

Diagnosing developmental coordination disorders

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Received 9 August 2013
Revised 29 October 2013
Accepted 30 October 2013

ABSTRACT

Developmental coordination disorder (DCD) affects around 5% of children and commonly overlaps with other developmental disorders including: attention deficit hyperactivity disorder (ADHD), autism spectrum disorders (ASDs) and specific language impairment (SLI). There is evidence to demonstrate the wide-ranging impact on all areas of functioning including psychiatric and learning domains. There is increasing evidence of the continuing impact into adulthood and the long-term negative effects on relationships and employment. There is a need for early identification and intervention to limit the likelihood of these secondary consequences from emerging. This paper addresses the diagnosis of DCD.

INTRODUCTION

Coordination difficulties in children have been described for nearly 100 years.¹ Historically, terms such as 'clumsy child syndrome' have been used. However, more recently there has been a move to standardise the terminology to more accurately reflect the condition. As a consequence, developmental coordination disorder (DCD) has become the most widely adopted term that is recognised internationally. Despite efforts in the UK and internationally to homogenise the terminology, educationalists and some support groups persevere in referring to the condition as 'dyspraxia', which can have various definitions. This inconsistency continues to create some confusion. The term 'DCD' has the advantage over dyspraxia of being internationally recognised and defined by the two major bodies, the American Psychological Association (APA) and the WHO, and is now accepted by leading researchers and clinicians in the field. The use of DCD is reflected in the Diagnostic and Statistical Manual for Mental Disorders,^{2,3} and the recently published fifth edition (DSM-V)⁴ has provided a modified version of the diagnostic criteria (see box 1).

Several European consensus on DCD⁵⁻⁷ have also provided additional clarity over definitions, diagnosis and intervention for children. In the latest European Consensus guidelines, evidence is cited to show that performance on activities of daily living and quality of life can be improved by effective intervention approaches.⁸

Following these most recent guidelines,⁸ a consensus meeting took place in London to try and further encourage consistency in the descriptors used across the UK. Unlike the European guidelines, this description also recognised the lifelong pervasiveness of the disorder and produced the following working definition of DCD:

Developmental coordination disorder (DCD) is a common disorder affecting fine and gross motor coordination in children and adults. This condition is formally recognised by international organisations

including the American Psychiatric Association²⁻⁴ and WHO.⁹ DCD is distinct from other motor disorders such as cerebral palsy and stroke. The range of intellectual ability is in line with the general population.¹⁰ Individuals may vary in how their difficulties present; the presentation may change over time depending on environmental demands and life experience, but for many DCD has a lifelong impact.¹¹

An individual's coordination difficulties may affect participation and functioning of everyday life skills in education, work and employment. Children may present with difficulties in self-care, writing, typing, riding a bike, play as well as other educational and recreational activities.^{12,13} In adulthood many of these difficulties will continue, as well as learning new skills at home, in education and work, such as driving a car and DIY.^{14,15} There may be a range of co-occurring difficulties which can also have serious negative impacts on daily life.¹⁶ These include social emotional difficulties as well as problems with time management, planning and organisation and these may impact an adult's education or employment experiences.¹⁷

There remains a paucity of information regarding the aetiological basis for DCD compared to what is known in other development disorders such as attention deficit hyperactivity disorder (ADHD) and autism spectrum disorders (ASDs). Some early studies have started to consider the neural mechanisms potentially implicated in DCD. These include, for example, whether potential mirror neuron deficits relate to dysfunction in the fronto-parietal system.¹⁸ However, the underlying neural processes remain unclear and the heterogeneous nature of the disorder further complicates attempts to find an underlying cause; hence, its aetiology remains poorly understood. Further research exploring the nature of DCD is necessary if we want to identify its aetiology.

