



Minerva Access is the Institutional Repository of The University of Melbourne

Author/s:

Spittle, AJ;FitzGerald, T;Mentiplay, B;Williams, J;Licari, M

Title:

Motor impairments in children: More than just the clumsy child

Date:

2018-10-01

Citation:

Spittle, A. J., FitzGerald, T., Mentiplay, B., Williams, J. & Licari, M. (2018). Motor impairments in children: More than just the clumsy child. *Journal of Paediatrics and Child Health*, 54 (10), pp.1131-1135. <https://doi.org/10.1111/jpc.14149>.

Persistent Link:

<https://hdl.handle.net/11343/284591>

Title: Motor impairments in children – more than just the clumsy child

Manuscript type: viewpoint

Authors: Alicia Jane Spittle^{1,2,3}, Tara FitzGerald^{1,2}, Benjamin Mentiplay^{1,2} Jacqueline Williams⁴ and Melissa Licari⁵

Affiliations:

¹ Department of Physiotherapy, University of Melbourne, Parkville, Victoria, Australia

² Murdoch Children's Research Institute, Parkville, Victoria, Australia

³ The Royal Women's Hospital, Melbourne, Parkville, Victoria, Australia

⁴ College of Sport and Exercise Science, Institute for Health and Sport, Victoria University, Melbourne, Victoria

⁵ Telethon Kids Institute, The University of Western Australia, Perth, Western Australia, Australia

Corresponding author: A/Professor Alicia Spittle, 7th Floor, 161 Barry Street, Parkville, Victoria, Australia, 3052; Email – aspittle@unimelb.edu.au; Phone +61390355390.

Word count: 2500 words

This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as doi: [10.1111/jpc.14149](https://doi.org/10.1111/jpc.14149)

Abstract: Developmental Coordination Disorder is a motor skill disorder that affects an estimated 5-6% of children, but lacks recognition and understanding, leading to under-diagnosis. Essential for diagnosis is a marked impairment in motor coordination that significantly impacts on daily living, including education. Though 'clumsiness' is often dismissed, the impact of this disorder is significant and extends beyond motor skills into physical and psychological health, and educational and vocational success. This is discussed here in regard to the framework of the International Classification of Functioning, Disability and Health. This review also discusses the importance of an accurate, early diagnosis and factors that inhibit this; dual-diagnosis with comorbid neurodevelopmental disorders; the multi-disciplinary approach to diagnosis and the role of the paediatrician within this; and current evidence regarding the most effective interventions.

Key words: Developmental Coordination Disorder, Motor Skill Disorders, Developmental Psychomotor Disorders, Cognitive Orientation, Dyspraxia

Introduction

Cerebral palsy (CP) and developmental coordination disorder (DCD) are two distinct, yet common motor impairments with onset in early development.¹ CP is an umbrella term to describe a group of disorders of the development of movement and posture, causing activity limitations, which are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain and is often considered on the severe spectrum of motor impairments.² Children with CP are a heterogeneous group in regards to the motor impairment, with approximately 60% of children with CP able to walk independently, 30% wheel chair dependent and 10% using a gait aid as their main form of mobility.³ Like CP, DCD is also an umbrella term, used to describe a heterogeneous group of children exhibiting marked impairment in motor coordination that interfere with activities of daily living or academic achievement, with the aetiology less well understood.⁴ The incidence of CP worldwide is 0.1-0.2%, whilst DCD is more prevalent and is estimated to occur in 5-6% of school age children.⁵ Both movement conditions involve deficits in higher order motor control processes such as movement planning and execution, yet the diagnosis and management pathways are currently very different in clinical practice.¹ Whilst some may consider DCD to be on the milder spectrum of motor impairments, it has considerable impact on a child and their family.⁶

In this review we will define DCD, how it is diagnosed, how it impacts on different aspects of a child's function, the role of the multi-disciplinary team and intervention options.

What is developmental coordination disorder?

