Developmental coordination disorder

Developmental coordination disorder affects the motor functioning of 5–6% of children in the population. While other disorders have been given a greater focus by clinicians and researchers, increasing knowledge of this condition is now seeing greater prominence and recognition in both child and adulthood.

Developmental coordination disorder is not a new condition. Different terms have been used to describe children with a predominant picture of motor difficulties over the years. In 1925, Dupré referred to the debilite motrice (motorically deficient). Clumsiness has been seen to be a more pejorative term, and was first used by Orton (1937) to describe a group of children with motor difficulties. Pioneering studies started to make their mark in the 1960s (Walton et al, 1962).

In 1962, the first article on clumsy children appeared in the *British Medical Journal* and referred to an earlier paper in the 1940s by Annell who had described the clumsy child as being:

> **'... awkward in movements, poor at games, hopeless in dancing and gymnastics, a bad writer and defective in concentration. He is inattentive, cannot sit still, leaves his shoelaces untied, does buttons wrongly, bumps into furniture, breaks glassware, slips off his chair, kicks his legs against the desk, and perhaps reads badly.'**

Today, dyspraxia is the term often used interchangeably in the UK with developmental coordination disorder, causing some confusion and inconsistency in terminology. However, the most recent, formal and widely internationally used term to describe these children is developmental coordination disorder. It appears in both the *Diagnostic and Statistical Manual for Mental Disorders* (American Psychological Association, 1994, 2000) and the *International Classification of Diseases and Related Health Problems* (World Health Organization, 1992a, b, 1993).

Developmental coordination disorder is defined on the basis of a failure of the acquisition of skills in both gross and fine movements, which is not explicable on the basis of impaired general learning and similar exposure to opportunity to gain motor skills as their peers. Developmental coordination disorder is often seen as the 'cinderella' of developmental disorders and not always considered routinely by clinicians (Kirby et al, 2007b). However, there is extensive evidence that motor difficulties have a pervasive effect on children's lives. The difficulties affect the child both in school and at home, and in contrast with similar aged children who acquire skills with little effort such as dressing, playing ball games and handwriting, these children take longer to learn and automate these skills.

Increasing interest in these children, in academic research and in clinical and educational practice, has focused on the need not only for early identification but also to consider the presentation in adolescence and adulthood, as around 70% of children continue to have difficulties when grown up (Kirby et al, 2008).

How are children identified and classified?

The American Psychological Association and the World Health Organization both have inclusive and exclusive criteria in their definitions. The American Psychological Association's inclusive criteria include: impairment in the development of motor coordination, which can be manifested in delays in milestones such as standing and walking; poor performance in sports activities; and untidy handwriting. This impairment leads to a disturbance in academic performance and/or activities of daily living. Exclusive criteria include the disturbance not being caused by a general medical difficulty such as cerebral palsy or a pervasive developmental disorder. In addition, if mental retardation (learning difficulty) is present the motor difficulties are in excess of those usually associated with it.

The World Health Organization (1993) definition overlaps with the American Psychological Association (2000) definition by noting that, on a standardized test of motor impairment, a child would score two standard deviations below the mean accompanied by interference with academic performance and/or activities of daily living. It notes that there should be no diagnosable neurological disorder and excludes those with an IQ below 70. The World Health Organization recommendation that individuals with an IQ of 70 and below are excluded from the formal definition is one that would be agreed by most clinicians and researchers.

Despite the guidance provided by the American Psychological Association and World Health Organization, there are still a number of issues surrounding the identification and definitions such as cut-off points for diagnosis, who undertakes the assessment, and what type of instruments are used.

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What is the underlying aetiology?

There has been a resurgence of interest in recent years regarding the underlying aetiology. One of the first studies by Querne et al (2008) using functional magnetic resonance imaging showed increased activity in particular areas in the left hemisphere, particularly from both middle frontal cortex and anterior cingulate cortex to the inferior parietal cortex and decreased activity between striatum and parietal cortex in the right hemisphere. The authors suggested that developmental coordination disorder could be characterized by abnormal brain hemispheric specialization during development.

A twin study undertaken in Australia by Martin et al (2006) did show a strong additive genetic component between subtypes of attention deficit hyperactivity disorder inattentive subtype and developmental coordination disorder (fine motor). However, as in attention deficit hyperactivity disorder and other developmental disorders, a single phenotype is highly improbable and any gene identified will vary in its penetration.

Morton's (2004) causal modelling approach considering biological, cognitive and behavioural levels may be a conceptual framework to use when undertaking research and to gain a greater understanding in this field. He presents examples of various developmental disorders such as attention deficit hyperactivity disorder, autistic spectrum disorders and developmental coordination disorder showing how a possible biological origin moves through cognitive processes to produce the behaviours that are identified.

There has been some interest in the relationship between omega 3 fatty acids and developmental coordination disorder. However, so far there has been no clear evidence of an association between improved coordination with supplementation, nor of lower levels being associated with poorer coordination. (Kirby et al (2010a) reviews current research.) Interestingly, antenatal maternal nutrition may influence motor outcomes in the child (Hibbeln et al, 2007).

