activities as they grew older (Barnett, Dawes, & Wilmut, 2013; Fitzpatrick & Watkinson, 2003). As with the fine motor items, scores for items relating to peer comparison in sports participation had greater mean differences between the SMD group and the TD group (Fig. 3). Most adolescents develop their friendship groups primarily based on the socializing opportunities associated with sports participation (Missiuna et al., 2008a; Payne et al., 2013). Such peer-related items are important to include with this age group yet have been overlooked in other questionnaires. It is possible that during later adolescence

and into adulthood, peer relationships are developed around more sedentary social activities as they enter the workforce or later education (Kirby et al., 2011a; Kirby et al., 2011b).

Surprisingly, the SMD group had similar or more positive mean scores than the TD group for three items (items 14, 18, 23; Fig. 3), although none were significantly different. Responses to Item 18 (nervous about coming last in a running race) suggest that the TD group experience greater feelings of nervousness about their performance when running than the SMD group. This could be because the SMD group know they are not going to perform well, as they have experienced coming last for most of their school life. It could also be that participation in running races during athletic carnivals becomes optional in secondary school, and the SMD group choose not to participate. Rose et al. (2015) found that many adolescents with motor difficulties withdrew from physical activities involving social comparison. Barnett, Cliff, Morgan, and van Beurden (2013) reported that a common motivator for individuals with SMD to participate in sport or physical activity was related more to social engagement than competition. Another item relating to breaking objects accidentally more than friends (item 23) also attracted similar scores. This is surprising as the AMPitup participants consulted in the second Phase considered this item reflected their poor co-ordination. However, the result could reflect a number of strategies put in place by the adolescent and/or his family to minimise breakages (Summers, Larkin, & Dewey, 2008). Finally, both groups scored similarly for Item 14 (difficulty using a fork and knife) which suggests that adolescents with SMD used utensils in a way that masked their motor difficulties, or their difficulty was accepted by the family, and this activity was not an issue (Fitzpatrick & Watkinson, 2003; Missiuna et al., 2008a). It is also possible that as the item did not adequately describe what was considered acceptable practice (e.g. not using a shoveling technique). These three items were retained in the AMCQ as the internal consistency measure remained high. However, their inclusion may be reconsidered after analyzing data from a larger sample.

A consideration of the content of excluded items also contributes to a better understanding of the impact of motor difficulties during adolescence. These related to difficulties using video game controllers, keeping up with friends while walking and tiring easily when being physically active. Unfortunately, these could be experienced by many unfit, low active, yet typically developing adolescents. Other items excluded related to fine motor skills such as using a vegetable peeler, possibly because adolescents with SMD avoided these tasks when helping with meal preparation. Finally, items that were mainly relevant for older adolescents such as shaving or learning to drive were removed.

3.1. Study limitations and strengths

Given this was an exploratory study, the sample size used to derive the preliminary cut score was small and therefore a limitation. Further research involving a larger sample may confirm the most valid cut score for identifying those with motor difficulties. At the same time, further evidence of the concurrent validity of the tool could be gathered by simultaneously assessing motor competence using the MAND. This study also had a number of strengths. The wide range of methods used for item generation and content validation, including consultation with local and international experts, and individual interviews and discussions with the target audience resulted in a rich selection of potential items. The in-depth discussions with the adolescents ensured the content and wording of each item captured the ecological presence of motor competence difficulties in this age group. The preliminary results reported here provide evidence of internal consistency, test-retest reliability and concurrent validity. It is the first self-report questionnaire developed to assist in identifying young adolescents with SMD.

4. Conclusions

The AMCQ has the potential to assist in future research and is a useful addition to the range of tools used to assess motor competence. Further research is needed to explore possible clinical applications of the questionnaire, for example to examine if a childhood diagnosis of DCD is still present during adolescence or to identify the extent of SMD in adolescents with other developmental disabilities such as ASD, ADHD or learning disabilities. Responses from the AMCQ will provide information to researchers about adolescent's perceptions of their SMD and may also be useful for families and health professionals to better understand the condition in this age group.

Acknowledgements

The authors would like to acknowledge the key informants, experts and participants who were involved in phases of the questionnaire validation process. We would also like to thank the Western Australian DCD research collaboration team (Move.Grow.Engage): Jan Piek, Melissa Licari, Helen Parker, Elizabeth Rose, Paola Chivers, Daniela Rigoli and Helen Beaton who assisted in the development and validation of the questionnaire. This project is supported through the Australian Government's Collaborative Research Networks (CRN) program.

References

- American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders (text rev.)* (4th ed.). Arlington, VA: American Psychiatric Publishing.
- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.
- American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: American Psychiatric Press.