DCD is characterised by marked impairment in motor coordination. The diagnostic criteria for DCD, as outlined in the Diagnostic and Statistical Manual of Mental Disorders Fifth Edition (DSM-V),⁵ include: a) lower than expected motor skills given chronological age and relative opportunity, b) skill deficits that significantly and persistently interfere with daily living, c) symptoms occur early in the developmental period, and d) motor deficits are not better explained by intellectual disability, visual impairment or another neurological condition affecting movement (e.g. CP).

However, clear consensus regarding the definition and diagnosis of DCD has historically been lacking in clinical practice and research.⁷ Previous descriptions of DCD have included clumsy child syndrome and physical awkwardness.⁸ More recently, the International Classification of Diseases, 10th revision (ICD-10) refers to DCD as 'specific developmental disorder of motor function' (SDDMF).⁷ Consistent with the DSM-V criteria, SDDMF involves serious impairment of motor coordination development which is not solely explained by intellectual disability, or congenital/acquired neurological disorder. Developmental dyspraxia, an alternative frequently used term for DCD, is defined as impaired or immature organisation of movement.⁹ A consensus statement published by the European Academy for Childhood Disability recommends that the term DCD should be used in regions where the DSM-V is used, such as Australia, whereas SDDMF is to be used in countries where ICD-10 has legal status.⁷

IMPACT survey

We present here preliminary data from the IMPACT from DCD survey (ethics registration RA/4/20/1045) from Australia. This web-based survey was launched in February 2018 to collect vital information surrounding the difficulties faced raising a child with DCD in Australia. We present the results on 252 children. The mean age of the sample was 9.4 years (standard deviation 3.4 years; range 5-18 years).

Functional presentation in children with DCD

The motor impairments experienced by individuals with DCD vary, with some experiencing solely fine motor impairment, solely gross motor impairment or combined motor impairment.⁴ DCD is a lifelong condition, that children do not outgrow. The most commonly reported difficulties for children with DCD include activities such as drawing/writing, dressing (buttons, zips, laces), eating with utensils, pouring a drink, opening packaging, brushing hair/teeth, art and craft, indoor and outdoor play/games/sport,¹⁰ whilst in adulthood difficulties could include learning to drive a car. In the IMPACT for DCD survey, parents described their child's movement as uncoordinated, awkward, clumsy, disorganised, or poorly timed. Irrespective of the skill, children and adolescents with DCD typically perform motor tasks with less accuracy compared to children without DCD.¹ Survey parents in the IMPACT for DCD study reported that it takes their child longer to accomplish tasks compared to other children (97%), their child became more fatigued when they found a task difficult (92%) and their child was more tired at the end of the day (82%).

A framework for understanding the impacts of DCD on children

The International Classification of Functioning, Disability and Health (ICF) framework is a valuable method of conceptualising functioning across three domains of body structure and function, activity and participation, alongside personal and environmental factors (Figure 1).¹¹ Individuals with DCD experience body structure and function impairments, including poor balance, strength and motor coordination.¹⁰ As a consequence of these impairments, altered gait has been observed.¹² Within the activity domain, performance of activities of daily living are affected for children/adolescents with DCD, as specified by the DSM-V diagnostic criteria.⁵ Common activity limitations including running, jumping, skipping and swimming, which can affect participation in free play, organised sports and ball games.¹⁰ For the participation domain, children/adolescents with DCD have been found to be involved in less physical activity than their unaffected peers, especially when participating at higher physical activity intensities.¹³⁻¹⁵

Within the ICF framework, contextual factors include personal and environmental elements which either positively or negatively affect individual functioning.¹¹ Examples of personal factors include age, gender, social background and coping style. Children and adolescents with DCD can show internalising behaviour and negative coping styles, which may be a consequence of the psychosocial stressors associated with poor motor performance.^{16,17} Children with DCD can also display lower self-efficacy, which may affect participation in exercise, and school and leisure activities.¹⁸ Environmental factors are defined as the

