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Diagnostic criteria for DCD: Past and future

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ABSTRACT

The aim of this review was to gather information on how well authors comply to DSM criteria in their description and selection of children with DCD. We investigated which selection criteria were used in experimental and intervention studies published in the last 5 years (2010–2014). Results on 176 papers are summarized. Compliance to the DSM criteria has improved over this time period. In general, detailed information was provided on motor performance using standardized test scores and cut-off values are reported. Method sections were far less detailed about other DSM criteria (i.e., whether motor coordination problems interfered with activities of daily living and how IQ, other medical conditions or co-occurring disorders were checked). Views on how the new DSM-5 criteria could be specified for clinical and research use are discussed.

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1. Introduction

In the 2001 special issue of *Human Movement Science* on Developmental Coordination Disorder (DCD), the topic of diagnostic criteria for DCD was reviewed and discussed (Geuze, Jongmans, Schoemaker, & Smits-Engelsman, 2001). In that study 41 papers were examined on the selection criteria used to classify children with DCD. We showed that nearly all studies reported a main inclusion criterion related to motor performance, however in many studies no cut-off score was mentioned. In addition, it was mentioned that adherence to exclusion criteria (medical condition, intelligence and comorbidity) was not common practice and information on these criteria was completely missing in a third of the studies.

Now that DSM-5 (American Psychological Association, APA, 2013) has been published and new publications on DCD have appeared during the past 12 years, we feel it is appropriate to reconsider the criteria used for the description and selection of children with DCD in order to enhance the ability to compare results between future studies and to consider the clinical implications. In the current paper we start with a review of the criteria (Table 1) used to select children with DCD for experimental and intervention studies using literature published over the last 5 years. We will then finish with suggestions to operationalize the DSM-5 criteria.

2. Method

2.1. Selection of publications

For the purpose of this review, we collected publications reporting on investigations conducted on children with DCD in the last 5 years using PUBMED and PEDRO. The following search terms were used: (“motor skills disorders”[MeSH Terms] OR (“motor”[All Fields] AND “skills”[All Fields] AND “disorders”[All Fields]) OR “motor skills disorders”[All Fields] OR (“developmental”[All Fields] AND “coordination”[All Fields] AND “disorder”[All Fields]) OR “developmental coordination disorder”[All Fields]) AND (“2001/01/01”[PDAT]: “3000/12/31”[PDAT]) AND English[lang]).

Using these terms, we found 2745 papers published between 2010 and 2014 (see Fig. 1). These were screened on title and abstract. After this process, 307 titles remained that met the inclusion criteria for this paper (i.e. cohort, clinical and experimental studies with a description about how the authors selected the children with DCD). Reviews, commentaries, editorials, position papers and single case studies were excluded. We did include papers on children with DCD with co-morbid or co-occurring disorders such as attention deficit hyperactivity disorder (ADHD), learning disabilities (LD) and developmental language disorder. We were unable to obtain full text versions of 7 papers. After reading all the full text papers, data of 176 papers met all inclusion criteria and were used for our review. [The selected publications are listed in the reference list and marked with an asterisk.](#)

2.2. Information extracted from the publications

Information on the following 14 categories was extracted from each publication: title; authors and journal; the populations from which the DCD groups were drawn; the number of children with DCD; sex ratio; age; if and how motor performance was assessed; which cut-off value was used and how its impact on daily life was tested; how neurological status, co-morbidity related criteria and intelligence level were checked; and the type and purpose of the study.

3. General description

In total, 176 papers were analyzed. Of these, 81 were published in the journal *Research in Developmental Disabilities*, 12 in *Human Movement Science* and 10 in *Developmental Medicine and Child Neurology*. All other journals had fewer than 10 papers on DCD. Importantly, most of the studies described a comparison between DCD and Typically Developing (TD) groups with or without correlations between the measures used. In total, 21 intervention studies were included.

Table 1

Diagnostic criteria for DCD (DSM-IV, APA, 2000, p. 58).