- Barnett, L., Cliff, K., Morgan, P., & van Beurden, E. (2013). Adolescents' perception of the relationship between movement skills, physical activity and sport. *European Physical Education Review*, 19(2), 271–285. <http://dx.doi.org/10.1177/1356336x13486061>
- Barnett, A. L., Dawes, H., & Wilmut, K. (2013). Constraints and facilitators to participation in physical activity in teenagers with Developmental Co-ordination Disorder: An exploratory interview study. *Child Care Health Development*, 39(3), 393–403. <http://dx.doi.org/10.1111/j.1365-2214.2012.01376.x>
- Bo, J., Colbert, A., Lee, C. M., Schaffert, J., Oswald, K., & Neill, R. (2014). Examining the relationship between motor assessments and handwriting consistency in children with and without probable developmental coordination disorder. *Research in Developmental Disabilities*, 35(9), 2035–2043. <http://dx.doi.org/10.1016/j.ridd.2014.04.027>
- 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. <http://dx.doi.org/10.1037/a0017315>
- Bruininks, R. H., & Bruininks, B. D. (2005). *Bruininks-Oseretsky test of motor proficiency* (2nd ed.). Windsor, England: NFER-Nelson.
- Bruininks R.H., Bruininks-Oseretsky Test of Motor Proficiency: Examiner's Manual, 1978, Circle Pines, MN: American Guidance Services.
- Cairney, J., Hay, J. A., Veldhuizen, S., Missiuna, C., & Faght, B. E. (2010). Developmental coordination disorder, sex, and activity deficit over time: A longitudinal analysis of participation trajectories in children with and without coordination difficulties. *Developmental Medicine Child Neurology*, 52(3), e67–e72. <http://dx.doi.org/10.1111/j.1469-8749.2009.03520>
- Cantell, M. H., Smyth, M. M., & Ahonen, T. P. (2003). Two distinct pathways for developmental coordination disorder: Persistence and resolution. *Human Movement Science*, 22(4–5), 413–431.
- Clark, C. J., Thomas, S., Khattab, A. D., & Car. (2013). Development and psychometric properties of a screening tool for assessing developmental coordination disorder in adults. *International Journal of Physical Medicine & Rehabilitation*, 1(5), 1–9. <http://dx.doi.org/10.4172/2329-9096.1000145>
- Cousins, M., & Smyth, M. (2003). Developmental coordination impairments in adulthood. *Human Movement Science*, 22, 433–459. <http://dx.doi.org/10.1016/j.humov.2003.09.003>. Elsevier Inc.
- 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. http://dx.doi.org/10.1300/J006v20n02_03
- Cronbach, L. J., & Meehl, P. E. (1955). Construct validity in psychological tests. *Psychological Bulletin*, 52(4), 281–302. <http://dx.doi.org/10.1037/h0040957>
- Fitzpatrick, A., & Watkinson, J. (2003). The lived experience of physical awkwardness: Adults Retrospective views. *Adapted Physical Activity Quarterly*, 20(3), 279–297.
- Hands, B., Kendall, G., Larkin, D., Rose, E., & Parker, H. (2009). Perinatal risk factors for developmental coordination disorder. *International Journal of Disability, Development and Education*, 56(4), 317–331. <http://dx.doi.org/10.1080/10349120903306533>
- Hands, B., & Larkin, D. (2002). Physical fitness and developmental coordination disorder. In *Developmental coordination disorder*. pp. 172–184. Albany, NY: Delmar Thomson Learning, Inc.
- Hands, B., Larkin, D., Parker, H., Straker, L., & Perry, M. (2009). The relationship among physical activity, motor competence and health-related fitness in 14-year-old adolescents. *Scandinavian Journal of Medicine and Science in Sports*, 19(5), 655–663. <http://dx.doi.org/10.1111/j.1600-0838.2008.00847.x>
- Hands, B., Larkin, D., & Rose, E. (2013). Reprint of 'The psychometric properties of the McCarron Assessment of Neuromuscular Development as a longitudinal measure with Australian youth'. *Human Movement Science*, 32(5), 1163–1175. <http://dx.doi.org/10.1016/j.humov.2013.08.003>
- Hands, B., Licari, M., & Piek, J. (2015). A review of five tests to identify motor coordination difficulties in young adults. *Research in Developmental Disabilities*, 41–42, 40–51. <http://dx.doi.org/10.1016/j.ridd.2015.05.009>
- Hands, B., Parker, H., Rose, E., & Larkin, D. (2015). Gender and motor competence affects perceived likelihood and importance of physical activity outcomes among 14 year olds. *Child: Care, Health and Development*, 42(2), 246–252.