‘physical, social and attitudinal environment within which individuals conduct their lives’.¹¹ Children and adolescents with DCD are more likely to experience social difficulties than their unaffected peers.¹⁹ Negative social experiences have been described as secondary stressors directly attributable to DCD.¹⁶

Risk factors for DCD

Preterm birth is an established risk factor for DCD. Children born very preterm (< 32 weeks’ gestational age) and with very low birth-weight (< 1500g at birth) have over 6 times the likelihood of developing DCD by school age compared with term-born children.²⁰ Gestational age at birth is inversely associated with DCD risk, with decreased gestational age by 1 week associated with a 19% increased risk of the disorder.²¹ Further perinatal risk factors for DCD in preterm infants include male sex, low birth weight and postnatal corticosteroids.²² To date, there has been less research of DCD risk factors for children born at term ($\geq$ 37 weeks’ gestational age), however intrauterine growth restriction has been identified as a risk factor for DCD regardless of gestational age at birth.²³

Co-morbidities and DCD

The motor impairments characteristic of DCD are also seen in other neurodevelopmental conditions, in particular autism spectrum disorder (ASD) and attention deficit hyperactivity disorder (ADHD). When the diagnostic criteria for both disorders are met, individuals can be given a dual diagnosis. The rates of DCD in children with ADHD and ASD are as high as 50%.²⁴ In addition to ASD and ADHD, DCD is also highly prevalent with academic difficulties (e.g., dyslexia)²⁵ and speech and language impairments.²⁶

Importance of getting a diagnosis of DCD

Delayed DCD diagnosis limits opportunities for early, targeted interventions and timely referral to support services. Early intervention is crucial to prevent sequelae such as reduced quality of life¹⁹ and physical activity participation.¹³ However, early and accurate diagnosis of DCD is limited by clinical challenges, including the recommendation that formal DCD diagnosis should not be made before 5 years of age.⁷ The Little DCD Questionnaire (Little DCDQ) has been developed to address delayed diagnosis. The Little DCDQ is a parent report measure designed to screen for motor difficulties in children aged 3 and 4 years.²⁷ This tool facilitates identification of preschool age children who are at risk of a formal DCD diagnosis at school age, and subsequent opportunities for enhanced surveillance and motor enrichment.²⁷

A second clinical challenge is that the motor impairment attributable to DCD can be more subtle than other common conditions of childhood such as CP, with less clearly defined functional subgrouping and neural mechanisms.¹ Limited awareness of DCD and diagnostic criteria may result in delayed referral to appropriate services. Furthermore, due to high rates of co-morbidities associated with DCD, clinicians may attribute motor impairments with established ADHD/ASD rather than considering multiple diagnoses.

Preliminary findings from IMPACT for DCD have revealed that of the 252 children whose parents completed the survey, the majority of children (89%) had a diagnosis of a non-CP motor impairment, but only 20% were diagnosed with DCD, with dyspraxia being the most common label (41%). Other diagnostic labels used include sensory integration disorder, perceptuomotor dysfunction and DAMP (deficits in attention, motor and perceptual abilities). In regard to the health professional making the diagnosis, the most commonly reported professional was an occupational therapist (40%), followed by a paediatrician (29%). Whilst over 83% of parents were concerned about their child's motor development <4 years, average age of diagnosis was close to 6 years.

Whilst there are still challenges surrounding the diagnosis of DCD, like other neurodevelopmental disorders, a multi-disciplinary approach to diagnosis is recommended. This should include a detailed investigation of a patient's medical history and duration of impairment, detailed evaluation and assessment of current functional impact, and to ensure factors such as intellectual impairment, reduced experience or visual impairment are not responsible. It is also important that the motor functioning of those presenting with other clinical phenotypes associated with motor impairment be assessed (e.g. ASD, ADHD) and a dual-diagnosis given where appropriate. A paediatrician should be involved in making the diagnosis of DCD and plays a key role within this team, particularly in regard to their knowledge of a patient's medical history, and in confirming that the motor impairment cannot be attributed to other neurological disorders or intellectual or visual impairments. Paediatricians should ask questions about how a child is keeping up with peers at school, not only academically but also with their motor skills.