-
- A. Performance in daily activities that require motor coordination is substantially below that expected given the person's chronological age and measured intelligence. This may be manifested by marked delays in achieving motor milestones (e.g., walking, crawling, and 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
-

Across all studies, the total number of children with DCD was 10,392. Large samples were used in a several papers, like the Avon Longitudinal Study of Parents and Children (ALSPAC) and the Population based study of motor coordination and Physical Health in children (PHAST); in these cases the number of children was counted only once. For all other studies a separate sample was assumed although this was not always clear to the reviewers (BSE, TD and JH). The mean sample size of the DCD groups across the different studies was 60 children and the median group size was 24. The mean (median) age of the children was 10.2 (9.8) years, ranging between 4 and 25 years of age. In 154 papers, the sex distribution within the DCD sample was reported, with a mean (median) sample size for boys of 29 (17) and for girls 19 (9).

3.1. Meeting DSM criteria

Some 85% of the included studies complied with criterion A by using a motor performance test with an adequate cut-off. The Developmental Test of Visual-Motor Integration (VMI, Beery & Beery, 2004), the subset of motor items in from the Child Behavior Checklist (Achenbach, 1991), the DCD-Q (Wilson, 2007) and clinical judgment alone were deemed inadequate to assess whether motor skills are below the level of peers. The Movement Assessment Battery for Children (MABC) (edition 1 and 2) (Henderson & Sugden, 1992; Henderson, Sugden, & Barnett, 2007) was by far the most frequently (73%) used test to assess motor performance ($n = 128$), with the Bruininks Oseretsky Test of Motor Performance (Long and Short Form) (Bruininks & Bruininks, 2005) as second most frequently (7.4%) reported test in 13 papers.

To operationalize criterion A, "...substantially below that expected given the individual's chronological age", two cut-off values were most commonly cited in the literature: the 5th and the 15th percentile.¹ The choice of cut-off value is often related to the term used to describe the children; e.g., children with a cut-off score below the 5th percentile are called DCD or severe DCD as reported in 24% ($n = 42$) of the papers, and between the 5th and 15th percentile (48%, $n = 84$) probable-DCD, at risk or moderate DCD. In the remainder of studies (6.2%, $n = 11$), other cut-off values below the 15th percentile were used to identify children as having DCD and in (22%, $n = 39$) cut-off values were not reported.

Our results show a variable picture on confirmation of criterion B, the impact of the motor problems on daily life and academic achievement. Only in 38% of the studies could we find reports on how criterion B was checked. Of those, the DCD-Q (14%, $n = 24$) and a self-designed teacher and parent questionnaire ($n = 17$) were clearly the most frequently used methods. Specific tests for the impact on academic achievement were limited to writing tests ($n = 4$).

Regarding the exclusion criteria stated in criteria C and D, (motor problems not due to a neurological impairment and due to poor intelligence) information provided in the studies is less clear. In 41% ($n = 72$) of the studies, it was not mentioned whether other medical conditions were checked, and 38% ($n = 67$) of the studies reported that there was "no evidence of physical or neurological disorder"; however it was not reported how this information was gathered. Only 12.5% ($n = 22$) of the children were seen by a medical doctor (mostly a pediatrician) or it was reported that a medical history was

¹ Whenever we mention at or below 15th percentile, it could also be read as 16th, if this cut-off value is not available in the norms, like in the Movement ABC-2.