PREVALENCE

DCD is a common disorder, and although varying prevalence rates have been cited, largely as a result of the definition used and the tools chosen to assess the child or adult, the ALSPAC UK-based large population study recently showed a prevalence of 1.7% in 7-8-year-old children. They also identified a further 3.2% of children as having 'probable DCD' by using broader cut-off criteria on tests of motor coordination and activities of daily living.¹⁹ There is also a general agreement that the condition is more prevalent in boys than in girls, with estimates ranging from a small difference¹² to three or four to one.¹³ However, the reported gender bias in children may relate to several factors including the assessment tasks not being differentiated by gender²⁰; clinicians may be more likely to consider DCD in girls where there are other developmental disorders present, for

To cite: Kirby A, Sugden D, Purcell C. *Arch Dis Child* Published Online First: [please include Day Month Year] doi:10.1136/archdischild-2012-303569

Box 1 DSM-V developmental coordination disorder diagnostic criteria

- 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 (eg, dropping or bumping into objects) as well as slowness and inaccuracy of performance of motor skills (eg, 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 (eg, 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 (eg, cerebral palsy, muscular dystrophy, degenerative disorder).

example, dyslexia; teachers may be more likely to identify DCD in boys who have ADHD, where marked signs of hyperactivity are more apparent; teachers may have different expectations of skill levels in boys and girls which may influence identification;²¹ and family importance of sporting skills in boys may be driven by the dominant coverage of male sports on TV.

COEXISTING DISORDERS

In diagnosing DCD, it is important to remember that the core of the condition is significant motor impairment. However, the so-called pure individual with DCD, who only has motor difficulties, is the exception rather than the rule.²² This is supported by evidence from, for example, Green *et al*,²³ who have shown that DCD often overlaps (other terms used include co-occurrence and comorbidity) with other developmental disorders. Research has demonstrated this overlap with DCD to a significant degree with ADHD, dyslexia and ASD, and there is also evidence suggesting that one-third of children with speech and language impairment are likely to have DCD as well.^{16 24} In addition, other medical conditions such as benign epilepsy of childhood with centrotemporal spikes (BECTS) syndrome²⁵ and joint hypermobility syndrome (JHS²⁶) have also been associated with DCD. However, despite this compelling evidence showing the heterogeneous nature of DCD, it is not routinely considered by clinicians and remains the 'Cinderella' of developmental disorders.²⁷ Furthermore, in addition to the functional consequences of living with significant motor deficits, secondary consequences have been shown to include: social, emotional and behaviour challenges; lower self-esteem; and the presence of anxiety and depression in children from an early age and in adults.^{28 29} However, differentiating between the co-occurrence with other disorders and the day-to-day consequences may be difficult at times.

LIFELONG CONDITION

The vast majority of research concerning DCD has focused on school-age children. However, DCD along with other developmental disorders such as ADHD are now viewed as lifelong

conditions. Without intervention, it is estimated that nearly three-quarters of children with DCD will continue to have difficulties as adults.^{11 15 30} The progression and presentation of the condition can be variable, but recent work has demonstrated increased risks of anxiety and depression and the negative effect on educational and employability outcomes.^{15 31 32}

WHY AND WHEN ARE CHILDREN REFERRED TO ASSESSMENT FOR POSSIBLE DCD?

Routes to assessment will be varied and may be initiated by concerns from parents, teachers or health professionals (see box 2). The reasons why a young child may be identified might include: late walking or talking, or a child may present at an older age for an assessment during a time of crisis such as exam failure or difficulties with writing. However, health or educational professionals should always consider motor coordination difficulties whenever a child presents with any symptoms suggestive of any developmental disorder, a learning difficulty, speech and language delay or behavioural issues. Forsyth *et al*³³ and Salmon *et al*³⁴ describe the need for a defined pathway, for DCD and other developmental disorders. The European guidelines also emphasise the need for a multi-disciplinary assessment.

