Occupational Therapy for Children with Developmental Coordination Disorder (Dyspraxia): Outcomes and Effectiveness

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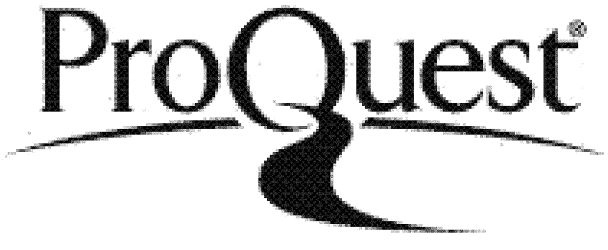
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Summary

The overall aim of this thesis is to identify methods of improving the efficiency and effectiveness of occupational therapy services to children with developmental coordination disorder and their families.

A method of applying the Diagnostic and Statistical Manual IV diagnostic criteria for developmental coordination disorder in a clinical setting is described. This process found that the majority (69%) of referrals were inappropriate. These included children whose difficulties could not be attributed to coordination as they scored above the fifteenth percentile on the Movement Assessment Battery for Children (28%), children with general learning difficulties (21%) and other medical conditions (10%).

The similarities and differences between parent, teacher and child views of the impact of developmental coordination disorder on activities of daily living are assessed. Whilst parents, teachers and children all expressed concerns about schoolwork the children's concerns give us much more information about self-care, play and leisure tasks such as dressing, using cutlery, playing sports and riding a bike.

A pilot trial is conducted which reflects child and parent/carer identified goals. It also explores how to measure the effectiveness of group occupational therapy intervention using a goal-orientated approach and the Canadian Occupational Performance Measure proved an effective tool when combined with other measures. The group was innovative as it was goal oriented and, rather than the usual once a week took place eight times in a two-week period. This new style group intervention appears to be successful in firstly achieving goals as 22/30 goals were met and secondly improving coordination as Movement Assessment Battery for Children scores improved significantly. These findings suggest that although this was an exploratory trial and there were therefore potential confounders such as non-blinded outcome assessment, there should be further evaluation of group occupational therapy intervention.

The richness of information to show individual development and progressions is explored demonstrating that each child's and family's experience of intervention is unique. Finally combining the results of studies 1-3, current practice and the literature a model for service delivery is proposed.

Rationale and aims of the study

Watching children grow, develop and acquire new skills is one of life's pleasures for parents and, conversely, one of life's sorrows when they fail to achieve things as easily as other children. Children's motor skill development plays a huge part in every day life skills. Most children acquire these skills easily, but some do not, and this becomes particularly obvious when they start school. For some children performing activities of daily living such as dressing, handwriting and playing is constrained by poor motor coordination. Difficulty with acquiring daily living skills often leads to feelings of inadequacy, frustration, underachievement and passive lifestyles. These types of difficulties have been recognised by doctors and therapists since early in the 20th century, when Orton[1] first described it as 'congenital maladroitness' although the early Greek physician Galen (cAD129-216) described children with poor motor skills as "ambilevous". This condition has been described by a number of labels such as minimal brain dysfunction, dyspraxia and clumsy child syndrome together with the currently most acceptable term worldwide, developmental coordination disorder. This thesis explores the role of occupational therapists when working with children who have problems with daily living skills requiring motor coordination. It is common for a range of professionals to assess these children and many will be given the diagnosis of developmental coordination disorder (DCD). In the UK it is usual for these children to be referred to occupational therapy for assessment, advice and intervention. Occupational therapists have had an interest in these children since the pioneering work of American occupational therapist Jean Ayres, started in the 1960s.[2] Ayres' work has been very influential for occupational therapists working with children with movement difficulties. She introduced the theory of sensory integration to explain the movement difficulties and devised therapy techniques based on this theory and sensory integration continues to be popular with many occupational therapists. Children with movement difficulties have formed a significant proportion of paediatric occupational therapists' caseloads for many years. In the last 15 years the number of children's occupational therapists in the UK has increased and this has often been driven by the demands of assessing and treating children referred with DCD type movement difficulties.

Traditional occupational therapy practice has tended to focus on attempting to change the motor impairment rather than reducing the impact of the impairment on activities of daily living.[3], [4] Ayres' believed that the underlying sensorimotor foundation skills could be remediated and that this would lead to functional gains has influenced this approach.[5] However modern NHS guidelines and recent government initiatives call for services that are evidence-based as well as child and family orientated have thrown out challenges to some of the traditional practices.

Therapy that aims to reduce the motor impairment using hierarchical, neuro-maturational approaches to development and learning are being challenged by new and different methods. For example, first, many investigations have focussed on understanding the motor and sensory basis of the impairment rather than the activities of daily living that are difficult for children with DCD.[6] Secondly, the therapist is seen as the expert who decides the goals for intervention rather than the child or family and may decide on different set of goals than a child and family centred approach that is more likely to lead to identification of difficulties with activities of daily living. Identifying specific activity of daily living tasks that are compromised by DCD can guide assessment and intervention methods towards a functional approach. Therefore, in order to improve skills in activities of daily living it is important to assess and treat activities of daily living, reflecting a child and family oriented approach. This requires a greater understanding of children's activities of daily living (or occupations in occupational therapy language) than we have currently. Outcomes can be measured by how effectively the activities of daily living based goals have been met. Much of the literature available measures the success of intervention by improvement in motor skills rather than improved function in daily tasks. Therefore, methods of assessing and measuring change in activities of daily living would appear to be an appropriate move forwards.

Clinicians use two major diagnostic manuals when diagnosing neuro-developmental disorders in children; the International Classification of Diseases (ICD10)[7] published by the World Health Organisation or the Diagnostic and Statistical Manual (DSM-IV)[8] published by the American Psychiatric Association. Both these manuals provide diagnostic guidelines for a wide range of conditions. In 1994 the London, Ontario, International Consensus Statement[9] endorsed the use of DSM-IV, and the term developmental coordination disorder for this group of children. DSM-IV has four diagnostic criteria for DCD. Application of these criteria requires clinical interpretation and the Leeds Consensus Statement (2006)[10] proposes a number of clarifications and amendments to aid clinical interpretation. One of the diagnostic criteria (Criterion B) requires the clinician to establish whether the coordination difficulties are impacting on activities of daily living. Assessing the impact of DCD on activities of daily living requires an individualised approach that aims to identify the activities of importance to the child, as well as those that are of importance to their parents/carers and teachers. Once the child, parents/carers and teachers have identified specific activities that are of concern to them, the occupational therapist can assess the child's current level of skill and participation in that activity. Once a method of assessing activities of daily living has been established this can also be used as a method of outcome measurement. An intervention approach that responds to child and parent identified activities requires development. The proposed approach to assessment, intervention and outcome measurement reflects the current

literature and evidence base and will be relevant to National Health Service provision of children's occupational therapy within the UK.

The overall aim of this thesis is to identify methods of improving the efficiency and effectiveness of occupational therapy services to children with DCD and their families.

In order to achieve this aim the following objectives are set:

Study 1

1. To identify and describe a method of applying the DSM-IV diagnostic criteria for DCD in a clinical setting.

Study 2

2. To assess the similarities and differences between parent, teacher and child views of the impact of DCD on activities of daily living.

Study 3

3. To develop an intervention method that reflects child and parent/carer identified goals.
4. To conduct a pilot trial to explore how to measure the effectiveness of group occupational therapy intervention for children with DCD using a goal/task-orientated approach.
5. To explore richness of information using an analysis of individual development and progressions.

Studies 1-3

6. To propose methods for service delivery by combining the results of studies 1-3, current practice and the literature.

The rationale and aims of the thesis are described in an introductory passage. The **first** chapter describes my personal involvement and reasons for undertaking this study and presents a summary of the overall aim and objectives. The **second** chapter explores motor development in children. In this chapter the current issues and theoretical frameworks relevant to DCD are explored by discussing descriptions and explanations of motor development. The **third** chapter considers developmental coordination disorder as a neuro-developmental condition. Labels, definitions and general characteristics are presented. Aetiology, prevalence, co-occurring conditions, motor development and the prognosis of people with DCD are described. The **fourth** chapter presents the development of the occupational therapy profession and models of practice. It also explores what is meant by activities of daily living, children's occupations and participation. A framework for considering the child, task and environment is proposed. It continues by examining the evidence on occupational therapy intervention for children with DCD and implications for future practice. The **fifth** chapter outlines the first study, which examines the

clinical picture of DCD by applying the diagnostic criteria. This includes the use of standardised tests and the children's, parents' and teacher's perceptions of their difficulties. Diagnosing DCD and the occupational therapy role within this are considered. The difficulties with identifying children with DCD and applying the diagnostic criteria are discussed. The **sixth** chapter details the second study, which analyses the children's, parents and teacher's perceptions of the impact of DCD on activities of daily living. The **seventh** chapter presents a pilot feasibility study for a clinical trial to measure the effectiveness of occupational therapy in reducing the impact of DCD on children's everyday lives using a goal orientated approach and intensive scheduling. The **eighth** chapter describes individual progressions of children in the pilot study to explore how the richness of case study data can further our knowledge of individual cases and the implications this has for intervention. This data is analysed using a simple content analysis and the framework described in chapter 4. The **final** chapter discusses the results and considers the implications for future research and practice. A model for service delivery is proposed.