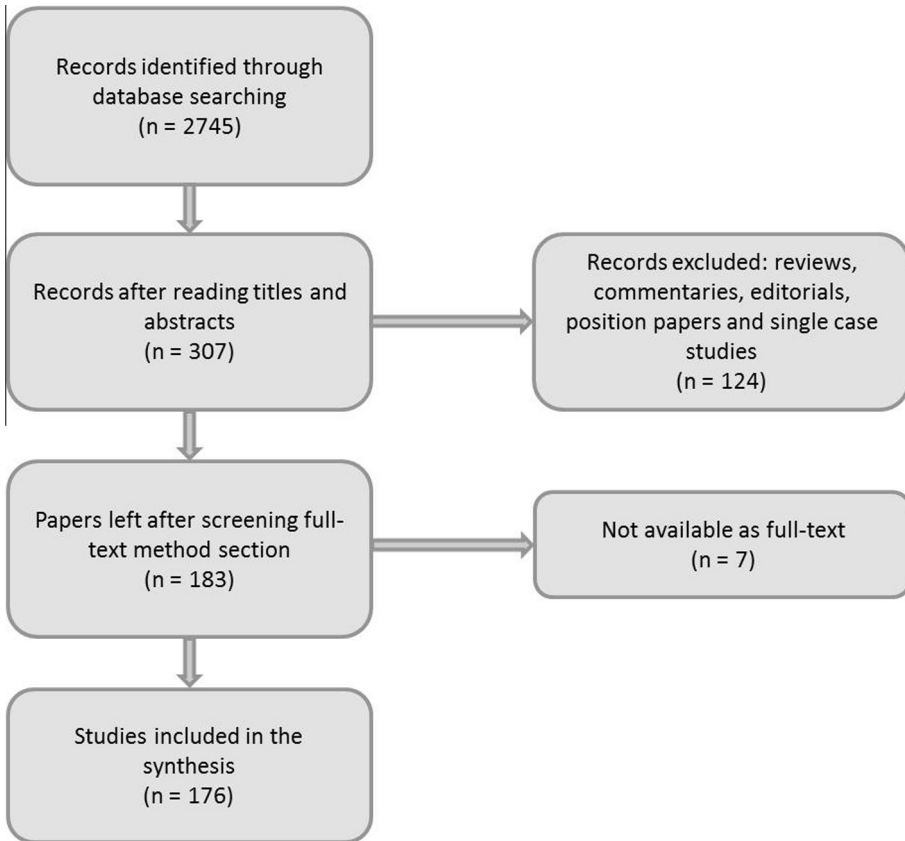


Fig. 1. Flowchart showing the selection process of the papers used in this review.

taken. Lastly, in 8.5% ($n = 15$) of the included studies, parental reports were used to confirm that there were no physical or neurological disorders.

Information on the impact of intelligence was scarce despite the fact that the relationship between motor coordination and intelligence across the IQ range has been shown (Smits-Engelsman & Hill, 2012). In 57% of the cases the method for his criterion was not specified. In 30% ($n = 53$) an IQ test was administered. Of these, different forms of the Wechsler Intelligence Scale for Children (WISC; Wechsler, 2003) were administered 27 times and the Kaufman Brief Intelligence Test (Kaufman & Kaufman, 2004) was used 13 times. In 4.5% ($n = 15$) of studies it was reported that "...being able to follow mainstream education..." was validation of IQ in the normal range. None of the studies that reported IQ included children with a score below 70 in the DCD groups.

Generally, children with co-morbidities were excluded from the DCD groups. In 32 papers (18%) some children with other disorders were included (in 25 papers this was ADHD) or the co-morbid group were part of the design (i.e., studies where children with DCD with and without co-morbidity were compared).

3.2. Conclusion: compliance to DSM-IV

To summarize, most of 176 studies published on DCD in the last 5 years included children that have (i) motor coordination problems that interfere with activities of daily living based on the opinion of their parents or teachers, (ii) no co-occurring disorders, (iii) an IQ above 70, and (iv) motor performance test scores at least on or below the 15th percentile using a standardized test.

This is in line with the general recommendations made in the DSM-IV. Moreover, operationalization of the statement, “motor coordination is substantially below that expected given the person’s chronological age” is the most reported criterion in the literature, both for clinical and research purposes. However, only 38% of the studies reported how criterion B was checked. Of these studies around 2/3 used validated questionnaires.