The use of a clear and consistent diagnosis to recognise motor impairments that sit outside other movement-related conditions is important (i.e. DCD and not Dyspraxia). Whilst the use of the label DCD is currently limited in Australia, its acceptance and appearance in the DSM-V offers the opportunity of one definitive label which needs to be adopted by all. Diagnosis of this disorder is important, with 80% of parents from the IMPACT for DCD survey reporting that receiving a diagnosis has been helpful. It has "given their child's difficulties an identity", "a label they can use to source information to understand their child's difficulties", "a label to know which therapies might help", and "has assisted in providing information to educational providers".

Intervention

Various interventions have been implemented in children with DCD,²⁸⁻³¹ with improvements in motor skills often observed after intervention. A systematic review reported 22/24 intervention studies in DCD improved motor performance regardless of the intervention type.²⁸ However, task-oriented interventions (e.g. learning particular skills to teach essential ADLs), also called activity-orientated interventions to align with the ICF framework,³¹ appear to result in the greatest improvements in motor skills.^{28,30,31} As such, the EACD recommend task-orientated approaches to improve motor tasks for DCD.⁷ Common forms of task-oriented interventions in DCD include neuro-motor task training³² and Cognitive Orientation to Occupational Performance (CO-OP).³³

Therapeutic interventions for children with DCD need to be targeted to the child's impairment/s rather than the diagnosis. This approach is also essential to ensure the child is able to access funding for interventions, e.g. the National Disability Insurance Scheme (NDIS) in Australia. The role of the multidisciplinary team will vary according to the individual child and family's needs. A paediatrician should lead the diagnosis process and work together with the multi-disciplinary team including occupational therapists, physiotherapists, exercise physiologists, speech pathologists, psychologists and teachers. In Figure 2, the roles of each member of the team is described, although it should be acknowledged there is overlap between roles and the team needs to work together depending on the individual child with DCD needs.

All members of the multi-disciplinary team need to work together to promote an active lifestyle and minimise the secondary consequences such as mental health issues, decreased physical activity and social isolation that may occur in children with DCD. It is important to challenge children but also find activities they can succeed in and enjoy to encourage a life-long positive approach to being active. This is supported by the IMPACT for DCD survey, where parents reported their children experienced anxiety, low confidence, depression, bullying, social isolation and exclusion. Parents reported their child often avoided participating in movement related activity (48%), were anxious performing movement related activity (53%), had difficulty socialising (44%) and had many worries or often seemed worried (81%).

Involving teachers and the school in the management of children with DCD

Given the functional implications and motor planning difficulties in children with DCD, such as limitations with hand writing, involving teachers and the school in the management of children with DCD is essential. In the IMPACT for DCD survey, 77% of parents reported that they felt that their child's movement difficulties were negatively impacting their ability to reach their potential at school. Whilst more than 82% of teachers were made aware of children's movement difficulties, only 56% met with families to discuss the child's needs, 39% engaged/communicated with the therapists that the children were seeing, and only 46% of children had individual learning plans in place. Of those with individual learning plans, some accommodations included slope boards, additional time to complete tasks, rest breaks, and assistance to complete more complex tasks at school (e.g. using scissors), electronic devices (tablets and computers), and one-on-one time with support teachers. It is important to consider how therapy is delivered in schools and needs to be supported at home, with use of home programmes rather than constant withdrawal from class for therapy recommended. However, where possible, it is useful for therapy to occur or involve a visit to the school to ensure the therapy is ecologically appropriate.

Longer term, it is important to consider the effects that DCD may have on students completing assessment tasks, such as exams at school. Support for additional time to complete exams may be needed, and in discussion with health professionals, students may consider applying for special consideration in advance of assessment tasks. In most cases, to

support special consideration applications it is important for the child have a documented history from their paediatrician of the functional limitations and how special consideration could benefit the child.

