Adolescents and Adults Coordination Questionnaire: Development and Psychometric Properties

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OBJECTIVE. This article describes the development of a brief, ecologically valid, self-report questionnaire, the Adolescents and Adults Coordination Questionnaire (AAC–Q), used to identify developmental coordination disorder (DCD) in adolescents and adults.

METHOD. The AAC–Q was completed by 28 adolescents and adults with suspected DCD ages 16–35 yr (mean \( M \) age = 21.18 yr) and 28 peers without DCD (\( M \) age = 27.64 yr). Cutoff scores for suspected DCD were established using data from a sample of 2,379 participants ages 19–25 yr (\( M \) age = 20.68 yr).

RESULTS. Reliability of the AAC–Q was determined using Cronbach’s \( \alpha \) (\( \alpha = .88 \)) and test–retest reliability (\( r = .94, p < .001 \)). Independent-sample \( t \) tests to assess construct validity revealed significant differences between participants with and without DCD, \( t(27) = 9.37, p < .001 \).

CONCLUSION. The AAC–Q is a standardized, reliable, and valid tool with potential for both research and clinical use.


Developmental coordination disorder (DCD) is defined by the Diagnostic and Statistical Manual of Mental Disorders (4th ed., text rev.; DSM–IV–TR; American Psychiatric Association [APA], 2000) according to four criteria:

A. Performance in daily activities that require motor coordination is substantially below expected given the person’s chronologic age and measured intelligence.  
B. The disturbance in Criterion A substantially 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, muscular dystrophy), and it 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. (APA, 2000, p. 58)

Among children, the prevalence of motor coordination dysfunction has been estimated at 6%–10% (APA, 2000; Dewey, 1995; Hamilton, 2002), yet little data exist with respect to the prevalence of this condition among adolescents and adults (Germak, Gubbay, & Larkin, 2002) despite accumulating evidence that this condition is often not outgrown (Cantell & Kooistra, 2002). In recent years, awareness has increased of the high occurrence of motor coordination deficits among older populations (Kirby, Edwards, Sugden, & Rosenblum, 2010; Kirby, Sugden, Beveridge, & Edwards, 2008), yet whether such deficits occur in the same people diagnosed in childhood is unknown. It is possible that children who were within the “borderline” or even “normal” range in childhood would be diagnosed in a different category as they get older because of differing environmental and functional demands. Moreover, people who learn coping strategies might also find themselves in a different diagnostic category in adulthood.
Moreover, comorbidity of DCD and other conditions, such as attention deficit hyperactivity disorder, has also been recognized (Martin, Pick, & Hay, 2006). Data are lacking, however, regarding the prevalence of DCD in adulthood in the absence of comorbid conditions (Cermak et al., 2002). The development of a DCD screening instrument designed to suit the specific needs of adolescents and adults is important because the environmental and functional demands of adolescence and adulthood differ from those of childhood. Older people are required to cope in environments that demand more independence than those of childhood and need to succeed at tasks requiring higher levels of independence, organization, and planning. In addition, adolescents and adults experience greater demand for multitasking and smooth transfer between activities than children (Cantell & Kooistra, 2002; Cousins & Smyth, 2003).

Despite the lack of data concerning the prevalence of DCD in adulthood, studies have shown that motor coordination deficits identified in childhood are likely to continue into adulthood, influencing a range of areas (Cermak et al., 2002; Kirby et al., 2008). For example, Cousins and Smyth (2003) found that adults ages 18–65 who had been identified with motor coordination deficits in childhood continued to suffer from motor coordination difficulties in adulthood, expressed as slowness in performing motor activities, clumsiness, and avoidance of common daily activities.

Adolescents with motor difficulties have also been described as having difficulty in performing complex daily functions that involve organization and time management, such as driving, writing, using technical appliances, and engaging in technologically related activities (Cousins & Smyth, 2003; Hellgren, Gillberg, Gillberg, & Enerskog, 1993; Losse et al., 1991; Pereira, Eliasson, & Forssberg, 2000). Mandich, Polatajko, and Rodger (2003) found that adults with DCD were limited in their participation in daily life activities.