CHAPTER 1: Personal involvement and key points

As a children's occupational therapist I have worked with many children with a wide range of developmental disorders, syndromes and conditions. Whilst the children with complex physical and medical needs can be emotionally and physically demanding, the children with coordination difficulties demand attention simply by the sheer numbers in which they are referred to our services. In addition children referred for coordination difficulties often present with a wide range of additional difficulties which can make managing their care difficult. This is true for occupational therapy services in Gwent and throughout the UK. Some, but not all, of these children are diagnosed with developmental coordination disorder (DCD). Referrals are received from a range of professionals including school health nurses, health visitors, paediatricians, educational psychologists, teachers, general practitioners and others. Despite a range of strategies to manage this group of children effectively and efficiently the waiting list fails to meet Welsh Assembly Government waiting time targets. This picture is not unique to Gwent as a survey[11] of **134** occupational therapy services for children throughout the UK found that the mean waiting time for assessment was 46 weeks with a span that ranged from one week (1 service) to 2-4 years (8 services). In Gwent we aim to see children within 36 weeks of referral but in 2000 the waiting list time was 70-80 weeks. In addition this survey found that children with DCD comprised 30% of occupational therapist's caseloads and 62% of the children waiting for assessment.

Long waiting lists mean that children are not seen at the time the initial concerns are noted so they cannot be responded to immediately. Waiting for an assessment causes distress to parents/carers and the service receives many phone calls and letters from parents begging and/or demanding to be seen. Some of these parents will implement the Trust's complaint procedure and some have approached their Assembly Members resulting in questions to ministers in the Welsh Assembly. Some parents choose to pay for an assessment by an independent occupational therapist. When children are eventually seen the initial referral information is often out of date and in some cases the children's problems have increased during the time they have been waiting. Occupational therapists feel pressured by the long waiting list as they are constantly being asked whether they have room on their caseload to take on new children. They are also often frustrated by the fact that for some children a small amount of input can make a big difference but the child has had to wait a long time for this. Other services in the UK have opted to offer assessment and advice only, as a method of managing the large numbers of referrals.[11] This means they do not have clinical experience of working with these children. In my opinion lack of clinical experience with children with coordination difficulties compromises the clinical quality of the assessment and advice given

by these therapists. Suggestions given are less likely to be practical when they are not based on ongoing personal experience. Also, if they never see these children and families again they do not know if their input and advice was effective or not. This opinion has been formed from discussions with occupational therapists whose services offer only assessment and advice.

In this sort of pressured climate, taking time out to consult the literature and think about the service being offered may seem like a luxury. That time could always be spent seeing more children. However, the Gwent service decided that a long-term view was needed to ensure best practice and that creation of a clinical specialist/research post to address these problems was justified even though it would reduce the amount of clinical time available unless the research was funded from elsewhere.

The ultimate aim is to manage this group of children effectively to ensure the best use of scarce occupational therapy resources. In order to do this it is necessary to establish that the correct children are being referred to occupational therapy. Anecdotal evidence suggests that some referrals are inappropriate and this perception needed to be tested. Methods of identifying DCD have not been clearly established and in reality decisions are often based on clinical judgement rather than a clear diagnostic process. Ideally occupational therapists should contribute to the diagnostic process in collaboration with health and education colleagues. This is very dependent on local arrangements for multi-disciplinary working.

In order to ensure that the professionals involved with children with DCD do not duplicate services it is important to establish the unique role of each profession. Enabling people to engage in activities of daily living, or occupations, is a core role of occupational therapy. There is no definitive definition of activities of daily living and those in existence are adult orientated. A clear definition of activities of daily living for primary school children would be a useful guide for occupational therapy intervention. Assessments should aim to apply the diagnostic criteria, identify strengths and difficulties and set goals for intervention. Assessments that focus on motor skills are unlikely to identify intervention goals based on improving activities of daily living. There needs to be a sound theoretical link between assessment and intervention approaches.[4]

I believe that all children who qualify for a DCD diagnosis would benefit from, at least, some advice from an occupational therapist. Many of them would also benefit from additional intervention in the form of group or individual intervention, school and/or home programmes and school/home visits. It is unclear which is the best method of intervention so a thorough literature review of the evidence base is needed to establish which intervention methods are most effective.

It is tempting to only offer services from the Children's Centre as this saves time spent on travel and may appear a more efficient use of resources. However, children with DCD need to be considered within the context of home, school and the wider community. This requires the therapist to see children in their own environments and to use a multi-agency approach. Given that these children are usually receiving intervention from other multi-agency professionals I felt that it was necessary to identify the unique and specific contribution that occupational therapy had to offer children with DCD. Clarity about the occupational therapy role would also have the potential to reduce the number of inappropriate referrals through articulating our role in assessment and intervention of children with DCD to referrers.

Clarity about the occupational therapy role should also guide the selection of appropriate outcome measures. It is appropriate to consider how successful intervention is measured. Does it mean the improvement of scores on tests of coordination, increased independence in age appropriate activities of daily living or the belief of the parents/carers and children that things have improved? It is possible that all these variables are important for consideration when measuring the success of interventions. My clinical experience is that parents report that the child is much more willing to "have a go" at activities they find difficult after receiving therapy. We ought to consider if we can capture this and measure it. The contribution of a range of professionals including teachers, educational psychologists, psychologists, physiotherapists, speech and language therapists, psychiatrists and paediatricians ought to be considered.

Selecting and agreeing on an appropriate name for the condition dominated the first international meeting about these children in London, Ontario.[7] It was not until there was this agreement on the use of the term DCD that people began to study the DSM-IV criteria in more detail. One of the reasons for selecting the term DCD was that it came with diagnostic criteria "attached". The application of the four diagnostic criteria requires the specific skills of a number of professionals. Each criterion requires some clinical decisions to be made in order to consider whether a DCD diagnosis is appropriate and most studies tend to focus on criterion A, the motor impairment. The recent Leeds Consensus Statement (2006) has built on the London, Ontario International Consensus Statement and provided additional guidance on the interpretation and clinical application of the DSM-IV diagnostic criteria. The Leeds Consensus Statement was published following a seminar series of meetings, which took place in Leeds, UK, over a year and were funded by an Economic and Social Research Council Grant. This was not published until 2006 and therefore was not available to guide the three studies but will be used retrospectively in analysing the process and discussing the results.

Diagnostic criteria for developmental coordination disorder DSM-IV[8]

A. Performance in daily activities that require motor coordination is substantially below that expected given the person's chronological age and measured intelligence.
B. The disturbance in criterion A significantly interferes with academic achievement or activities of daily living.
C. The disturbance is not due to a medical condition (e.g. cerebral palsy, hemiplegia or muscular dystrophy) and does not meet the criteria for pervasive developmental disorder.
D. If mental retardation is present, the motor difficulties are in excess of those usually associated with it.

Criterion A: The Leeds Consensus Statement[10] recommends the use of "an individually administered and culturally appropriate, norm referenced test of general motor competence" and a cut off level at the fifth percentile. All the available tests that meet these criteria need to be considered and the most suitable one selected. The assessment of measured intelligence needs to be done by an educational psychologist. However as many education authorities are reluctant to perform IQ tests the Leeds Consensus Statement[10] suggests that where this is not available other relevant data such as the teacher's opinion or results of national tests are acceptable. The child's intellectual potential is also considered in criterion D.

Criterion B: The impact of motor skills on academic achievement and activities of daily living requires the assessor to first identify which age appropriate activities of daily living are causing difficulties for the child and secondly whether the difficulty is due to poor motor skills. The Leeds Consensus Statement[10] considers the link between academic achievement and motor skills to be complex and often not proven but the activity of handwriting is invariably affected and therefore should be assessed. It therefore suggests focussing on activities of daily living with assessment reflecting culturally relevant developmental norms. It also recommends obtaining the views of the child, parent, teacher and relevant others on which activities are of importance.

Criterion C: Establishing if the child has a medical condition requires examination by a paediatrician. The details of the medical examination are generally left to the individual doctor. The DSM-IV states differential diagnosis must distinguish DCD from other motor impairments due to other medical conditions such as specific neurological disorders (e.g. cerebral palsy, progressive lesions of the cerebellum, muscular dystrophy), mental retardation and pervasive developmental disorders. The Leeds Consensus Statement[10] says that major neurological conditions should be ruled out by a neurological examination. It also states that DCD is known to commonly co-occur with other neurodevelopmental disorders including attention deficit hyperactivity disorder, autistic spectrum disorder and dyslexia. It suggests that a dual diagnosis of

autistic spectrum disorder and DCD should be given where appropriate. This would usually apply to children with a diagnosis of Asperger's syndrome.

Criterion D: Establishing whether a child's motor skills are commensurate with learning requires the clinician to combine the knowledge gained from applying criteria A-C and compiling a developmental profile for the child. The Leeds Consensus Statement[10] suggests that children with a measured or presumed IQ below 70 should not be given a DCD diagnosis and applying criteria A-C in the manner described covers considering the relevant differential diagnoses.