ASSESSMENT OF DCD

It is interesting to note that over 60 years ago, in a British Medical Journal editorial about 'clumsy children', the following assessment process was suggested:

Clumsy children are not at all uncommon. They should be referred to a paediatrician with interest and experience in the problem, who will enlist when necessary the help of an expert psychologist. The whole child must be studied. A detailed developmental and neurological examination is essential; hence, the suggestion that the child should be referred in the first place to a paediatrician rather than to a psychologist or psychiatrist (ref. ³⁸, pp. 1665–1666).

Today, different countries have until recently defined DCD typically using the DSM-IV criteria.^{39 40} Evidence for each of the stated criteria needs to be obtained from families and documented by other professionals to facilitate a comprehensive diagnostic process.^{41–43}

Box 2 Factors that increase the likelihood of making a referral for an assessment

- ▶ Presence of late developmental milestones, for example, walking or talking.³⁵
- ▶ Parental concerns and knowledge and comparison with other siblings.³⁶
- ▶ Known diagnosis in other family members.
- ▶ Presence of co-occurring developmental disorders, for example, autism spectrum disorder (ASD), attention deficit hyperactivity disorder (ADHD), speech and language impairment, dyslexia.
- ▶ Knowledge and awareness of developmental coordination disorder (DCD) by general practitioners, CAMHS, paediatricians and teachers.³⁷
- ▶ Behaviours noticed by others causing concern or affecting children's learning, for example, low self-esteem, anxiety, depression, bullying, externalising behaviours.
- ▶ Presence of other medical conditions.

Box 3 Red flags which require urgent paediatric/neurological referral

- ▶ Recent history of a head injury or trauma
- ▶ History of deterioration of motor skills
- ▶ History of headaches, eye pain, blurred vision
- ▶ Gait abnormalities, for example, ataxic, wide-based, prolonged toe walking
- ▶ Increased muscle tone, fluctuating tone or significant hypertonia
- ▶ Asymmetric muscle tone or strength
- ▶ Dysarthria, swallowing or feeding difficulties
- ▶ Gowers' sign—difficulty rising to a standing position
- ▶ Amber flags: areas requiring further consideration
- ▶ Musculoskeletal abnormalities
- ▶ Neurocutaneous lesions, for example, café au lait spots, neuromas
- ▶ Avoids eye contact, unwilling to engage socially
- ▶ Dymorphic features
- ▶ Visual impairments (untreated), for example, strabismus

It seems appropriate that an in-depth assessment should be by an experienced and appropriately qualified professional and not a knee-jerk reaction and should come after the implementation of everyday support and practical guidance at home and in the classroom has been assessed, otherwise too many children will be referred, leading to unnecessarily long waiting lists.⁴³ However, an urgent referral bypassing this approach can be made if there are clear 'red flags' present (see box 3).

Stage one: history taking

A thorough history taking should be the starting point of any assessment (see box 4). This enables the mapping of consistent patterns of behaviour and the impact of motor difficulties on everyday functioning. During this it is important to gather information from more than one setting, where possible, as this informs the pervasive effect of the disorder to be evaluated, for example, at home and school. This can be harder to do when working with adults; however, obtaining past school reports, sending out screening tools, requesting past history information or a telephone call with a parent can often assist in gaining a more complete and accurate picture. Put simply, there is no substitute for obtaining a detailed past history which should cover: medical, developmental and educational information, to supplement information on current functioning.

At the beginning of a consultation, the parents' or carers' current primary concerns should be clarified, along with establishing the trigger that initiated the consultation. It should be noted that the principal concerns of families are often related to secondary consequences^{15 36} but are likely to be educationally related as well.⁴⁴ It is important to be able to distinguish between a child that may gain a skill developmentally later than their peers and/or gain a skill but lack proficiency in it, despite practice, for example, the child is able to ride a bike but may be more unsteady in doing so; the child can tie their shoe laces but only after several attempts and they always come undone. Additionally, enquiring about any secondary consequences of the child's primary motor difficulties such as self-esteem, levels of participation, impact on friendships, symptoms of anxiety and mood and if the child has been bullied in school helps to provide a more complete picture.