3.3. Theoretical basis for the stated purpose of the study

A striking observation is that most studies compare a group of children with DCD with a matched group of TD children, and in general report the differences at a descriptive level. Interesting as this may be, descriptive studies mainly inform the generation of hypotheses about relationships that may explain the problems of children with DCD at an individual or group level. Studies that explicitly test such hypotheses from a firm theoretical footing are more the exception than the norm, unfortunately. Intervention studies, especially those that compare different interventions or search for the best intensity are scarce.

3.4. DSM-5

Lastly we summarize our recommendations to operationalize the new DSM-5 criteria (See [Tables 2 and 3](#)). The proposed flowchart (see [Fig. 2](#)) is in line with the current practice guidelines ([Blank, Smits-Engelsman, Polatajko, & Wilson, 2012](#); [Sugden, 2006](#)) and studies completed so far with DSM-IV. Research comparing children that were selected following the two routes described in [Fig. 2](#) will help verify whether results from one group can be generalized to the other, and vice versa.

Table 2

DSM-5 Diagnostic Criteria ([APA, 2013](#)).

-
- A. The acquisition and execution of coordinated motor skills is substantially below that expected given the individual’s chronological age and opportunity for skill learning and use. Difficulties are manifested as clumsiness (e.g., dropping or bumping into objects) as well as slowness and inaccuracy of performance of motor skills (e.g., catching an object, using scissors or cutlery, handwriting, riding a bike, or participating in sports)
 - B. The motor skills deficit in Criterion A significantly and persistently interferes with activities of daily living appropriate to chronological age (e.g., self-care and self-maintenance) and impacts academic/school productivity, prevocational and vocational activities, leisure, and play
 - C. Onset of symptoms is in the early developmental period
 - D. The motor skills deficits are not better explained by intellectual disability (intellectual developmental disorder) or visual impairment and are not attributable to a neurological condition affecting movement (e.g., cerebral palsy, muscular dystrophy, degenerative disorder)
-

Table 3

Proposed terminology for the papers describing DCD populations.

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- Overall: For the description of a DCD group all DSM 5 criteria should be described and also how they were or were not met (questionnaires and tests used with the cut-off scores applied)
- Moderate DCD* (m-DCD): All DSM 5 criteria are described and met. Children score 1–1.64 standard deviations below the mean on a validated motor test (between 15 and 6th percentile)
- Severe DCD* (s-DCD): All DSM 5 criteria are described and met. Children score at least 1.64 standard deviation below the mean on a validated motor test (at or below 6th percentile)
- Probable DCD* (p-DCD): DSM 5 criteria are described, but one or more criteria may not have been evaluated. For example, there is no parent report on ADL, or there is no information available on criterion C or D. Children in p-DCD score at least 1 standard deviation below the mean on validated motor test (at or below 16th percentile). Moreover, if based on the child’s history, there has been insufficient exposure to skill learning, the child will also be classified as p-DCD. After the opportunity has been given to learn the specific skill over a short period of time, sufficient progress needs to be demonstrated otherwise, depending on the motor score the condition would be categorized as s-DCD or m-DCD
- At risk for DCD*: All DSM 5 criteria are described and met, and children are under 5 year of age. If a later repeated motor test and evaluation confirms that all criteria are met, the diagnosis DCD will be given
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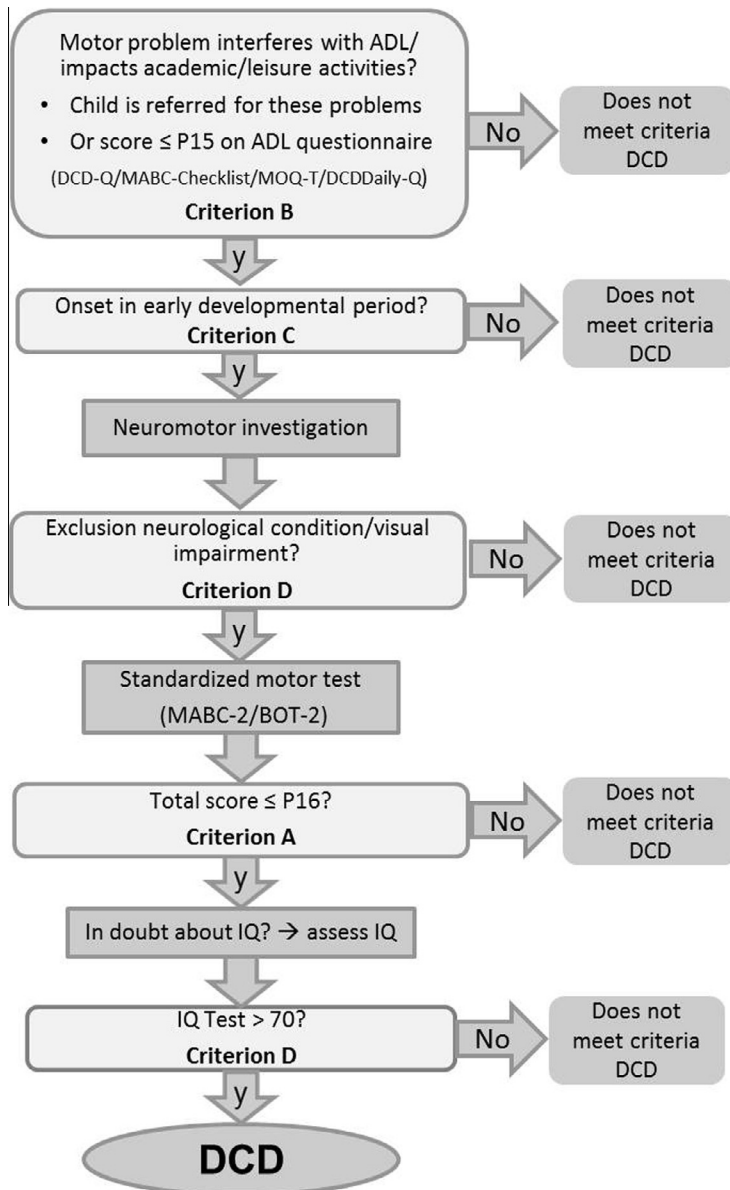