What is the prevalence of developmental coordination disorder?

There have been wide discrepancies in the prevalence of this disorder and much of this has been a result of how it is assessed. Two studies using precise measures are narrowing the range of prevalence. Wright and Sugden (1996) advocated a two-step approach to assessment using the Movement Assessment Battery for Children (Movement ABC-2, Henderson and Sugden, 2007) as the standardized measure for motor impairment and the Movement ABC Checklist as a guide to examining the effects on daily living. Using this methodology, they found that the prevalence figure was 4–5% in mainstream primary schools. More recently, the large UK-based population study, the Avon Longitudinal Study of Parents and Children, has shown a prevalence of 1.7% with a further 3.2% of children considered as having 'probable developmental coordination disorder' by using broader cut-offs for coordination testing and activities of daily living (Lingam et al, 2009).

Gender differences have been examined on numerous occasions and the consensus is that the condition is more prevalent in boys than girls, with estimates ranging from a small difference to three or four to one. However, numbers identified may be related to the assessment tools used having a gender bias (Lefebvre and Reid, 1998). Teacher perception of skills among boys and girls may also influence identification (Rivard et al, 2007).

How do you diagnose developmental coordination disorder?

Children with developmental coordination disorder are assessed in a variety of ways, but currently there is no appropriate gold standard assessment instrument. In the UK the Movement ABC-2 (Henderson and Sugden, 2007) is the most widely used instrument, and contains a standardized normative referenced test plus a criterion referenced checklist. However, other instruments such as the Bruininks-Oseretsky-2 test of motor proficiency (Bruininks and Bruininks, 2005) are also used. There is also a range of screening instruments available for use in clinical practice, for example the Early Years Movement Checklist for 3–5-year-olds (Chambers and Sugden, 2006), DCDQ-2 for school age children (Wilson et al, 2009) and Adult DCD Checklist for the 16-plus age range (Kirby et al, 2010b).

The assessment needs to include a developmental history to identify developmental delay, especially in the motor and language domains that commonly overlap (Missiuna et al, 2002). A neurological examination is also essential to exclude children with other neurological conditions such as cerebral palsy or muscular dystrophy. Additionally, one needs to consider common genetic conditions where coordination difficulties are often seen such as fragile X and neurofibromatosis type 1. Other associated conditions such as BECTS (benign epilepsy of childhood with centrotemporal spikes) syndrome (Scabar et al, 2006) and joint hypermobility syndrome (Kirby and Davies, 2007) have been associated with developmental coordination disorder. Checking for common comorbid or overlapping conditions is essential, including attention deficit hyperactivity disorder, speech and language impairment, dyslexia and autistic spectrum disorders, as these may impact on educational support and type of intervention approaches undertaken.

Key areas of difficulties for children and adolescents with developmental coordination disorder are:

- At home: difficulties with self care such as dressing, eating, slower learning to ride a bike
- At school: ball skills especially in team games, handwriting difficulties, changing for games, copying from the board.

Common associated difficulties include:

- Poor executive functioning including organization of self and possessions, time management, e.g. losing items, late with assignments, difficulty packing a bag
- Low self esteem, difficulty in making and maintaining friendships, potentially associated with lack of opportunity and practice
- Weight gain.

Is this a single syndrome?

Green et al (2002) highlighted the widespread prevalence of motor impairment in developmental disorders. The so-called 'pure' developmental coordination disorder with only motor difficulties is the exception rather than the rule (Peters and Henderson, 2008). When viewing developmental coordination disorder alongside other developmental disorders, it cannot be seen not as a categorical but a dimensional concept where children are on a continuum of disorder. Extensive evidence from a number of researchers has shown high levels of overlap of developmental coordination disorder with other developmental disorders including attention deficit hyperactivity disorder, dyslexia and autistic spectrum disorders (Kaplan et al, 1997; Rasta and Eliot, 1999; Pitcher et al, 2003). Additional examples of this include reading, attention and motor deficits (Kooistra et al, 2005), social and emotional and behaviour, anxiety and depression (Sigurdsson et al, 2002), speech and language impairment (Hill, 1998), and social and communication impairment (Taylor et al, 2004).

Impact of developmental coordination disorder in the short and longer term

There was a view until the early 1990s that children with developmental coordination disorder 'grew out' of the condition. Hall (1988) discussed the need to look at the cause for clumsiness as related to 'motivation and good teaching' and referred to extrinsic factors affecting the young person. He stated: 'motor difficulties seem to resolve in the teen years, though they may re-emerge under stress of learning a new motor skill.'

'... we do our patients no service by treating clumsiness as if it was a disease. With only rare exceptions clumsiness is a talent deficit and like other learning disabilities is primarily an educational problem.'

The need to move away from a narrower medical model to a wider biopsychosocial model is essential when considering a longer-term view of the disorder.