Box 4 Taking a full history

- ▶ Ante and perinatal history: including history of low birth weight, especially in boys,⁴⁹ and history of prematurity⁵⁰ and alcohol ingestion during pregnancy.⁵¹
- ▶ Developmental milestones: a detailed developmental history including identifying developmental delays, especially in the motor and language domains which commonly overlap.³⁵
- ▶ Family history: including known developmental disorders, anxiety and depression and epilepsy.
- ▶ Presence of other known medical conditions or recent trauma: where motor symptoms are associated but would preclude a diagnosis of developmental coordination disorder (DCD) for example,
 - Cerebral palsy, muscular dystrophy;
 - Changing or deterioration in symptoms over the past 2 years or a history of head injury;
 - Genetic conditions such as Klinefelter's syndrome;
 - Fetal alcohol syndrome;
 - Head injury or falls;
- ▶ Deteriorating functioning which may indicate muscular dystrophy, brain lesions or in adults conditions such as multiple sclerosis, Parkinson's disease.
- ▶ Educational history (dependent on the age of the individual) and evidence of difficulties using, where possible, school books and reports. Information on whether the child has been diagnosed with a learning difficulty, for example, dyslexia or dyscalculia and has additional assistance within the educational setting.
- ▶ Impact of difficulties on day-to-day functioning, including self-care, tool usage and the extent to which the difficulties limit activity and participation of the child and the family⁵²; the impact of DCD on the child's quality of life¹⁴ and on the child's fitness levels;⁵³ and symptoms affecting mood, for example, becoming more anxious in specific settings or during certain actions.
- ▶ Other symptoms that may alert one to the presence of other developmental disorders, including behaviour causing disruption at home or school, sleep disturbance, impact of socialisation and friendships, difficulties with concentration. Consideration of the presence of autism spectrum disorders (ASD), attention deficit hyperactivity disorder (ADHD), speech and language impairment, dyslexia, dyscalculia as they can all impact on educational support and the type of intervention undertaken.
- ▶ Information gained from the child on their perception of their strengths and challenges and what their key concerns are. Information on vision and hearing with assessments undertaken to check for the presence of strabismus and/or hearing impairment.⁵⁴

Asking the parents what support they have put in place to help compensate for the child's daily functional difficulties provides an understanding of the type and amount of scaffolding support that has been put in place, for example, the child dictates their homework for the parent to type, or parental help with dressing in the morning to speed up the process. It is also useful to identify any adaptations to social choices that the family may have adopted, for example, not going for a family bike ride, avoiding specific settings such as parties or social activities that have been arranged by parents to help encourage friendships.

During the consultation, checklists can be used to help focus on the appropriate information that relates to motor function. Examples of these include: Movement Assessment Battery for Children Checklist⁴⁵; the Early Years Movement Checklist for 3–5-year-olds⁴⁶; DCD-Q for school-aged children⁴⁷ and the Adult DCD Checklist for adults.⁴⁸

Stage two: examination

Good clinical observation is the obvious starting point for the examination in order to rule out any other possible and observable diagnosis. Missiuna, Gaines and Soucie⁵⁵ describe a practical and pragmatic approach to assessment in the article: “Why every office needs a tennis ball: A new approach to assessing the clumsy child”. They make the point that most general practitioners and paediatricians will not necessarily have access to a comprehensive assessment battery which includes standardised motor assessments. However, after taking a full history, the family doctor can observe and undertake some tasks with the child or adult that can inform the presence and pattern of any motor coordination difficulties and then, if appropriate, can trigger onward referral for a more in-depth assessment.