In addition, social, behavioral, and emotional challenges with a direct influence on self-image are commonly reported among people who have difficulties in motor coordination (Kaplan, Dewey, Crawford, & Wilson, 2001; Mandich et al., 2003; Miller, Missiuna, Macnab, Malloy-Miller, & Polatajko, 2001; Missiuna & Polatajko, 1995; Segal, Mandich, Polatajko, & Cook, 2002). In a study by Skinner and Piek (2001), adolescents with DCD were found to have lower self-image and self-esteem than adolescents without DCD.

Despite the increasing awareness of the implications of DCD, Kirby et al. (2008) noted that the testing of adults with DCD remains a new phenomenon. Only in recent years have tools that identify DCD been expanded to include slightly older age ranges. For example, the Movement Assessment Battery for Children, Second Edition (MABC–2; Henderson, Sugden, & Barnett, 2007) was expanded to assess children and teenagers ages 3–16 yr, 11 mo (the earlier version assessed children up to age 12; Brown & Lalor, 2009), and the second edition of the Bruininks–Oseretsky Test of Motor Proficiency (BOT–2; Bruininks & Bruininks, 2005) was designed to assess children and teenagers ages 4–21 yr (the earlier version assessed children up to age 14.5). These norm-referenced tests, however, assess activities that are not functionally appropriate for older age groups, and they are time consuming to administer.

For older people, few checklists and questionnaires are available; two such instruments are the Checklist of the MABC–2 (Henderson et al., 2007) and the Adult Developmental Coordination Disorders/Dyspraxia Checklist (ADC; Kirby et al., 2010). Although the development of these instruments for older populations is indeed encouraging, they are inadequate to assess all elements of DCD in adolescence and adulthood. The MABC–2 Checklist has benefits in that it assesses movement in static and dynamic environments and nonmotor factors affecting movement, yet its expansion to include adolescents up to age 16 is insufficient to adequately assess people with DCD at older ages.

The ADC is a recent contribution to the battery of questionnaires for adolescents and young adults (Kirby et al., 2010). The developers of this questionnaire included a wide range of areas of occupation, and the questionnaire provides important information regarding the person’s motor history. Initial evidence of the psychometric properties of the ADC is encouraging. As the developers noted, however, this questionnaire is still in the initial stages of development, and the need remains to develop cutoff scores for its use. In addition, the questionnaire includes 40 items, and the person is asked to expand on his or her responses in writing; this format implies that the ADC may be useful in treatment planning for older people with DCD. Brief screening instruments for this population, however, are still lacking.

A commonly used tool for conducting research with adolescent and adult populations is the self-report questionnaire. This method is advantageous because it generally involves fewer costs, making it easier to administer to a larger sample. Further advantages are that no specific training is required, and the interviewer does not play a role in influencing the person’s answers, thus enhancing standardization (Pedhazur & Pedhazur-Schmelkin, 1991). When developing an instrument to objectively assess
performance through self-report, content validity is an important first step in the process (Haynes, Richard, & Kubany, 1995). A table of specifications is a commonly used and recommended method of assessing content validity because it enables the systematic assessment of whether all areas are represented (Benson & Clark, 1982). To be sure that the instrument generates consistent information over time, test–retest reliability must be assessed (American Educational Research Association, 1991). In addition, examination of internal consistency is essential to ensure homogeneity of the test items (Domholdt, 2005).

Another important consideration in developing an instrument is construct validity. Construct validity may be evaluated in several ways, including the known-groups procedure and factor analysis (Pedhazur & Pedhazur-Schmelkin, 1991), which tests whether a common factor exists using different observable items (Domholdt, 2005). In addition, it is important to assess ecological validity, or the degree to which the behaviors observed reflect the behaviors that occur in the natural setting (Shadish, Cook, & Campbell, 2002). It is crucial to include items that reflect functional tasks and activities that can be generalized to naturalistic environments such as home and work (Long, 1996; Norris & Tate, 2000).