Occupational therapy has been defined as a complex intervention process[12] as it comprises "a number of separate elements which seem essential to the proper functioning of the intervention although the "active ingredient" of the intervention that is effective is difficult to specify". Creek's study defined occupational therapy (OT) as a complex intervention by identifying the parameters of OT, writing a definition of OT and describing a model of the complex content of OT and the connections between elements that can predict and test the relative contributions of these elements.[12] Given that OT had been defined as a complex intervention then the guidelines and framework published by the Medical Research Council (MRC) for the development and evaluation of complex interventions is considered. This is a useful structure to guide the process of gaining evidence to support clinical practice.[13] This framework identifies five stages in identifying evidence for clinical practice. The first three stages are covered in this thesis.

The first stage is the pre-clinical phase. This explores "relevant theory to ensure best choice of intervention and hypothesis and to predict major confounders and strategic design issues"[11](pp4). This will be covered in chapters 2, 3 and 4.The second stage is modelling. This identifies "the components of the intervention, and the underlying mechanisms by which they will influence outcomes to provide evidence that you can predict how they relate to and interact with each other". This is covered in Chapter 5 by selecting a group of children with DCD through applying the DSM-IV criteria and in Chapter 6 by analysing their perceptions of the impact of their motor impairments on their daily lives. The third stage is an exploratory trial. This describes the "constant and variable components of a replicable intervention AND a feasible protocol for comparing the intervention to an appropriate alternative". Chapter 7 is a small trial that explores a range of outcome measures with the aim of identifying the components of the intervention. In addition Chapter 8 explores individual progressions through case studies as and additional qualitative measure to examine the effects of the intervention.

Summary of key points

- Large numbers of children are referred to occupational therapists in Gwent and throughout the UK, because of concerns about their coordination. This creates long waiting lists and impacts on occupational therapy services to other groups of children, for example those with neuro-developmental conditions.

- Anecdotal evidence suggests that not all the children are appropriately referred to occupational therapy and this requires further investigation.

- Assessment, diagnosis and intervention practices are variable and therefore need to be grounded in, and guided by, up to date theories and the available empirical evidence.

- There is no gold standard method for assessing children and applying the DSM-IV diagnostic criteria in clinical settings. Each of the four diagnostic criteria ought to be considered and methods of applying them explored.

- The diagnostic criterion of most interest to occupational therapists is criterion B. Criterion B requires the clinician to establish whether the child's motor difficulties are "impacting on academic achievement or activities of daily living". Assessing the impact of motor impairments on everyday tasks is a core occupational therapy skill within the context of family centred practice. Different professionals have interpreted criterion B in a multitude of ways and little attention has been paid to it in many studies.

- In order to fully explore the impact of motor impairments on activities of daily living it is appropriate to consult the children, their parents and teachers for their views. Parents and teachers can readily give their views via questionnaires but consulting young children is more difficult. It requires careful attention to the language that is used, the addition of concrete stimuli such as pictures and clarity about the response options.

- In addition to clearly identifying how to apply the diagnostic criteria it is also necessary to be clear about the role of the occupational therapist. Traditionally occupational therapists have focussed on remediating the motor coordination deficit. There is a move within the profession towards a more occupation-focussed approach. Occupations are daily activities that children need to, want to or are expected to do. This clearly links in with considering criterion B and the impact of the coordination difficulties on activities of daily living.

Given that this is a new approach there are less courses, conferences and training available in how to implement this approach in a clinical setting. Continuing with traditional methods where the occupational therapist feels they have skills, knowledge and training may feel more comfortable than trying newer methods. To adopt this new approach we need to consider what activities of daily living are for children of different ages within their social, cultural and political environment. This requires consideration of self-care, productivity, play and leisure occupations for children.

- Once a robust method for selecting children for intervention has been identified we need to establish which type of intervention works best. Intervention methods should be supported by empirical evidence and grounded in appropriate theories about DCD, motor development and learning. Methods of assessing, treating and measuring outcomes of intervention for activities of daily living will be devised and tested.

Introduction to Chapters 2, 3 & 4

Chapters 2, 3 and 4 are what would traditionally be described as the literature review. This was divided into three areas; motor development, DCD as a condition and, occupational therapy and DCD intervention. When examining the literature relevant to the thesis it is clear that there are multiple bodies of work from a variety of disciplines. For example children with DCD are often referred to health professionals such as General Practitioners, paediatricians, school doctors, occupational therapists and physiotherapists. These professionals are often the people who set in motion the diagnosis and intervention process. They may also provide background information on the condition for parents and educators. Since this is a developmental disorder a body of literature of great relevance is that which deals with motor development in children. For a century formal observation of children's motor development has taken place and theoretical positions taken. Thus in order to get a comprehensive picture of the literature that has guided the formulation of this thesis the relevant topics are presented logically in three chapters.

The first of these, Chapter 2, covers motor development in children. It is essential that we understand how children develop and learn motor skills if we are to be successful in intervention and management procedures.

Secondly, Chapter 3 examines the condition of DCD, which has been recognised with various titles for a century, and selective literature on it obviously needs to be included.

Thirdly, Chapter 4 examines practices within occupational therapy with the logic that occupational therapists are very often the professionals who work with these children and this thesis aims to identify best practice. Intervention studies by occupational therapists, and others are examined to gain an understanding of best practice.

Analysis and synthesis of the topics in these three chapters lead us towards and then focus on the questions under investigation. At the beginning of each chapter there will be a short rationale for how and why the particular approach, and content of that chapter has been addressed.

CHAPTER 2: Motor development in children

Introduction

This chapter details aspects of motor development describing what happens during development and why the observed changes take place. The literature that has been chosen in this chapter addresses these two topics. First of these is what happens during development. This is often described as "ages and stages" and chronicles progress from birth through maturity. It is obvious that knowing what happens at various ages is important for all those concerned with children who develop typically and children who develop in an atypical manner. It allows expectations to be set and comparisons to be made. Selected bodies of literature have been chosen to illustrate the major milestones of children's motor development. The second part of the chapter attempts to unravel the question of why these changes have taken place. This is a more complex question and in this thesis can only be dealt with by giving a general overview of the positions that people have taken. However the literature has been chosen to accurately represent these positions with a preference for one particular line of theorising that represents the author's current thinking.

It is always fascinating to watch children develop from a state of relative immobility to one in which they are competent in numerous movement skills. Between birth and two years of age the child begins to walk around the environment, negotiates small stairs, uses a pincer grip to pick up objects and begins to interact with others in a physical sense.[14] By the school age of five years the child can run and jump, throw and catch, scribble and draw in a rudimentary fashion.[14] The typically developing child on entering school has numerous skills like these, allowing them to actively participate with success in the school environment. Some children, for a variety of reasons, do not possess these skills on entry into school thus reducing the opportunities for active engagement in the school learning process. The reason for this in some children is lack of experience or exposure with the activities in question, for others the reasons may be more complex and serious.

The new born child is totally dependent on their parents/carers to provide them with all their needs for basic survival and safety such as food, shelter and warmth. The baby cannot live, let alone develop, without this adult support. However, they do have a number of core movements some of which are reflexive and others, which are voluntary.[15] They are able to communicate their needs at a basic level by crying, for instance, when they are hungry or when their nappy is wet or soiled.[14] In a few short years children acquire skills that allow them to perform many everyday tasks independently and the level of adult support is greatly reduced. In the UK at the age of five

years a child is expected to attend school for several hours every day without their parent/carer and therefore perform many everyday skills independently. Many researchers have studied the process by which the child moves from dependence to independence and analysed the skills that are developed as part of this process.[16, 17] Developmental norms have been identified and attempts made to understand the drivers, facilitators and barriers that support or hinder development. Child development has been studied from a range of perspectives including neurobiological, psychodynamic, cognitive, social, cultural and humanistic. Each perspective views development with a particular emphasis. More recently development has been considered using dynamic systems theory and ecological perspectives that take a broader view of the interaction between the ranges of influences that impact on child development. Rather than seeing one aspect of the child as the principle driver for development, such as the central nervous system (CNS) or cognitive development, dynamic and ecological perspectives consider all of the aspects that potentially shape development and considers how they interact with, and influence, each other.

Child development encompasses all aspects of the child with growth and motor development being just two of the components or sub systems. The acquisition of motor skills enables the child to respond to, and change, their environment and effects emotional and social development, communication, and the understanding of distance and space.[18] In children who show movement difficulties such as those with DCD, there may be delays in achieving developmental motor milestones such as walking, crawling, sitting, tying shoelaces, buttoning shirts and zipping trousers. The difficulties children with DCD have with acquiring developmental motor milestones are elaborated in the next chapter. Motor skills cannot be considered in isolation but need to be viewed within the context of general development and our current level of knowledge about how this occurs. Motor skill acquisition is examined using historical and current ideas of motor development of typically developing children.