During the initial examination, it is therefore critical to look at the whole child, from head to toe because, for example, the presence of neurocutaneous lesions may highlight neurofibromatosis that could otherwise be missed; dysmorphic features could indicate a specific disorder (eg, Klinefelter’s syndrome or fetal alcohol syndrome). This initial evaluation should therefore begin as soon as the child walks through the door, even simply observing their gait, for example, a wide-based gait or the presence of toe walking in an older child, could be indicative of cerebral palsy. Equally, the presence of pes planus (loss of the medial longitudinal arch of the foot) has been associated with JHS.²⁶ Following the initial examination, a neurological assessment should aim to exclude other conditions such as cerebral palsy, muscular dystrophy and JHS of small and large joints (see box 3 for red flags).

Although there are no defined diagnostic markers for DCD, watching the child while standing, walking, throwing and catching a ball, sitting and doing some fine motor tasks allows a useful overview of skill level and behaviour.

Consider standing tasks, for example, balancing on the dominant and non-dominant leg with their eyes closed may differentiate a child with DCD from their typically developing peers.⁵⁶ Additionally, understanding what the developmental milestones are given the age of the child allows an indication of whether a delay is present. Equally, fine motor function can be observed in tasks such as writing a sentence, a copy writing task or writing their own name and using scissors to cut along a line, as this may provide an indication that a more detailed assessment is needed. Observation of muscle tone in sitting and standing may give an impression of the ability of the child to maintain their posture against gravity (eg, slumped). Motor sequencing using finger to thumb in sequence may reveal some associated movements, also known as overflow or mirror movements; however, these are not diagnostic because they are also commonly seen in young typically developing children, but may along with other features be an alerting sign.²⁵ A fine tremor, difficulties with heel-toe walking and past-pointing may indicate the presence of cerebellar pathology. In addition, good observation by skilled health professionals will also assist in building up the child’s or adult’s profile for example, noting the way a child approaches a task, whether they opt for speed or accuracy, whether they lose interest or focus or fail to listen to the task instructions can also

alert one to other diagnoses, for example, ASD, specific language impairment (SLI) or ADHD.

The measurement of significant motor difficulties in gross and fine motor domains can only be fully ascertained using a standardised motor assessment. In the UK, the test component of the Movement Assessment Battery for Children (MABC-2⁴⁵) is the most widely used instrument and includes standardised normative scores plus a criterion-referenced checklist. However, other instruments such as the Bruininks-Oseretsky Test of Motor Proficiency⁵⁷ may also be used. There are also standardised tests for handwriting assessment (eg, Detailed Assessment of Speed of Handwriting (DASH⁵⁸)).

CONCLUSIONS

Despite receiving less focus and funding directed towards research and clinical development compared to, for example, ASD, DCD is not a rare developmental disorder. Similar to ASD, it has long-term morbidity with increased risks of psychiatric and other health-related symptoms. The direct impact on quality of life has also been shown (eg, Cairney *et al*⁵⁹).

The presentation of DCD may vary over time and differ with contexts making the identification of the disorder challenging across the lifespan and, as a consequence, does mean that clinicians working in different areas, for example, adult and child psychiatry, as well as paediatrics need to remain alert to the potential diagnosis.

Early identification, assessment and intervention can mean that lives can be changed and pathways diverted. This requires interdisciplinary team working and clarity in the diagnostic processes. In a recent article that reviewed the literature to assess the effectiveness of occupational therapy for children with DCD, it was concluded that intervention that addresses the everyday occupations and social consequences for children with DCD was found to be more important than the remediation of motor difficulties. Therefore, intervention pathways that actively involve children and parents in partnership with professionals should be encouraged.⁶⁰

Optimistically, there are some pathways starting to emerge in some areas of the UK, for example, the West Lothian CHCP Diagnostic Pathway for DCD. This has also been linked to provision of suitably trained professionals and the need for raising awareness. In Canada, Missiuna has developed an excellent web-based resource for physicians to assist them with assessing DCD, and this will be trialled and contextualised in the UK in the next year or so.

Competing interests None.

Provenance and peer review Commissioned; externally peer reviewed.

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