Finally, for an instrument to be useful, the establishment of cutoff scores for defining the phenomenon is necessary. Different purposes, such as clinical practice or research, may necessitate different cutoff scores. Geuze, Jongmans, Schomaker, and Smits-Engelsman (2001) considered this question extensively in the context of DCD and concluded the following:

For clinical practice a cut-off at the 15th centile (1 SD) is proposed (Clinical Diagnostic Criteria). For basic research a cut-off at the fifth centile (1.65 SD) is recommended (Research Diagnostic Criteria). Children with scores in the intermediate range, i.e. between the fifth and the 15th centile, may be considered as "borderline." (p. 34)

We developed the Adolescents and Adults Coordination Questionnaire (AAC–Q) in light of the limited information available regarding DCD among adolescents and adults and the limited means available of assessing this population. This article describes the development of this brief, user-friendly, and ecologically valid self-report questionnaire to identify and investigate DCD in adolescents and adults up to age 35 and describes its psychometric properties. Because of the extensive steps we took to ensure its psychometric properties, this questionnaire may address the important question of the prevalence of DCD among this population. In addition, it may provide answers as to how DCD is expressed beyond childhood. Moreover, with its ecological orientation, the AAC–Q can enable a greater understanding of how DCD influences participation and function in the daily life activities of adolescents and adults, information that may guide the development of more effective intervention programs for this population.

**Method**

Our study included three phases: (1) the development of the AAC–Q, (2) the initial assessment of its psychometric properties, and (3) the establishment of cutoff scores for suspected DCD using the AAC–Q with adolescents and adults up to age 35. Data collection procedures for the first two phases were approved by the ethics committee of the School of Occupational Therapy of the Medical Faculty of the Hebrew University of Jerusalem. Phase 3 was approved by the ethics committee of the Israeli Defense Force.

**Phase 1: Development of the AAC–Q**

**Item Development.** The first step in constructing the questionnaire was to develop a pool of functional tasks and activities likely to cause difficulty for adolescents and adults up to age 35 with DCD, in accordance with DSM–IV–TR Criteria A and B. We developed this pool following a comprehensive review of the literature (Cermak et al., 2002; Geuze et al., 2001; Kirby et al., 2008), an extensive review of the items on existing DCD checklists for children and young adults (Henderson & Sugden, 1992; Wilson, Kaplan, Crawford, Campbell, & Dewey, 2000), interviews with typical adolescents and adults about the activities they participated in, and input from professionals with extensive clinical experience in the assessment and treatment of adolescents and adults with deficits in motor coordination. We transformed the resulting pool of functional tasks and activities into 18 potential items.

**Content Validity.** For the 18 items, we established content validity through a table-of-specifications procedure. All items represented areas and realms of function that are vital to the everyday performance of life tasks such as basic and instrumental activities of daily living (BADLs and IADLs), organization skills, spatial and temporal orientation, fine and gross motor function, and writing; in this way, we also established ecological validity of the instrument. We presented the 18 items to eight occupational therapy practitioners who had expertise in treating people with DCD and asked them to rate the relevance of the items
The American Journal of Occupational Therapy

409

The purpose of Phase 2 was to determine the internal consistency, test–retest reliability, and construct validity of the AAC–Q among a pilot sample of adolescents and adults with and without DCD.

Participants. The DCD group was a convenience sample of 28 adolescents and young adults (mean [M] age = 27.82 yr, standard deviation [SD] = 4.73; 32.1% male, 67.9% female) diagnosed with DCD by qualified medical professionals including neurologists, occupational therapists, and physical therapists. We recruited participants with DCD by contacting professionals who worked with adults who had motor coordination deficits and asking them to refer adults who fulfilled the inclusion criteria. The control group was a convenience sample recruited through advertisements within the university setting and workplace; this group included 28 age- and gender-matched participants (M age = 27.64 yr, SD = 3.75; 32.1% men, 67.9% women) who had no diagnosis of DCD and had never been referred or treated for motor coordination problems. For all participants, inclusion criteria included age of 16–35 yr; no known complications at birth; no physical, neurological, or psychiatric deficits; and no other diagnosed medical condition.