Fig. 2. Flowchart for the diagnosis of DCD using DSM-5 criteria. There are two possible routes to enter the flowchart: *Route 1* Research reported on referred groups: In clinical situations a child will enter the diagnostic process because it has multiple problems that interfere with daily activities. These can be confirmed (y = yes) using a standardized questionnaire. Criterion C and D are checked and a standardized motor test is administered. If all criteria are fulfilled the diagnosis DCD will be given. *Route 2* Research reported on non-referred groups: Step 1: Active search for children of which parents and teachers report persistent motor problems in present-day that interfere with their daily activities (for instance using a Traffic Light Questionnaire, Ferguson, Jelsma, Jelsma, & Smits-Engelsman, 2013). If children are between 5 and 12, early onset is confirmed (if not it should be checked with parents). Step 2: A standardized motor test is administered. If the problem interferes with daily activities has to be confirmed by a teacher and/or parent (preferably standardized) questionnaire. Criterion C and D are checked. If all criteria are fulfilled the term DCD can be used.

3.5. Proposed operational definition of the DSM-5 criteria

In the next section a short clarification will be given of the proposed flowchart (Fig. 2) and terminology for DCD (Table 3).

Criterion A. To confirm if acquisition and execution of coordinated *motor skills* are *substantially below* that expected given the individual's chronological age, the international guidelines for the assessment of DCD as agreed upon for DSM-IV criteria are also valid for DSM-5. Briefly, a norm-referenced motor test should be used; cut-off scores of 15th percentile on a standardized test; motor performance should not be evaluated using questionnaires alone (although they may be used as an addition).

The phrase regarding the relationship between motor performance and the *opportunity for skill learning and use* is a new addition to criterion A in the DSM-5. When children do not learn a motor skill despite sufficient exposure, instruction or parental assistance, this new addition of criterion A has been met. However, clear advice on how to verify this part of criterion A is not available in the guidelines nor in the literature. If there has been insufficient exposure to skill learning, based on the child's history, we propose to classify the child as probable-DCD. After the opportunity has been given to learn the specific skill over a relatively short period of time (weeks rather than months), sufficient progress or not needs to be demonstrated to conclude about a definite diagnosis DCD.