Conclusions

DCD is a common motor impairment occurring in 5-6% children, with a higher rate of up to 50% in children born preterm. Better recognition of DCD across medical and educational sectors is needed to ensure children reach their potential, as the functional impairments and secondary consequences of DCD can have a significant impact on a child's quality of life and academic achievement. Diagnosis of DCD allows children to access therapy that focuses on the individual child's functional impairments. Further, teachers need to be aware of the condition and have appropriate information that they can access. Future research is needed on models of funding for public access to diagnosis and intervention as the majority are privately funded. Motor impairment can have considerable functional impact. Whether it occurs alone, or in conjunction with the clinical symptoms of another disorder, it is important that it is identified early and appropriate support provided throughout various stages of life.

Acknowledgement: IMPACT for DCD:

https://uwa.qualtrics.com/jfe/form/SV_bHk8fjaGby5lFbL

References

1. Williams J, Hyde C, Spittle A. Developmental Coordination Disorder and Cerebral Palsy: Is there a continuum? *Curr. Dev. Disord. Rep.* 2014; **1**: 118-24.
2. Rosenbaum P, Paneth N, Leviton A, et al. A report: The definition and classification of cerebral palsy April 2006. *Dev. Med. Child Neurol.* 2007; **49**: 8-14.
3. Novak I, Hines M, Goldsmith S, Barclay R. Clinical prognostic messages from a systematic review on cerebral palsy. *Pediatrics.* 2012; **130**: e1285-e1312.
4. Vaivre-Douret L, Lalanne C, Golse B. Developmental Coordination Disorder, an umbrella term for motor impairments in children: Nature and co-morbid disorders. *Front. Psychol.* 2016; **7**: 502.
5. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders*. 5th ed. American Psychiatric Association, Washington DC, USA, 2013.
6. Tal-Saban M, Ornoy A, Parush S. Young adults with developmental coordination disorder: A longitudinal study. *Am. J. Occup. Ther.* 2014; **68**: 307-16.
7. Blank R, Smits-Engelsman B, Polatajko H, Wilson P. European Academy for Childhood Disability (EACD): Recommendations on the definition, diagnosis and intervention of developmental coordination disorder (long version). *Dev Med Child Neurol.* 2012; **54**: 54-93.

8. Zwicker JG, Missiuna C, Harris SR, Boyd LA. Developmental Coordination Disorder: A review and update. *Eur. J. Paediatr. Neurol.* 2012; **16**: 573-81.
9. Peters JM, Barnett AL, Henderson SE. Clumsiness, Dyspraxia and Developmental Coordination Disorder: How do health and educational professionals in the UK define the terms? *Child Care Health Dev.* 2001; **27**: 399-412.
10. Magalhães LC, Cardoso AA, Missiuna C. Activities and participation in children with Developmental Coordination Disorder: A systematic review. *Res. Dev. Disabil.* 2011; **32**: 1309-16.
11. World Health Organisation. *International Classification of Functioning, Disability and Health: Children and Youth Version (ICF-CY)*. World Health Organisation, Geneva, 2007.
12. Rosengren KS, Deconinck FJA, DiBerardino LA, et al. Differences in gait complexity and variability between children with and without Developmental Coordination Disorder. *Gait Posture.* 2009; **29**: 225-9.
13. Cairney J, Hay JA, Veldhuizen S, Missiuna C, Faught BE. Developmental Coordination Disorder, sex, and activity deficit over time: A longitudinal analysis of participation trajectories in children with and without coordination difficulties. *Dev. Med. Child Neurol.* 2010; **52**: e67-e72.
14. Green D, Lingam R, Mattocks C, Riddoch C, Ness A, Emond A. The risk of reduced physical activity in children with probable Developmental Coordination Disorder: A prospective longitudinal study. *Res. Dev. Disabil.* 2011; **32**: 1332-42.
15. Kwan MYW, King-Dowling S, Hay JA, Faught BE, Cairney J. Longitudinal examination of objectively-measured physical activity and sedentary time among children with and without significant movement impairments. *Hum. Mov. Sci.* 2016; **47**: 159-65.
16. Cairney J, Rigoli D, Piek J. Developmental Coordination Disorder and internalizing problems in children: The environmental stress hypothesis elaborated. *Dev. Rev.* 2013; **33**: 224-38.
17. Cairney J, Veldhuizen S, Szatmari P. Motor coordination and emotional-behavioral problems in children. *Curr. Opin. Psychiatry.* 2010; **23**: 324-9.
18. Engel-Yeger B, Hanna Kasis A. The relationship between Developmental Co-ordination Disorders, child's perceived self-efficacy and preference to participate in daily activities. *Child Care Health Dev.* 2010; **36**: 670-7.
19. Zwicker JG, Harris SR, Klassen AF. Quality of life domains affected in children with developmental coordination disorder: A systematic review. *Child Care Health Dev.* 2013; **39**: 562-80.