Procedure. The DCD and control group participants completed the AAC–Q and a questionnaire to obtain sociodemographic information and information regarding the inclusion and exclusion criteria. Three weeks after the initial administration, the 28 participants of the control group completed the AAC–Q for a second time to enable us to assess test–retest reliability.

Results. Internal consistency using Cronbach’s α was high for both rating scales (frequency scale α = .88; degree or intensity scale α = .87). To assess test–retest reliability, we calculated Pearson correlation coefficients for scores attained at the first and second administrations. For the frequency scale, a high, strong correlation was found between administrations (r = .94, p < .001). For the degree or intensity scale, a slightly lower correlation was found (r = .84, p < .001).

We examined initial construct validity for the AAC–Q using three procedures. The first approach was to test whether the questionnaire differentiated between adolescents and adults with and without DCD using the known-groups procedure (Benson & Clark, 1982) according to the original criteria for group placement. Independent-sample t tests revealed significant group differences for the frequency scale, t(27) = 9.37, p < .001 (DCD group M = 35.96,
were also found, the degree or intensity scale, significant group differences were also found, $r(27) = 8.86, p < .001$ (DCD group $M = 35.32, SD = 8.28$; control group $M = 9.07, SD = 5.04$).

Second, we used discriminant analysis to examine the percentage of participants correctly placed in their study group (DCD or control) according to the original criteria for group division. Findings from the AAC–Q correctly placed 88% of the participants in their study group (Wilks $\Lambda = .38, \kappa = .75, p < .001$). Of the DCD group, 4 participants (14.3%) were incorrectly identified as not having DCD, and 3 participants (10.7%) from the control group were identified as having DCD.

We analyzed construct validity by calculating Pearson correlation coefficients for the scores of the two AAC–Q rating scales (frequency and degree or intensity) and comparing them to assess whether the two scales examine separate or similar abilities. A high, significant correlation was found between the scores of the two scales ($r = .973, p < .05$), indicating that although separate, the scales assess the same construct.

After these procedures were completed, we removed the degree or intensity scale from the AAC–Q as a result of both the initial qualitative assessment, which revealed that respondents did not prefer this scale, and the finding that the test–retest reliability for this scale was lower. Our decision to remove this scale was supported by the analysis indicating that the two scales assess sufficiently similar concepts; therefore, removal of one scale would not significantly impair the strength of the questionnaire. Thus, the final version of the AAC–Q comprises 12 items to which respondents are asked to respond using a 5-point Likert frequency scale and that require less than 10 min to complete.

**Phase 3: Establishment of Cutoff Scores**

**Participants.** The final stage in developing the AAC–Q was to establish cutoff scores for suspected DCD. Military service is mandatory in Israel, and at the completion of service, a random sample of people being discharged complete a standard health survey. Because the military selects people to complete the survey using simple random selection, the health survey provides results for a systematic and representative sample of young adults in the country. The AAC–Q was added to this health survey, and a random sample of 2,379 adolescent and young adult participants ages 19–25 (45.5% men, 49.5% women; 5% of respondents did not indicate their gender) completed the AAC–Q when they completed the health survey. The mean age of the sample was calculated using a randomly selected subsample of 400 participants ($M = 21.18 \text{ yr}, SD = 1.24$).

All participants had no known complications at birth and no psychiatric or physical deficits (e.g., cerebral palsy). All participants had attended high school in regular education frameworks, a fact that we used to infer normative cognition. All participants completed the final version of the AAC–Q, which incorporated only the frequency scale.