Motor skills in the context of child development

A holistic view of child development considers the width and depth of knowledge and theories relating to the growing and developing child. Development is a process of change over time.[19] Observing and describing the changes that take place are much easier than explaining *why* they have taken place. Developmental changes include physical growth, maturation of cognitive, psychosocial and communication abilities. Descriptions of changes in children's growth, such as how bones and muscles lengthen and fat deposits change with age are readily available. Growth alters the bio-mechanics of the limbs and trunk and affects motor skills, and it is common for children's motor skills to seemingly become worse during growth spurts. Physical growth can be viewed as an independent variable or constraint on motor development. Cognitive development

also plays an important part and Piaget and others have considered cognition as a prime driver for development.[20] Cognitive development includes intelligence, attention and problem solving, a child with poor attention can appear uncoordinated, in the absence of any motor deficit, by tripping, falling and stumbling because they are not paying attention.[21] It has been shown that medication such as Ritalin can have a beneficial impact on children's handwriting which demonstrates the impact of attention on motor skills.[22] Psychosocial development includes dealing with emotions, social cognition and self-management and a child with poor social skills finds it difficult to join in games with their peers, which reduces the opportunities for physical play as well as social interaction.[23],[24] A child's development of temperament includes confidence and motivation with a confident child being more likely to be motivated to try a new task and risk failure than a child who lacks confidence. The child's communication skills progress from crying to express that they want something, to pointing and showing, with words emerging and being built into sentences. The child's ability to understand language is usually ahead of their expressive abilities in the early years. The child's environment and context are known to be powerful forces in constraining or facilitating all aspects of child development. In addition every child has a unique personality, set of genes and experiences all of which shape the way in which they develop and learn.

Flavell in 1972[25] proposed an old but still classic analysis of cognitive-developmental sequences and explored the relationship between emerging skills, abilities and concepts, which he referred to generically as items. This classification provides a useful framework for considering child development and can be applied to motor skills as well as cognitive skills. Flavell[25] considered whether earlier developing items were related in a causal way to later developing ones. He proposed that developmental sequences are related to one another in five principle ways: Addition, substitution, modification, inclusion and mediation. Addition is when the later emerging item supplements, but does not extinguish, the earlier item. For example crawling is replaced by walking as a form of locomotion but the child can still crawl and will do so on occasions even once they have learnt to walk. Substitution is when the later item replaces the earlier item. For example reaching and grasping are substituted by batting and swiping. Modification is when the later item is a differentiation or generalisation of the earlier item. For example step-hop becomes skipping. Inclusion is when the earlier item becomes incorporated into the later one as an integral part. For example kicking a ball becomes part of the movement sequence of dribbling and shooting a ball in a game of football. Finally mediation is when the earlier item represents a developmental bridge or stepping stone to the later one. For example a sequence of motor actions such as hop-step-jump could be mediated by the development of memory that allows the child to remember the sequence and therefore enact the sequence more smoothly. Flavell suggested that

cognitive growth may have many significant non-sequential features in addition to the obvious sequential ones and this also appears to be true of motor development. Classifying developmental skills in this way facilitates task analysis as it provides insights into how to break tasks down into components that have a meaningful relationship with the whole task by considering how the desired skill relates to current skills. It also acts as a powerful reminder that in order for children to discover how skills are related to each other they need to be given opportunities to practice and explore tasks. When teaching new skills we need to consider the skills that are being built on, replaced or modified and when the child needs to build a developmental bridge to the new skill. Thinking of skills in this way during intervention may help the therapist to guide the child more effectively.

Parents often chart their child's development and celebrate new skills as they are acquired such as sitting unaided, walking, talking, toilet training and so on. Many of these milestones reflect the motor learning that is taking place as the child grows and develops. Acquisition of motor skills provides tangible evidence of the child's progression and is often more visible and obvious than skills in other areas of development. There is an abundance of books, leaflets and magazines offering advice to parents on how to help their child develop including improving fine and gross motor skills. In the UK, health visitors conduct child health surveillance visits with every child by their first birthday and at 2-3 years. It is during these visits that potential developmental concerns may be noted as well as addressing other health issues such as immunisation. Developmental concerns raised by the parent(s) or health visitor, would initiate further investigation, for example by referral on to another health professional such as a paediatrician.[26] Developmental screens and assessments are conducted when there are concerns and always include fine and gross motor skills, examples include the Griffiths[27], Bayley Scales of Infant and Toddler Development[28] and the Schedule of Growing Skills[29]. However, children with DCD are rarely identified with these assessments. The majority of children with DCD are identified after they have started school suggesting their difficulties are not readily identified in the first few years.[30] However many believe that the pre-school years is an optimum time for intervention.[31] Therefore new assessments are required to accurately identify younger children and the Early Years Movement Skills Checklist looks a promising tool for this purpose as it identifies children from 3 to 5 years.[32]

As was outlines in the introduction there are two major issues to be considered in motor development. Firstly the *description* of what happens, often referred to as ages and stages and secondly the *explanation* of why and how it happens. There is a wealth of literature describing ages and stages of motor development giving age ranges that typically developing children reach

each stage such as rolling, crawling, walking or using a pincer grip. Commonly used scales and assessments are the Schedule of Growing Skills[29], Bayley Scales of Infant and Toddler Development[28] and Peabody Developmental Motor Scales[33]. These scales report the ages in terms of percentiles using the 5th, 25th, 50th 75th, 90th and 95th as marker points and for considering whether a child is delayed or advanced in their motor skills. Whilst different studies may vary within a month or two at either end of the age range for a particular skill they are generally fairly consistent, even across cultures. For instance the age of onset of walking is quoted as 9-17 months by Bayley[28] and 8-18 months by Herbert[34]. There is much greater variation with the second issue – the explanations of how and why these changes occur.

Explanatory theories of motor development can be categorised into three broad groups – maturational, information processing and dynamical systems theory. The views of what constitute the drivers for changes in motor development have shaped each of these theories. The maturational theorists view change as driven by the central nervous system and the information processing theorists see change as driven by the input and processing of information; whereas dynamic systems theorists see changes driven by a series of transactional interactions between the mover, the environment and the movement task.[35] All of these theories have contributed to our understanding of child development and the central themes and ideas of each one will be presented. Further important information about motor development has been provided by methodologies such as functional brain imaging but these studies have not been explored in detail, as they are not the focus of this thesis.[55] Initially the descriptions of motor development will be presented followed by the different explanations of how and why motor development happens.

Taxonomies and descriptions of motor development

First it is necessary to establish what is meant by motor development. Motor development encompasses development, motor control and learning. Motor control is the way in which the body organises itself to produce skilful movements and is assessed by observing performance of a motor task at a given time. Motor learning is the process by which motor control is acquired and is associated with practice and experience. The fact that motor learning has taken place is assessed by changes in performance over time.[36],[37] In order to understand what is the nature of movement difficulties we can study the classifications and taxonomies that have been presented. Taxonomies provide descriptions, definitions and groupings of skills that may be considered for assessment and other purposes. There is no definitive taxonomy of movement skills but Burton and Miller[38] proposed a taxonomy that included foundation skills, early movement milestones, fundamental movement skills, specialised movement skills and functional movement skills. (See Figure 2:1)

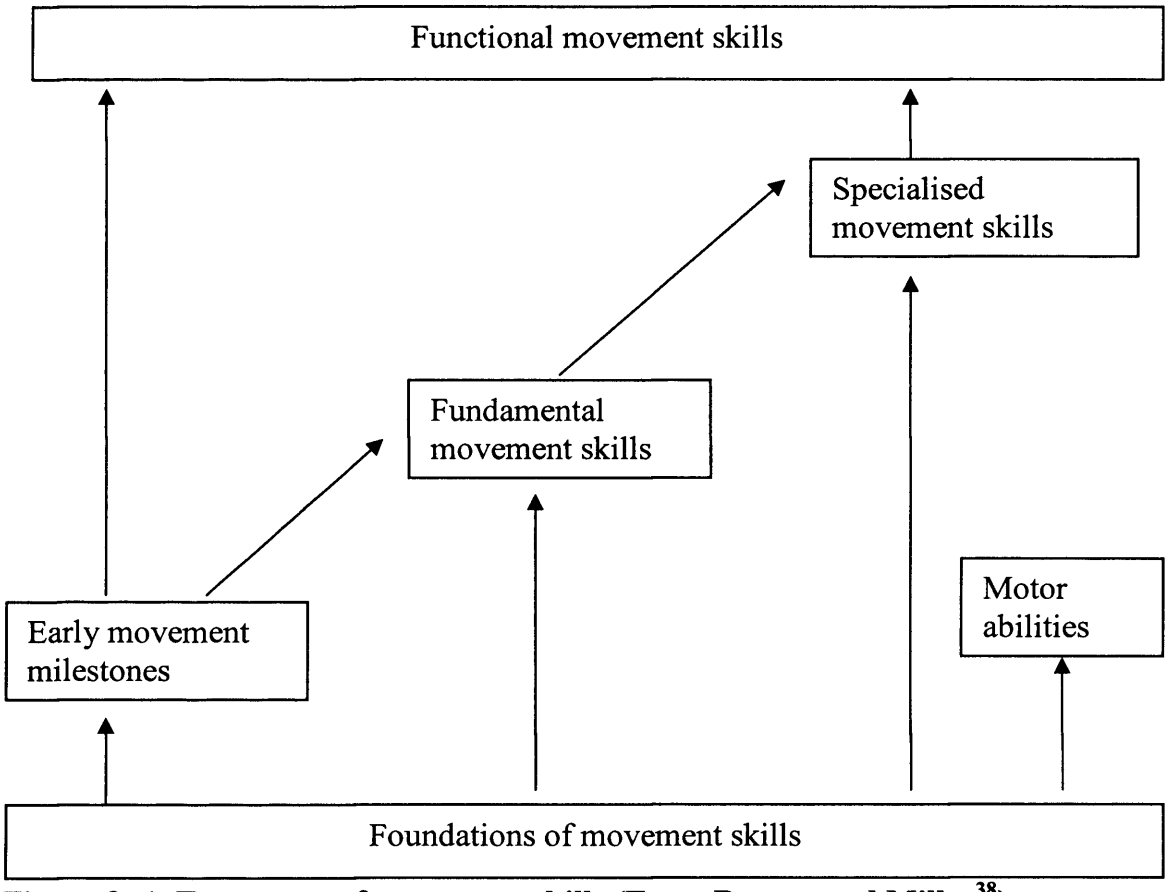


Figure 2: 1. Taxonomy of movement skills (From Burton and Miller[38])