20. Edwards J, Berube M, Erlandson K, et al. Developmental Coordination Disorder in school-aged children born very preterm and/or at very low birth weight: A systematic review. *J. Dev. Behav. Pediatr.* 2011; **32**: 678-87.
21. Zhu JL, Olsen J, Olesen AW. Risk for Developmental Coordination Disorder correlates with gestational age at birth. *Paediatr. Perinat. Epidemiol.* 2012; **26**: 572-7.
22. Zwicker JG, Yoon SW, MacKay M, Petrie-Thomas J, Rogers M, Synnes AR. Perinatal and neonatal predictors of Developmental Coordination Disorder in very low birthweight children. *Arch. Dis. Child.* 2013; **98**: 118-22.
23. Faebo Larsen R, Hvas Mortensen L, Martinussen T, Nybo Andersen AM. Determinants of Developmental Coordination Disorder in 7-year-old children: A study of children in the Danish National Birth Cohort. *Dev. Med. Child Neurol.* 2013; **55**: 1016-22.
24. Goulardins JB, Marques JCB, De Oliveira JA. Attention Deficit Hyperactivity Disorder and Motor Impairment: A critical review. *Percept. Mot. Skills.* 2017; **124**: 425-40.
25. Lingam R, Golding J, Jongmans MJ, Hunt LP, Ellis M, Emond A. The association between Developmental Coordination Disorder and other developmental traits. *Pediatrics.* 2010; **126**: e1109-e1118.
26. Flapper BCT, Schoemaker MM. Developmental Coordination Disorder in children with specific language impairment: Co-morbidity and impact on quality of life. *Res. Dev. Disabil.* 2013; **34**: 756-63.
27. Wilson BN, Creighton D, Crawford SG, et al. Psychometric properties of the Canadian Little Developmental Coordination Disorder Questionnaire for preschool children. *Phys. Occup. Ther. Pediatr.* 2015; **35**: 116-31.
28. Smits-Engelsman BCM, Blank R, Van Der Kaay AC, et al. Efficacy of interventions to improve motor performance in children with Developmental Coordination Disorder: A combined systematic review and meta-analysis. *Dev Med Child Neurol.* 2013; **55**: 229-237.
29. Sugden D. Current approaches to intervention in children with Developmental Coordination Disorder. *Dev. Med. Child Neurol.* 2007; **49**: 467-71.
30. Pless M, Carlsson M. Effects of motor skill intervention on Developmental Coordination Disorder: A meta-analysis. *Adapt. Phys. Activ. Q.* 2000; **17**: 381-401.
31. Smits-Engelsman B, Vinçon S, Blank R, Quadrado VH, Polatajko H, Wilson PH. Evaluating the evidence for motor-based interventions in Developmental Coordination Disorder: A systematic review and meta-analysis. *Res. Dev. Disabil.* 2018; **74**: 72-102.