**Results.** Before establishing the cutoff score for this new sample, we assessed internal reliability and construct validity and found internal reliability to be high (Cronbach’s $\alpha = .90$). A factor analysis performed on the 12 items of the questionnaire revealed one factor with an eigenvalue >1, explaining more than 50% of the variance.

Following the recommendation of Geuze et al. (2001), we calculated cutoff scores for suspected DCD diagnostic criteria (15th percentile, 1.00 $SD$), borderline DCD diagnostic criteria (5th–15th percentile, 1.00–1.65 $SD$), and clinical DCD diagnostic criteria (5th percentile, 1.65 $SD$). In addition, we calculated separate cutoff points for male and female participants (Table 1). The scores of all participants in the suspected DCD group from the pilot study (Phases 1 and 2) were in the range of the diagnostic group cutoff scores from the total sample.

**Discussion**

Our analyses support the use of the AAC–Q as a standardized, brief, ecologically valid, user-friendly measure to screen for DCD. We found sufficient evidence of the reliability and validity of the instrument and identified cutoff points indicating suspected DCD. The development of the AAC–Q yielded a short 12-item, self-report questionnaire that can be used to screen for difficulties in motor coordination in an older population.

The increased awareness of the effects of DCD in adolescence and adulthood in recent years has led to a need to develop screening and assessment tools for this population; to meet this need, the age ranges of several existing test batteries have been expanded, and the ACD was developed (Kirby et al., 2010). The AAC–Q provides an

| Table 1. Cutoff Scores for the Adolescents and Adults Coordination Questionnaire |
|---|---|---|---|
| Gender | $n$ | Clinical Cutoff (15th Percentile, 1 $SD$) | Diagnostic or Research Cutoff (5th Percentile, 1.65 $SD$) |
| Male | 1,081 | 19.44 (8.408) | 27.848 | 33.313 |
| Female | 1,178 | 18.87 (6.033) | 24.903 | 28.824 |
| Total | 2,379 | 19.26 (7.453) | 26.713 | 31.557 |

*Note. $M =$ mean; $SD =$ standard deviation.*
additional contribution over the ACD in that it was developed using a very large sample \( N = 2,379 \) and has established cutoff scores. Moreover, although the initial evidence shows that the ACD has much potential as a useful instrument for guiding clinical intervention, the AAC–Q has potential for use as an initial screening tool because of its length and ease of use. As with any disorder, additional instruments are needed that look at other aspects of DCD to ensure concurrent validity of the instruments used to guide diagnoses and to make clinical decisions.

Gregory (2007) suggested that the most straightforward method for determining the reliability of test scores is to examine test–retest reliability and recommended examining internal consistency when a single construct is being assessed. We found the internal consistency for both samples in this study and the test–retest reliability of the AAC–Q tested on the pilot study to be high, implying that the instrument is reliable.

The study also provided considerable evidence for the validity of the AAC–Q. The comprehensive content validation procedures we performed suggest that the items encompass the construct of functional tasks and activities that may be problematic for adolescents and adults with DCD. These results ensure that the questionnaire is ecologically valid and capable of identifying deficits in the identified areas, in keeping with the DSM–IV–TR Criteria A and B for a DCD diagnosis.

We devoted special attention to establishing construct validity for the AAC–Q because this psychometric property is the strongest proof that a tool indeed measures the traits it purports to measure (Benson & Clark, 1982; Gregory, 2007). The initial assessment of construct validity for the AAC–Q used three separate approaches (with two of the three approaches relevant for the final version of the questionnaire). The first approach, the known-groups procedure (Benson & Clark, 1982; Gregory, 2007), showed that the scores of participants with and without DCD differed significantly, indicating that the questionnaire enables practitioners to discern adolescents and adults with DCD from those without DCD. The second approach was discriminant validity, which was proved by the high level of group placement prediction for participants. The third approach involved internal reliability and factor analysis; internal reliability was high, and factor analysis proved that the AAC–Q assesses a singular construct. Completion of these steps provided initial evidence for the construct validity of the AAC–Q.