The foundations of movement skills are aspects such as strength and range of motion. Early movement milestones are the skills that emerge before independent walking which is considered to be the last early movement milestone. Fundamental movements develop during the first six or seven years and encompass the phylogenetic, locomotor and object control skills used by all persons of the world in all cultures. Fundamental movement skills include walking, running, jumping, sliding, hopping, leaping, throwing, catching, striking, bouncing, kicking, pulling and pushing. Specialised movement skills are specific, complex skills required for particular sports or tasks. Functional movement skills are performed in natural and meaningful contexts and may be movement milestones, fundamental movements or specialised skills. Functional movement skills include activities of daily living. This taxonomy differentiates between motor skill and ability. Motor skill is used as a qualitative description of performance or refers to a specific group of goal directed movement patterns, such as running. Ability refers to a person's potential movement competencies. The taxonomy also emphasises that development may not occur in a hierarchical fashion as skills at higher levels may develop before all skills at the levels below are mastered.

Burton and Rodgerson[39] proposed a new taxonomy of movement skills and general motor ability with four primary levels – movement skills, movement skill sets, movement skill foundations and general motor ability. The concept of motor abilities is replaced with movement skill sets and

movement skill foundations. Movement skills are "a group or class of movements that have similar movement form and function, which can be modified by practice or experience" they are the "tools in life, discernable from one another, that are used to work and play".[38] When assessing movement skills it is necessary to consider the constraints of the task and the environment. This means it is important to consider the context in which assessment takes place and wherever possible to assess a skill in a range of contexts. Movement skill sets are groups of related movement skills. Movement skill foundations are "not movement skills themselves, but are all aspects of a person – physical, mental and emotional that facilitate or limit his/her performance of movement skills". Burton and Miller[40] list 11 commonly assessed movement skill foundation areas: balance/postural control, body composition, body size and morphology, cardiovascular endurance, cognition, flexibility/range of motion, knowledge, motivation and affect, muscular strength and endurance, neurological functioning/reflexes and sensations/sensory integration/perception. Burton and Rodgerson[33] state that movement skill foundations are only meaningful in the context of a specific skill. In this taxonomy the construct of general motor ability is accepted as they believe the evidence supports the construct, it is in common usage as a construct (but not used consistently) and the fact that the specificity of movement skills increases with age of the child provides further support. It is suggested that the Movement ABC[41] checklist might offer the best estimate of general motor ability in currently used tests[38].

Taxonomies can act as a guide to the areas for consideration when exploring the development of movement skills. Those described above show that movement incorporates a range of different skills and is not a single entity that can be simply described or assessed. It is only possible to assess performance of skills through direct observation, at a given time, or by interview of the child and parent. An interview can ask about skills that are not readily observed at the assessment and the ages at which earlier skills were acquired. Using a top down logical approach to movement skill assessment one would start with looking at functional movement skills also referred to as activities of daily living, and identifying specific difficulties. Intervention can be targeted at teaching the specific activity by breaking the task down into movement skills or skill patterns. Should intervention at this level be unsuccessful then it may be necessary to assess the movement skill foundations of the skill patterns required for the functional task. This process is shown in Figure 2 adapted from Burton & Miller[38]. Using this top down approach to assessment ensures identification of the difficulty at the level that requires intervention and always ensures intervention is clearly linked to functional skills. Assessment and intervention are inextricably intertwined as intervention focuses on areas that assessment has pinpointed.

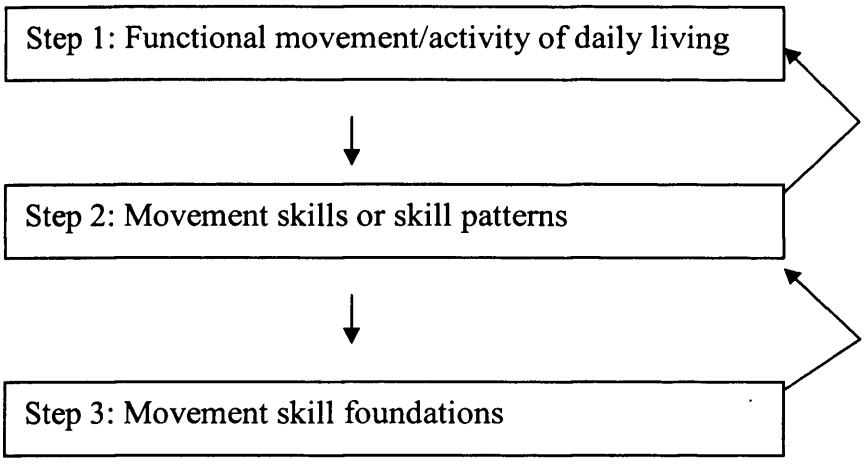


Figure 2: 2 Intervention levels. Adapted from Burton & Miller[38]

Motor coordination

Since the DSM-IV definition assumes a deficit in the development of coordination the meaning of this term is explored. Coordination may be viewed as an intrinsic skill or ability or can be inferred from the assessment of motor skills.[42] It has been argued that the construct of motor coordination is not well defined.[43] Burton and Rodgerson[33] note that there is an inconsistent use of terms and constructs used in motor assessment instruments. A wide range of terms is used, motor skills, motor ability, motor proficiency, motor development and coordination. Bernstein[44] in 1967 viewed coordination as

"The process of mastering redundant degrees of freedom of the moving organ, in other words its conversion to a controllable system."

This means controlling body and limbs in a smooth, economical manner. Walter described coordination "as the generation of appropriate spatial and temporal relations among movement-related events such that the goal of an action is successfully achieved".[45] Newell described three aspects of movement; coordination, control and skill resulting from an interaction between the organism, the environment and the task. He viewed coordination as constraining the possibilities or degrees of freedom of the motor system, in order to produce a functional movement. He saw control as determining how the chosen coordination pattern is used, such as the speed of action. Skill emerges when the ideal set of parameters has been found for a given action. The movement taxonomy described above of functional skills, movements skills/skill sets and skill foundations views coordination as part of general motor ability that is a combination of function, skill sets and foundations and is therefore not directly assessed but assumed from the sum of function and skills.