- Henderson, S. E., Sugden, D. A., & Barnett, A. L. (2007). Movement assessment battery for children. In *Examiner's manual* (2nd ed.). London: Harcourt: Assessment.
- Kirby, A., Edwards, L., & Sugden, D. (2011a). Emerging adulthood in developmental co-ordination disorder: Parent and young adult perspectives. *Research in Developmental Disabilities*, 32(4), 1351–1360. <http://dx.doi.org/10.1016/j.ridd.2011.01.041>
- Kirby, A., Edwards, L., & Sugden, D. (2011b). Emerging adulthood and developmental co-ordination disorder. *Journal of Adult Development*, 18(3), 107–113. <http://dx.doi.org/10.1007/s10804-011-9123-1>
- Kirby, A., Edwards, L., Sugden, D., & Rosenblum, S. (2010). The development and standardization of the adult developmental co-ordination disorders/dyspraxia checklist (ADC). *Research in Developmental Disabilities*, 31(1), 131–139. <http://dx.doi.org/10.1016/j.ridd.2009.08.010>
- Kirby, A., Sugden, D., Beveridge, S., & Edwards, L. (2008). Developmental co-ordination disorder (DCD) in adolescents and adults in further and higher education. *Journal of Research in Special Educational Needs*, 8(3), 120–131. <http://dx.doi.org/10.1111/j.1471-3802.2008.00111.x>
- Kwan, M. Y. W., Cairney, J., Hay, J. A., & Faght, B. E. (2013). Understanding physical activity and motivations for children with developmental coordination disorder: An investigation using the theory of planned behavior. *Research in Developmental Disabilities*, 34(11), 3691–3698. <http://dx.doi.org/10.1016/j.ridd.2013.08.020>
- Lingam, R. P., Novak, C., Emond, A., & Coad, J. E. (2013). The importance of identity and empowerment to teenagers with developmental co-ordination disorder. *Child Care Health Development*. <http://dx.doi.org/10.1111/cch.12082>
- Loh, P. R., Piek, J. P., & Barrett, N. C. (2011). Comorbid ADHD and DCD: Examining cognitive functions using the WISC-IV. *Resource Development Disability*, 32(4), 1260–1269. <http://dx.doi.org/10.1016/j.ridd.2011.02.008>
- Losse, A., Henderson, S. E., Elliman, D., Hall, D., Knight, E., & Jongmans, M. (1991). Clumsiness in children? do they grow out of it? A 10-year follow-up study. *Development Medicine Child Neurology*, 33(1), 55–68.
- Lynn, M. R. (1986). Determination and quantification of content validity. *Nursing Research*, 35(6), 382–386;385. Retrieved from: <http://journals.lww.com/nursingresearchonline/pages/default.aspx>
- McCarron, L. (1997). *McCarron assessment of neuromuscular development* (3rd ed.). Dallas, TX: McCarron-Dial Systems Inc.
- McIntyre, F., Chivers, P., Rose, E., & Hands, B. (2015). Exercise can improve physical self perceptions in adolescents with low motor competence. *Human Movement Science*, 42, 333–343. <http://dx.doi.org/10.1016/j.humov.2014.12.003>
- Missiuna, C., Gaines, R., Soucie, H., & McLean, J. (2006). Parental questions about developmental coordination disorder: A synopsis of current evidence. *Paediatric Child Health*, 11(8), 507–512.
- 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*, 75(3), 157–166. <http://dx.doi.org/10.2182/cjot.07.012>
- 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 Early Electronic Edition*, 75(1), 26–34. <http://dx.doi.org/10.2182/cjot.07.012>
- Moser, C. A., & Kalton, G. (1971). *Survey methods in social investigation* (2nd ed.). London: Heinemann Educational Books Ltd.
- Okely, A. D., Booth, M. L., & Patterson, J. W. (2001). Relationship of physical activity to fundamental movement skills among adolescents. *Medical Journal of Science Sports Exercise*, 33(11), 1899–1904.
- Onwuegbuzie, A. J., Bustamante, R. M., & Nelson, J. A. (2010). Mixed research as a tool for developing quantitative instruments. *Journal of Mixed Methods Research*, 4(1), 56–78. <http://dx.doi.org/10.1177/1558689809355805>
- Pallant, J. (2013). *SPSS Survival manual: A step by step guide to data analysis using IBM SPSS* (5th ed.). Sydney: Allen & Unwin.
- Payne, S., Ward, G., Turner, A., Clare Taylor, M., & Bark, C. (2013). The social impact of living with developmental coordination disorder as a 13-year-old. *British Journal of Occupational Therapy*, 76(8), 362–369. <http://dx.doi.org/10.4276/030802213x13757040168315>
- Piek, J., Baynam, G., & Barrett, N. (2006). The relationship between fine and gross motor ability, self-perceptions and self-worth in children and adolescents. *Human Movement Science*, 25, 65–75. <http://dx.doi.org/10.1016/j.humov.2005.10.011>