We calculated cutoff scores for each gender and for suspected or clinical DCD, borderline DCD, and diagnostic or research DCD (Geuze et al., 2001). Although for research purposes it is preferable to identify respondents who score below the 5th percentile, the borderline group (5th–15th percentiles) is an important group to identify with the aim of providing intervention to improve function. Although this group may attain scores indicating somewhat better functioning on assessments and questionnaires than those below the 5th percentile, their scores still describe functional deficits affecting their quality of life, which may benefit tremendously from intervention and the provision of appropriate coping strategies.

The AAC–Q was developed for screening purposes; a more comprehensive diagnosis of DCD requires further assessment. Further investigation to establish a DCD diagnosis should include a direct assessment of motor function in adulthood and a detailed history of motor difficulties in childhood; these can be obtained through questionnaires (Kirby et al., 2010) and from other sources, including parents and caregivers. Practitioners should consider motor function difficulties in relation to their consequences and impact on participation in everyday life activities, which are especially important for adolescents and adults.

Limitations and Future Research

Future research with adolescents and adults with DCD should examine different areas of function to build a profile of the cognitive, emotional, and functional deficits of this population. Moreover, the need remains to establish concurrent validity of the few available instruments being used to screen and diagnose this population by comparing their results.

A number of limitations are evident in the current study. Foremost, although a self-report format has many benefits for populations of these ages, this method of attaining information may introduce bias; the mood of the respondent may influence his or her responses, and it cannot be guaranteed that the respondent will respond truthfully to all items (Ganellen, 2007). The use of a convenience sample for the first phase of the study is an additional limitation, as is the fact that no diagnostic tests are available to determine the accuracy of group placement.

Implications for Occupational Therapy Practice

The development of a psychometrically sound questionnaire to screen for motor coordination deficits among
adolescents and young adults has the following important implications for occupational therapy practice:

- Because deficits in motor coordination appear to continue into adolescence and young adulthood, there is a need to develop instruments to best serve this population’s assessment and treatment needs.
- Practitioners who treat adolescents and young adults with motor deficits should base the need for service provision on psychometrically sound screening tools that take the effects of the deficits on participation into account.
- Research into motor deficits with adolescents and young adults can be based on accurate group placement.

Because the AAC–Q was developed using data from a large sample, this questionnaire is an important contribution to the tools available to occupational therapists providing services for this population.

**Conclusion**

Results of the current study reveal that the AAC–Q is a valid and reliable tool that can be used to screen for motor coordination deficits. This study represents an important step in the development of the instrument. A need exists for examination of the research and clinical application purposes of the questionnaire. In addition, because the psychometric properties of the AAC–Q have been established and cutoff points calculated for both suspected and diagnosable DCD in both men and women, this instrument has the potential to serve future research projects designed to investigate the implications of DCD for participation and quality of life in adolescents and adults.

**Acknowledgments**

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**References**


Kaplan, B. J., Dewey, D. M., Crawford, S. G., & Wilson, B. N. (2001). The term comorbidity is of questionable value in


**Appendix 1. Sample Items From the Adolescents and Adults Coordination Questionnaire**

<table>
<thead>
<tr>
<th>Question</th>
<th>Never (0%)</th>
<th>Occasionally (25%)</th>
<th>Often (50%)</th>
<th>Frequently (75%)</th>
<th>Always (100%)</th>
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<tr>
<td>I tend to be clumsy, fall often, drop items, or bump into objects—for example, walking through narrow spaces.</td>
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<td>I have difficulties with physical activities—for example, playing ball games, riding a bike, dancing, doing extreme sports.</td>
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<td>I have difficulty performing tasks that require organization and order—for example, organizing my bag for a trip, shopping at the supermarket, organizing the kitchen or house.</td>
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<td>I have difficulty with handwriting—for example, writing in a legible manner, writing quickly.</td>
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