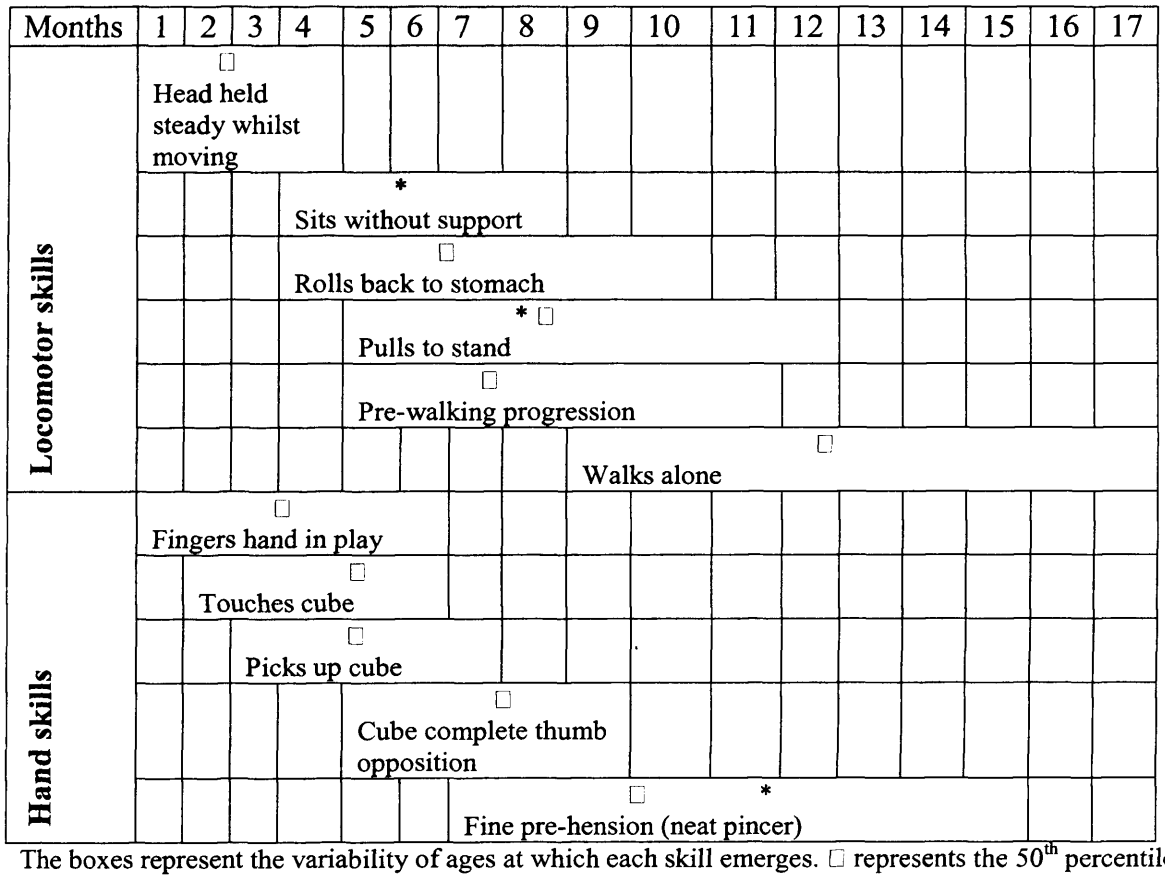
Clinicians rarely concern themselves with considering constructs although their practice suggests the implicit acceptance of some of these constructs. Those who work on component skills must believe they are working on general motor ability and therefore that it exists as an underlying variable that is required in order to develop functional skills. Many therapists consider improving coordination as an acceptable goal of therapy and measure the effects of therapy by changes on tests of coordination. However using the taxonomy described above, unless coordination is related to specific tasks, then it is difficult to see how the gains have impact on everyday functioning. These new taxonomies, dynamic systems theory, ecological approaches and the ICF (WHO)[46] all place a great emphasis on considering the child within their everyday context. Clinicians need to become skilled in weaving interventions into the everyday fabric of the child's life.[47] Burton and Miller's taxonomy[38] is used as a framework for considering child development, early movement milestones, fundamental movement skills and functional movement skills. Early movement milestones are all the skills gained up until the time that the child learns to walk and then followed by fundamental movement skills with new skills being acquired until about seven years and then skills are honed and refined. Functional movement skills are any everyday skill and may incorporate early milestones and fundamental skills.

Early movement milestones

There is a wide range of individual variability in the emergence of motor milestones and all charts of the ages at which children achieve skills should be viewed with caution when making developmental assessments. Cultural differences have been noted and many milestones are reached earlier now than they were at the turn of the century.[48]

Reflexes are involuntary movements that occur in response to a given stimulus. Some are present before birth such as sucking, palmar grasp and the asymmetrical tonic neck reflex. Present at birth are rooting, stepping and the Babinski reflex. Many of these reflexes "disappear" at 3-6 months others merge into voluntary control and some stay throughout life. Some have viewed the persistence of particular reflexes into later life as evidence of CNS immaturity. The persistence of the influence of the asymmetrical tonic neck reflex has been attributed to difficulties with sensory integration and has been incorporated into clinical observations by therapists using this approach.[49] However, Thelen and colleagues showed that the disappearance of a reflex is not just related to CNS maturity but other factors such as biomechanical and morphological changes also have a great effect and therefore reflexes alone could not be considered a marker for CNS development.[50]

Locomotor skills progress from lying to sitting to walking and hand skills start with reflexive grasping and progress to object control.[51] Examples of "ages and stages" of locomotor and hand skills are presented in Table 2:1. This has been adapted from Keogh and Sugden 1985[15] who have kindly given permission. The tables were constructed by an examination of two major developmental scales, the Denver[52] and the Bayley[53]. The beginning and end of the boxes show the 5th-95th percentile whilst the □ or * represent the 50th percentile for the Bayley and Denver respectively. Both scales were used, as neither scale covered all activities.



The boxes represent the variability of ages at which each skill emerges. □ represents the 50th percentile from the Bayley Scale[53] and * the 50th percentile from the Denver[52].

Table 2:1 Locomotor and hand skills adapted from Keogh & Sugden 1985[15]

It is also clear that performance and development in grasping patterns is strongly influenced by the task that is presented. Newell and colleagues have shown that grasping patterns are also influenced by the ratio of hand size to objects.[54] The hand size to object size ratio can determine the type of reach and grasp, for example whether it is a unimanual or bimanual thus indicating that environmental variables have a strong influence on reaching and grasping performance.[15, 53] It has been shown, through the use of functional magnetic resonance imaging techniques, that the force of the grip used to hold an object is changed in response to changes in the force of the load.[55] This has strong, optimistic implications for all of those involved in therapy and teaching as we are able to manipulate the environment.

Fundamental movement skills

Once a child can walk independently, at 8-18 months, fundamental movement skills are developed. This will include walking sideways and backwards and up and down stairs, which is also a functional movement skill. At 22 months a child can walk up and down stairs but it is not until five years that they can walk downstairs in an adult manner with one foot to each step. (Griffiths[27]) In their second year children learn to run (Griffiths[27]), at four they can run fast indoors and by six years they can run fast out of doors. (Griffiths[27]) By the age of 5 the child is able to run, skip, stand on one foot for 8-10 seconds and hop forwards 2-3 yards (Sheridan[56]). Gross motor skills allow the child to explore the environment and engage in functional movements required for children's games on the street and playground.

At 18 months children can build a tower of three blocks. At two years hand preference is becoming evident. Towards the end of their second year children perform an action closely resembling a throw but with little control of force or direction. At three years they can close their fist and wiggle their thumb in imitation. They can also handle scissors and tries to cut paper. They thread beads onto a lace using lead/assist hand skills. At four years they can touch their thumb to each finger in opposition in turn. By the age of five they are likely to hold a pencil with a mature, dynamic grip (Sheridan[56]). Fine motor skill allows the child to manipulate and control small objects and perform functional movement skills such as using tools such as pencils and scissors. Throwing skills start with casting objects to the floor and evolve into specialised skills for specific sports such as cricket, basketball and tennis. Kicking skills start with the child walking into a large ball and evolve into accurate passing and shooting in football.

Ideas about movement skills and how they should be assessed are evolving and the Manual Ability Classification Scale (MACS)[57] is evidence that clinicians are identifying the need to develop assessments of manual ability that look beyond specific movements and considers the functionality of a child's skills. The MACS[57] classifies hand skills according to the level of functional skills that a child can achieve rather than measuring the level of impairment.

Functional movement skills

Functional movement skills may be early movement milestones, fundamental or specialised skills that are performed in natural and meaningful contexts and includes activities of daily living. The basic self-care tasks are considered here - eating, drinking, toileting, washing/bathing and

dressing. A broader range of self-care tasks is presented in Chapter 3. The ages and tasks are compiled from a range of sources Herbert[48], Griffiths[27], Sheridan[56], Gallahue and Ozman[60], Haley[59], Coley[58] and the Portage Checklist[61].

The one month old sucks well and sleeps much of the time when not being fed or handled. At six months they put their hand to the bottle when being fed. At one year they can drink from a cup and chew. By 18 months they can hold a spoon and get food to their mouth. They can lift a cup and drink from it and spoon-feed without spilling. At three they eat with a fork and spoon. By 4½ years they hold a fork in their fingers and by 5½ years they can cut soft food with a knife.

By two years they are usually dry by day and can sit on a potty. By five years of age most children are able to get on the toilet without using their arms for support. Children start attempting to wipe after a bowel movement from three and a half to four years and wipes thoroughly at five-and-half to six years. Successful wiping requires skilled manipulation and folding of the toilet paper plus control of direction and force without the use of vision. At three they can wash their hands but needs supervision drying. By four and a half years they soap a cloth and wash their body well but it is not until 8-9 years that they can wash their ears.

At 18 months to two years they will help with dressing by holding out an arm for a sleeve[58] or foot for a shoe[59]. By 4-5 years they can dress themselves except difficult fastenings and are completely independent by 6½ years. The key fundamental and functional skills for children and the age at which typically developing children achieve these, are presented in Table 2: 3.

It can be seen from Table 2:3 that skills emerge in the pre-school years (such as running, hopping, using cutlery and toilet paper) and are then refined over the next 2-3 years until they become mature. In my clinical experience many children with DCD do not achieve mature patterns in motor skills and this has been supported in the literature.[60] Children with DCD also have difficulty acquiring independence in self-help skills at a similar age to their peers. By the age of six-seven years typically developing children have mastered the fundamental motor skills such as walking, running, jumping, hopping. Sugden states 'A typically developing child, after the age of seven does not naturally develop any new skill; s/he learns specific ones, plays with old ones, refines them and combines them but does not develop new ones.[61] Functional skills are being refined and new skills need to be learnt with the onset of adolescence such as using deodorant, managing menstruation and shaving.