- Polit, D. F. (2014). Getting serious about test-retest reliability: A critique of retest research and some recommendations. *Quality of Life Research*, 23(6), 1713–1720. <http://dx.doi.org/10.1007/s11136-014-0632-9>
- Polit, D. F., & Beck, C. T. (2006). The content validity index: Are you sure you know what's being reported? Critique and recommendations. *Research in Nursing & Health*, 29(5), 489–497. <http://dx.doi.org/10.1002/nur.20147>
- Poulsen, A. A., Ziviani, J. M., & Cuskelly, M. (2007). Perceived freedom in leisure and physical co-ordination ability: Impact on out-of-school activity participation and life satisfaction. *Child Care Health Development*, 33(4), 432–440. <http://dx.doi.org/10.1111/j.1365-2214.2007.00730.x>
- Pratt, M. L., & Hill, E. L. (2011). Anxiety profiles in children with and without developmental coordination disorder. *Research in Developmental Disabilities*, 32(4), 1253–1259. <http://dx.doi.org/10.1016/j.ridd.2011.02.006w>
- Prunty, M. M., Barnett, A. L., Wilmut, K., & Plumb, M. S. (2014). An examination of writing pauses in the handwriting of children with developmental coordination disorder. *Research in Developmental Disabilities*, 35(11), 2894–2905. <http://dx.doi.org/10.1016/j.ridd.2014.07.033>
- Raz-Silbiger, S., Lifshitz, N., Katz, N., Steinhart, S., Cermak, S. A., & Weintraub, N. (2015). Relationship between motor skills, participation in leisure activities and quality of life of children with developmental coordination disorder: Temporal aspects. *Research in Developmental Disabilities*, 38, 171–180. <http://dx.doi.org/10.1016/j.ridd.2014.12.012>
- Riggen, K. J., Ulrich, D. A., & Ozmun, J. C. (1990). Reliability and concurrent validity of the test of motor impairment-henderson revision. *Adapted Physical Activity Quarterly*, 7(3), 249–258.
- Rose, E., Larkin, D., Parker, H., & Hands, B. (2015). Does motor competence affect self-perceptions differently for adolescent males and females? (October–December, pp. 1–9). SAGE Open Press. <http://dx.doi.org/10.1177/2158244015615922>
- Safrit, M. J., & Wood, T. M. (1995). *Introduction to measurement in physical education and exercise science* (3rd ed.). St. Louis, Missouri: Mosby.
- Summers, J., Larkin, D., & Dewey, D. (2008). Activities of daily living in children with developmental coordination disorder: Dressing, personal hygiene, and eating skills. *Human Movement Science*, 27(2), 215–229. <http://dx.doi.org/10.1016/j.humov.2008.02.002>
- Tal-Saban, M. T., Ornoy, A., Grotto, I., & Parush, S. (2012). Adolescents and adults coordination questionnaire: Development and psychometric properties. *American Journal of Occupational Therapy*, 66(4), 406–413. <http://dx.doi.org/10.5014/ajot.2012.003251>
- Tan, S. K., Parker, H. E., & Larkin, D. (2001). Concurrent validity of motor tests used to identify children with motor impairment. *Adapted Physical Activity Quarterly*, 18(2), 168–182.
- Terwee, C. B., Bot, S. D. M., de Boer, M. R., van der Windt, D. A. W. M., Knol, D. L., Dekker, J., & de Vet, H. C. W. (2007). Quality criteria were proposed for measurement properties of health status questionnaires. *Journal of Clinical Epidemiology*, 60(1), 34–42. <http://dx.doi.org/10.1016/j.jclinepi.2006.03.012>
- Timler, A., McIntyre, F., Cantell, M., Crawford, S., & Hands, B. (2015). AMCQ: Adolescent motor competence questionnaire [Self-report questionnaire]. *Unpublished Instrument*.
- van Damme, T., Sabbe, B., van West, D., & Simons, J. (2015). Motor abilities of adolescents with a disruptive behavior disorder: The role of comorbidity with ADHD. *Research in Developmental Disabilities*, 40(0), 1–10. <http://dx.doi.org/10.1016/j.ridd.2015.01.004>
- van der Linde, B. W., Van Netten, J. J., Otten, B., Postema, K., Geuze, R. H., & Schoemaker, M. M. (2014). Psychometric properties of the DCDDaily-Q: A new parental questionnaire on children's performance in activities of daily living. *Research in Developmental Disabilities*, 35, 1711–1719. <http://dx.doi.org/10.1016/j.ridd.2014.03.008>
- 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), 182–202. <http://dx.doi.org/10.1080/01942630902784761>
- Wilson, B. A., Emslie Hazel, J., Alderman, N., & Burgess, P. (2010). The development of an ecologically valid test for assessing patients with a dysexecutive syndrome. *Neuropsychological Rehabilitation*, 8(3), 213–228. <http://dx.doi.org/10.1080/713755570>
- World Health Organisation (2007) The ICD-10 Classification of Mental and Behavioral Disorders: F80 Disorders of Psychological Development.