The effect of having a diagnosis of developmental coordination disorder is not limited to motor functioning and studies in developmental coordination disorder have shown that children perceive themselves as less competent than their peers, not only in the domain of physical play (athletic competence), but also in several other domains including physical appearance and social acceptance (Skinner and Piek, 2001). Adolescents with developmental coordination disorder have also been shown to have psychiatric symptoms ranging from mood and anxiety disorders to social negativism and withdrawal (Sigurdsson et al, 2002). Research has also focused on the physical impact, increasing the risk of obesity associated with developmental coordination disorder, especially in boys (Cairney et al, 2005), and also of cardiovascular disease (Faught et al, 2005).

While the impact of developmental coordination disorder has been acknowledged as continuing into adulthood, the knowledge and understanding of symptoms and intervention approaches for this disorder comes mainly from studies in children. Understanding of the pattern of presentation in adults with developmental coordination disorder and the impact this has on individual's lives remains limited (Kirby et al, 2008) and is a focus for future research.

What do we know about intervention?

In general, the research on progression in children with developmental coordination disorder concludes that, without intervention, the majority of children do not outgrow the condition. However, the research base on intervention in developmental coordination disorder is not nearly as comprehensive as in other developmental disorders, highlighting the need for longitudinal studies in this field of work. There is a body of literature that can point to success in intervention (Polatajko and Cantin, 2005; Sugden, 2007). So far, there have been two major approaches to intervention, under different labels, but often referred to as either process-oriented or task-oriented approaches.

Process-oriented approaches are broad-based, usually administered by health professionals (e.g. occupational therapists or physiotherapists), and include such methods as sensory integration therapy. They aim at pinpointing the underlying process or processes in which the child has not developed appropriately and which are thought necessary for successful performance and acquisition of motor skills. Thus, the intervention, for example, would aim to improve the child's kinaesthetic functioning with the aim of this transferring to the functioning of several motor skills.

Task-oriented approaches use a range of cognitive methods but concentrate on the tasks themselves, and success using this approach has been achieved with a range of children. The basis of these approaches is the interaction between the child's resources, the task to be learned and the context in which it is set. The task, often determined through consultation with parents and the child, is taught directly, sometimes broken down into component parts.

In a meta-analysis of the different approaches, the task-oriented ones have emerged at this time as more successful and should be implemented by paediatricians running children's services (Pless and Carlsson, 2000).

So far, unlike attention deficit hyperactivity disorder, medication has not been indicated for use in children with developmental coordination disorder. However, Tucha and Lange (2001) noted in children with attention deficit hyperactivity disorder that handwriting became more accurate and legible, but not faster using methylphenidate. The link between executive functioning and motor control may in the future be an area of increased interest in research and provide a potential focus for pharmaceutical intervention. It is of interest to note that in the European clinical guidelines for attention deficit hyperactivity disorder (Taylor et al, 2004) developmental coordination disorder is highlighted as one of the comorbid disorders, stating: 'if significant interference with academic achievements or activities of daily living is observed, treatment with stimulants seems to be indicated.'

Further research is required in order to gain a greater understanding of the different subtypes or individuals, and how to further specify treatment approaches for these groups as compared to the whole, as has been done for attention deficit hyperactivity disorder.

Future direction and challenges

In the UK, as in many other countries in the past few years, there has been increased awareness of developmental coordination disorder by parents. This has also resulted in increased demand on the available services. One of the challenges for supporting children and their families with developmental coordination disorder will be providing effective and consistent management models supported by a good evidence base and working with parents at the centre of the intervention process. A consensus statement produced by professionals from a wide range of disciplines including health, education and psychology in the UK was launched following a series of meetings funded by the Economic and Social Research Council (Sugden, 2006). This is the beginning of the process and the statement remains available from www.dcd-uk.org.

A starting point would be for clinicians to make sure the initial enquiry not only looks across at the developmental spectrum, but also provides a method of triaging patients, so that those with the most complex difficulties are not waiting for support or therapy for several years. Working jointly with paediatricians, child and adolescent psychiatrists, and allied health professionals is essential to the improvement of both efficacy and efficiency and to minimize the long-term sequelae common among children with developmental coordination disorder. There is a need to design provision that takes into consideration the overlapping picture of developmental disorders rather than the segmentation of services that currently commonly exists (Kirby et al, 2007a).

In designing service provision it is important to consider that allied health professionals such as occupational therapists will never be able to provide the amount of intervention that will be required if given directly and that parent training has to be a key approach and a consultative approach with education to maximize impact and produce positive outcomes. **BJHM**

KEY POINTS

- Developmental coordination disorder is a common childhood disorder.
- Children with developmental coordination disorder will often present with other developmental disorders as well including attention deficit hyperactivity disorder, autism spectrum disorder or speech and language impairment.
- Around 70% of children with developmental coordination disorder continue to have some difficulties into adulthood.
- Developmental coordination disorder impacts on the child in a number of different domains increasing the risks of lowered self esteem, anxiety and depression.

Conflict of interest: Professor A Kirby has a son who has a diagnosis of developmental coordination disorder; Professor DA Sugden: none.

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