Fundamental movement skills		
Jumps (jumps off floor with both feet)	28 months	Gallahue & Ozmun[62]
Runs (first true run with non-support phase)	2-3 years	Gallahue & Ozmun
Hops (up to 3 times on preferred foot)	3 years	Gallahue & Ozm
Runs (mature run)	5 years	Gallahue & Ozmun
Mature pencil grasp	5 years	Sheridan[56]
Jumps (mature pattern)	6 years	Gallahue & Ozmun
Hops skilfully with rhythmical, mature pattern)	6 years	Gallahue & Ozmun
Functional movement skills		
Grasps spoon in fist	10-11 months	Gesell & Ilg[63]
Bladder control	18-24 months	Herbert[51]
Fork – spears & shovels food, little spilling	2-2½ years	Haley et al[59]
Bowel control	42-48 months	Herbert[51]
Tries to wipe self after toileting	3-3½ years	Haley et al
Walks up & down stairs reciprocally	3-4 years	Sheridan
Washes body well & hands thoroughly	3.5 – 4 yr	Haley et al
Prepares toothbrush, wets & applies paste	4.5 – 5 yr	Haley et al
Dresses self except difficult fastenings	4-5 years	Portage checklist[64]
Pedals tricycle turning corners	4-5 years	Portage checklist
Eats liquids, spoon held with fingers, few spills	4-6 years	Coley[65]
Fork held in fingers	4½ years	Coley
Climbs on/off adult toilet without arms	5 years	Haley et al
Knife – uses for spreading	5-5½ years	Haley et al
Wipes thoroughly after bowel movement	5½-6 years	Haley et al
Can jump rope by self	5-6 years	Portage checklist
Dresses self including all fastenings	6½ years	Haley et al
Cuts meat with knife	7-8 years	Coley

Table 2:3 Key motor and functional skills, compiled from various sources

In the UK the National Curriculum gives targets that children should have reached at certain ages, and many of these targets require motor skills. Children are assessed at the end of Key Stage 1 (seven years of age) in the core subjects of English, maths, science and Welsh in Wales. There are also targets identified for the other curriculum subjects such as design and technology, art and design and physical education. Targets that require motor skills at this age include writing neatly and clearly, cutting, folding, gluing, using tools and equipment safely and performing short gymnastic sequences.

Motor Development from 7 years of age to puberty

By the age of seven, typically children have developed and learned the fundamental skills that are necessary to meet the motor demands of daily life. They can locomote in many different ways- running, hopping skipping, jumping, they can use manual skills in a variety of different circumstances such as picking up objects and manipulating objects within the hand, and couple this with visuo-motor development to produce representational skills such as writing and drawing. Moving objects particularly if they are moving fast do present difficulties but they can catch and throw a ball with reasonable proficiency.

From the age of seven, new skills are not formally developed, but the ones that have been are progressed from a state of relative immaturity to a state by the age of 12, or 13 years of age when the skills are quite well developed. A number of developments take place in the purely physical domain leading to maximum performance increases. For example, if we look at an activity such as jumping, we note that standing broad jump increases in boys from 47 inches at age 7, to 66 inches by age 13; in girls the corresponding figures are 45 inches to 59 inches. In running speed, boys from 7 to 13 increase from 15 feet per second to 19 feet per second with the corresponding figures for girls being 14 and 18. In throwing for distance, boys at 7 throw 42 feet, while at 13 throw 130 feet; the corresponding figures for girls are 24 and 80. Speed of manual movement measured by moving pegs decreases in boys and girls by 50%. Processes affecting maximum performance also change dramatically with reaction time decreasing from around 375 milliseconds at 7, to around 240 milliseconds at 13. These developmental changes are well known and details can be found in texts such as Haywood and Getchell[59], and Keogh and Sugden[60]. Gender differences become more apparent in these ages with boys usually outperforming girls on tests of maximum performance. Although there are biological reasons why this is the case, there are also reasons that are more socio-cultural such as participation and gender stereotyping.[66] It is not the focus of this thesis to explore these differences.

The biological changes that take place include pure physical growth. This period before puberty is a period of growth but it is steady and consistent each year until puberty begins. For example on average both boys and girls will grow in height about 2-3 inches per year before puberty when it changes dramatically to 4-5 inches per year for boys and 3-4 for girls.[60] Functional changes also take place in the physiological system with lung vital capacity changing from around 2 litres at 7 to nearly 4 litres at 13.[60] This has obvious effects on participation in games that involve running and endurance.

Other changes that take place involve the development of the sensory systems. Of particular relevance to this study because of its influence on occupational therapy practice is the development of kinaesthesis. Kinaesthesis has long been an integral part of any explanation of motor control.[36] It is part of a closed loop system of motor control whereby the outcome of any movement is compared to the original intention and effector process. It is an integral part of any motor control model that involves feedback systems. It is therefore not surprising that individuals have examined this in typically developing children and those who have difficulties. While it is accepted that kinaesthesis does play a major part in the motor control process the manner in which this relates to the therapeutic process and the part it plays in this process has not been clearly identified. However it is appropriate here to illustrate how some researchers have examined this process in children. In a number of studies in the 1980s Laszlo and Bairstow examined the development of kinaesthesis in children finding for example that errors on their task decreased from 8 degrees at 7 to around 4 degrees at 12.[67] Wilson and Mackenzie's meta-analysis examined information processing factors and their influence on motor skills.[68] They found children with motor deficits had greatest difficulties with visual-spatial processing tasks and showed that kinaesthesis only playing a mild to moderate role.

There are even developments of the child's knowledge of their own body during this period particularly with respect to laterality. Vision of course is a major influence on motor skills and during this period several important changes take place. Actual visual acuity changes little during this period but what does change is the ability to make predictions from visual information. Younger children need more visual information to make the same predictions as older children. When targets are totally or partially occluded, 7-9 year olds make more than twice the number of errors than 12-14 year olds. When full visual information is given this differential is almost eradicated. This type of information gives the same results when vision is manipulated in a force task, such as pushing a slide to a target. If vision is taken away or reduced, the errors for the young children are almost double whereas they stay nearly the same for older children despite the reduction in visual information.[60]

Thus it is not only in maximum performance that there are great changes between 7 and 11 years of age. Children become much better at playing games involving prediction and anticipation of moving objects such as people and balls and these are dependent upon some of the abilities noted in the previous paragraph. In addition to these sensory developments there are also developments in the cognitive domain that affect the performance of motor skills. It is during the time period 7-13 years that such abilities as memory and attentional strategies develop thus paving the way for

the improvement of motor skills that are more complex and involve these processes. Such areas as dual task performance and processing of feedback both improve during this period. A simple example illustrates this point. Thomas et al, gave feedback on a positioning task to children and adults. They had to move a cursor to a position and there was a delay of 3, 6 or 9 seconds after feedback was given before they moved again. When the delay was only 3 seconds, 7 year olds made 3 times the size of errors than 11 year olds but when 9 seconds was given, there was hardly any difference between the two ages.[69] This indicated that young children need more time to process information, again a difference that will be seen in the learning of motor skills.

All of the above information either describes or explains what happens between the ages of 7 to around puberty in the development of motor skills. It is clear that children get faster and stronger and fitter, but it is also clear that they become more skilful. This skilfulness is due to a combination of factors such as biological maturation, sensory improvements, cognitive developments and the development of the motor system itself. This complexity of factors fits in well with a dynamical systems view of motor development that stresses multiple inputs affecting the final out put. The development of the child through puberty has not been covered here, as all the children in the studies are in the 7-11 year old range. However, it is recognised that children post puberty will have difficulties and this needs a future study. For more information on the development of the child 7-11 the text-books of Haywood and Getchell[70] and Keogh and Sugden[15] are recommended as useful starting points.

Explanations of motor development

The enormously detailed data collected by many dedicated researchers has given us the ages and stages of motor development of typically developing children.[14, 15, 17, 20, 27, 28] Following the collection of data on the descriptions and age of acquisition of motor skills people began to theorise about how and why these changes took place. Initially maturational theories were presented which saw CNS maturation as controlling developmental changes. Others presented information processing theories that viewed humans as processors of information responding to sensory input. More recently dynamic systems theories have viewed motor development as the result of the interaction of multiple sub systems that self organise. Each of these theoretical frameworks will be considered.

Maturational

The systematic study of development can be traced back to its origins in the 1930s and 1940s when several pioneer developmental scientists started observing and recording how children

develop motor control. Amongst these pioneers were Gesell[61, 71] , McGraw[72] and Bayley[73]. These classic longitudinal studies established the sequence of development of motor behaviour in infants and young children and thereby defined normal development. Some of the results of these studies have been presented in the previous section on descriptions of motor development. These scientists were not only patient observers but drew theories and conclusions from their observations. They concluded that development was ultimately controlled by heredity with maturation of the central nervous system being the driving process that determined the rate of change. From these observations arose what are now considered traditional theories about typical child development with an emphasis on the role of the maturation of the central nervous system (CNS). The fact that development was relatively uniform and predictable in terms of sequences and patterns was considered support for the concept that development was the result of unfolding structures within the nervous system. Motor behaviours were thought to be centrally programmed and regulated by the brain. The work of these early researchers provided an insight into developmental progressions and gave ages at which it could be expected that typically developing children mastered specific skills. These charts of developmental milestones still form some of the information used when assessing children's development and the age norms established by these early researchers are still widely used in developmental texts. The norms were accepted and found to be useful and the explanation of CNS maturation as the driver was accepted along with the norms. The belief that motor behaviour was directly linked to brain development seemed a plausible hypothesis, development simply happens in response to pre-determined genetic programmes. Correlations were made between emerging motor behaviours and changes in neural mechanisms and conclusions about causality were drawn. From these correlations rules were established such as the idea that development progresses from head to toe and proximal to distal.[66] Changes in neural organisation were assumed to be programmed into the CNS and therefore inevitable over time as the CNS matured.