Criterion B. The motor skill deficit should significantly and persistently *interfere with activities of daily living* appropriate for chronological age (e.g., self-care and self-maintenance), and impact academic/school productivity, prevocational and vocational activities, leisure and play. Multiple sources of information are useful here, preferably both parents and teachers, to be sure that the problems are noticeable in different contexts (e.g., at home and in school).

The fact that a child is referred for diagnosis or intervention can be seen as implicit evidence of meeting the ADL criterion. However, we strongly recommend additional the use of standardized questionnaires such as DCD-Q (Wilson, 2007), MABC checklist (Henderson et al., 2007), MOQ-T (Schoemaker, Flapper, Reinders-Messelink, & De Kloet, 2008) or the newly developed DCDdaily Questionnaire (Van Der Linde et al., 2013) that can be completed by a parent and/or teacher.

Persistent symptoms of poor motor performance, defined as present for at least 6 months, can be checked by history taking. A short parental questionnaire can also be used to inquire for how long the child has had motor problems, when the parents first started noticing these problems, and lastly if the child has other known disabilities or limitations.

Criterion C. *Onset of symptoms is in the early developmental period.* In accordance with other developmental disorders this can be defined as several symptoms of poor motor control present before age 12 years. However, the onset of DCD is usually apparent in the early years, but should not typically be diagnosed before 5 years of age (Blank et al., 2012). If clear motor skill deficits are present at an early age without another medical diagnosis, these young children may be called at risk for DCD (see Table 3).

Criterion D. *Mental retardation (or Intellectual disability)* is an exclusion criterion in DSM-IV but in the new description in DSM-5 this is formulated more subtly. It now states that the motor skills deficits are *not better explained* by intellectual disability (intellectual developmental disorder) or visual impairment and are not attributable to a neurological condition affecting movement (e.g., cerebral palsy, muscular dystrophy, degenerative disorders).

In the DSM-5, three categories of impairment are mentioned that may relate to poor motor performance to: (1) intellectual disability, (2) visual impairment and (3) neurological condition affecting movement. Since we have shown that the current practice is the use an IQ cut-off value of 70, and children with visual impaired or neurological condition have also not been included in the studies, we propose that the DSM IV exclusion criteria should still be used. Explicit reference to visual impairment and neurological condition affecting movement in DSM-5 has no consequences for the exclusion of children from a diagnosis of DCD as under DSM-IV these cases were excluded on grounds of medical condition. Nevertheless it is also important to be aware that uncorrected vision in children may be a factor causing disruptions in motor behavior.

For similar reasons, there is no point giving a child with cerebral palsy or muscular dystrophy a double diagnosis. The distinction becomes harder if we look at children born prematurely. While some

of these children do have some brain damage, they may not get a diagnosis of cerebral palsy. In sum, we suggest that if no other neurological condition is obvious, DCD could be considered.

4. General conclusions

Compared to our 2001 review, a higher proportion of studies published over the last 5 years have fully evaluated or reported the four DSM-IV diagnostic criteria in their description of how the children were selected. Moreover, if tests were administered, the proposed cut-off criteria of the 15th on a standardized test and an IQ score above 69 were widely followed (Geuze et al., 2001).

Nevertheless, many studies still provided insufficient information about the selection of their population. Use of our new recommendations for DSM-5 (Table 3) will hopefully improve reports on how children are selected and the comparability between the clinical and research groups in different studies.

For the operationalization of the new DSM-5 criteria, we can build on our experience with DSM-IV. However, new aspects of criterion A will require a new consensus on how to define that “a child is given enough opportunity for skill learning and use”. This new addition to criterion A implies that until a child has been exposed to a context where learning is optimized, a diagnosis DCD will have to wait. The issue of how long is long enough and in what ways children are exposed adequately to learning opportunities will be issues for future study.

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