32. Niemeijer AS, Smits-Engelsman BCM, Schoemaker MM. Neuromotor task training for children with Developmental Coordination Disorder: A controlled trial. *Dev. Med. Child Neurol.* 2007; **49**: 406-11.
33. Green D, Chambers ME, Sugden DA. Does subtype of Developmental Coordination Disorder count: Is there a differential effect on outcome following intervention? *Hum Mov Sci.* 2008; **27**: 363-382.

Figure 1. Developmental coordination disorder within the ICF framework¹¹

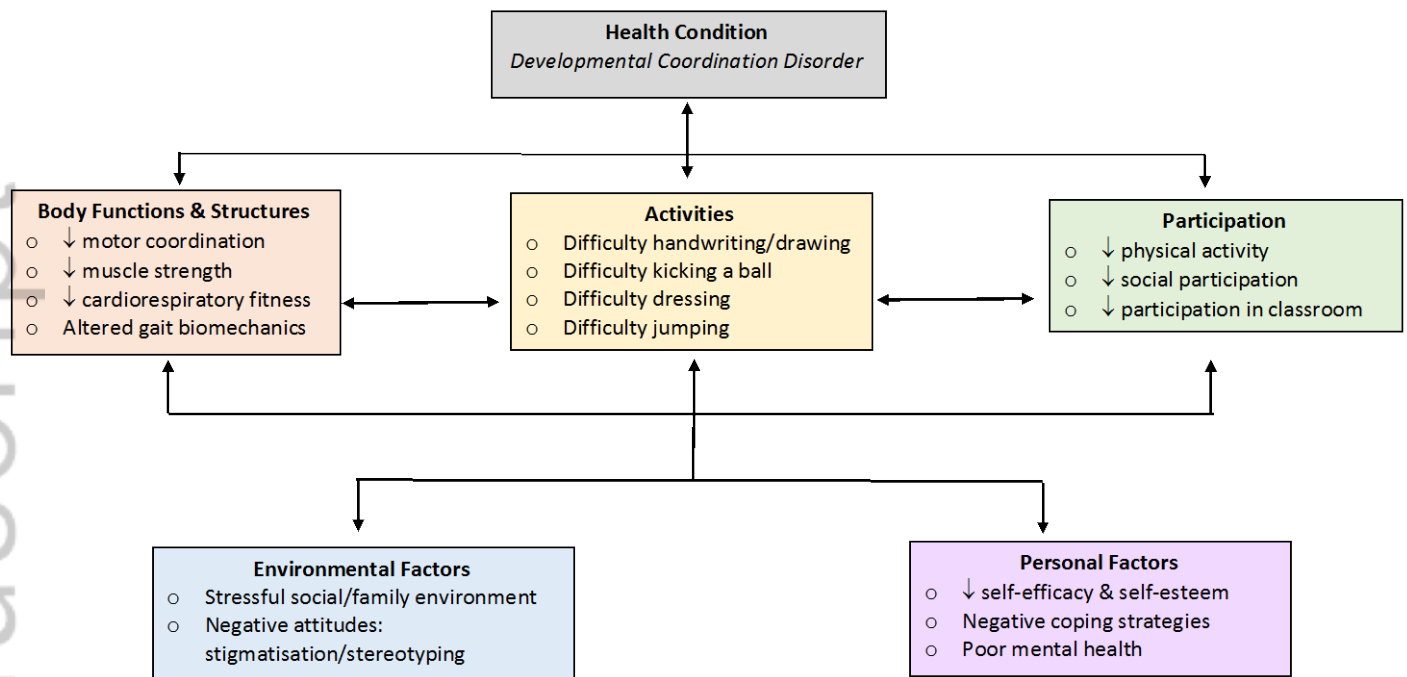


Figure 2. The role of the multi-disciplinary team in the management of a child with developmental co-ordinator disorder