Bernstein's work[60] (translated into English in 1967) initiated a paradigm shift from the traditional views of people such as Gesell[14] and McGraw[15]. Bernstein's work challenged the brain to behaviour causal link through describing movement in terms of coordination. This made it difficult to explain how the programming of all the muscles and joints were able to respond to all the multiple permutations of motor outputs. Bernstein expressed this as the "degrees of freedom problem" he asks

"How can an organism with thousands of muscles, billions of nerves, tens of billions of cells and nearly infinite possible combinations of body segments and positions ever figure out how to get them all working toward a single smooth and efficient movement without invoking some clever "homunculus" who has the directions already stored?"[74]

He pointed out that a particular set of muscle contractions does not always produce an identical movement proving that there must be other influences at work. However, a maturational view of development is still prevalent despite more recent work refuting the idea that all motor development is pre programmed. Genetically encoding all the movement patterns that may be required over a lifetime seems to be an impossible task. There appears to be insufficient storage capacity for all the possible programmes required to cover all variations. Behaviour is also much more complex than just a neural pattern, it incorporates a multiple range of other influences including muscle elasticity, posture and sensory information.[75] Even the simplest of movements such as reaching for a cup requires processing a range of sensory, motor and cognitive information. You see the cup and use memory to establish that you have seen similar (or possibly the same) item before. With that memory is stored information about the best way to pick up such an object and how heavy it might be. A motor plan is formed and enacted with visual guidance and on line adjustment if necessary. Arm and hand segments work together and the hand shapes itself in preparation for grasping the cup. Each of these processes described has a myriad of associated parts as well such as how the eyes work, how motor acts are neurally controlled and how memory works. It is this complexity, which is challenging for a maturational approach, and is more readily explained using a dynamic systems theoretical base.

During the 1990s Thelen[76] and others built on Bernstein's work and introduced a different approach called the "new synthesis" which challenged the maturational genetically driven theory of development as too simplistic. The idea that there was a simple one-to-one relationship between the coding and firing of neurones and movement was challenged. It is clear that neurological development plays a substantial part in the development of motor skills such as the development of ballistic pre-programmed movement the construction of motor engrams or templates are all well established. However it is also clear that these do not give the total picture and Thelen's work on the early development of walking has given us new insights into development and provides support for a dynamical systems view of development, which is described later.[75]

Cognitive approaches

Cognitive approaches incorporate the ideas of Piaget and the information processing theorists. Piaget has been very influential in developmental fields and presented the idea of the formation of "schemata" or behaviour plans. Piaget described cognitive development as occurring in stages that occur in a strict order and reflect underlying structural changes. These ideas were also applied to motor development as parallels were drawn between Piaget's cognitive sequences and the

observed sequences in children's motor development. Another cognitive approach is presented by Schmidt and Lee's[59] who view humans as processors of information with the environment providing inputs, signals or information. This approach is referred to as information processing theory. Sensory information is received through our sensory systems progressing through, and relating to, memory eventually to a motor response, or output, being selected and performed.[77] Schmidt and Lee's approach was at the height of its popularity during the 1960s and 1970s with its influence still being very important today.[59] Researchers on motor control and learning often use the Schmidt and Lee's text as the basis of their work. It was during the time of the rise of information processing that Ayres developed her theory of sensory integration, very much a process orientated approach, which drew on the theories and thinking of the time.

An information processing approach to motor control and learning is a component based approach and a simple information processing model with its components is shown in Figure 2: 3.

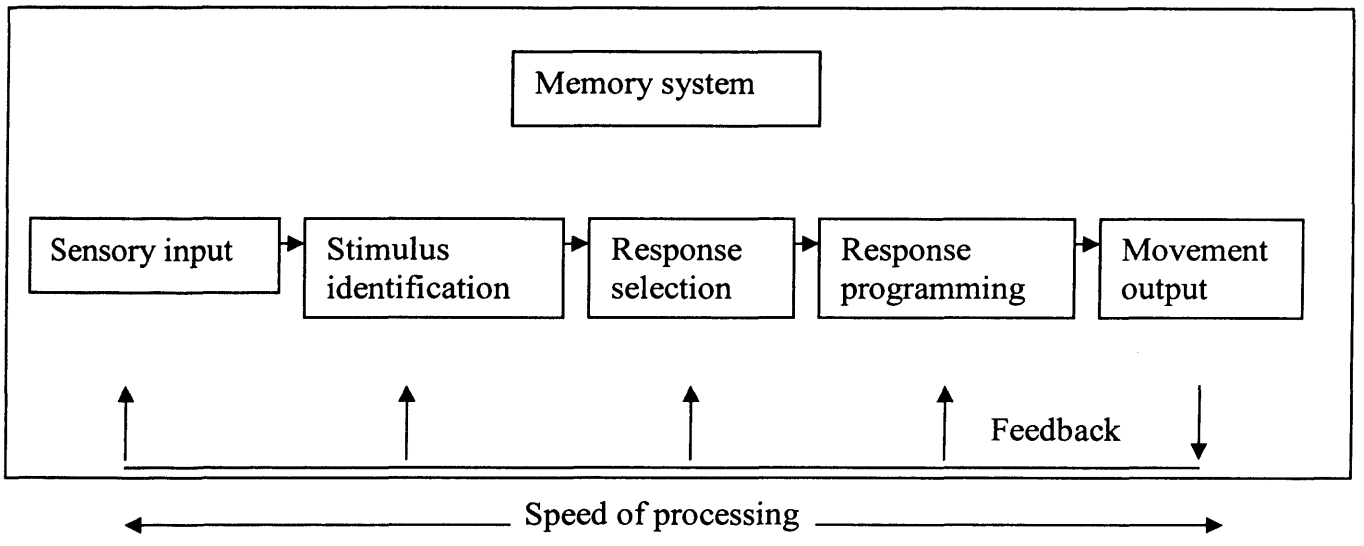


Figure 2: 3 Information processing model (adapted from Schmidt & Lee[78])

As Figure 4 shows, the information passes through the system in a sequential manner. That does not mean that there is no simultaneous processing, but it does mean that the study of motor control became compartmentalised with each component being examined in detail. The important idea in this explanation is that development occurs because children become more proficient in the components. For example if one examines speed of processing we know that children between the ages of 6 and 12 years decrease their reaction time from around 400-500 milliseconds to around 250 milliseconds. This obviously has an effect on movements where fast responding is required thus aiding actions such as catching. It is also known that between the ages of 5/6 years and 9/10 years children develop cognitive strategies such as grouping and rehearsal for short term memory thus making memory more efficient and contributing to more effective stimulus

identification and response selection. This would be incorporated in Favell's[19] "mediation" type of change.

The processing of information is therefore seen as taking place in stages within a component based system. Development is seen as the process of refining and speeding up each stage allowing for fast, adaptive responses to sensory inputs. The individual components of the information processing system are stimulus input, response selection and motor output. The process starts with a stimulus or input and the first stage is stimulus identification. Information from the sensory systems is registered and integrated with previous knowledge at an abstract, conceptual level. Development is a process of experiencing and storing a range of sensory stimuli. The second stage is response selection when the individual decides what to do. Finally once a response has been selected the system must prepare to perform the selected action, which is termed response programming. Following stimulus identification and response selection then a motor response or output occurs. A motor response is programmed and executed.[79] The speed of this process is measured in blocks of time such as reaction time, movement time and total response time. These times tend to increase with development and through the practising or repeating of movements and movement sequences.

Stimulus identification has two sub-stages, detection and recognition. Reaction time is influenced by the stimulus clarity, intensity and modality through which the stimulus is received. Visual stimuli are processed more quickly when they are sharp rather than out of focus, or bright rather than dim. Auditory and tactile stimuli are processed more quickly than visual stimuli. Stimuli in the real world (rather than the laboratory) usually require recognition of patterns such as the positions of players in a team game. Some pattern recognition appears to be genetically programmed for survival such as avoidance of objects looming into our visual field. Even when driving in a car and protected by the windscreen it is hard not to flinch if a branch hits the windscreen.[80]

At the response selection stage there are usually a number of responses to choose from and the greater the number of choices then the longer the reaction time. Hick studied the relationship between the number of stimulus response alternatives and reaction time. Hick's law states that "the choice reaction time is linearly related to the logarithm to the base 2 of the number of stimulus response alternatives" demonstrating that more choices require more processing time.[81] Exceptions to Hick's law are found when the subject responds to a familiar stimulus which they have experience of responding to. The actions that have been learnt and practised are executed more quickly. Stimulus response compatibility also has an effect. For example if a stimulus comes

from the right and the required response is with the right hand then this is quicker than if the desired response is with the left hand. Children with ADHD have been shown to have particular difficulties with making counter-intuitive non-compatible responses such as this.[82] However it is possible to learn stimulus responses so that they become compatible and seem "natural" such as which way to turn a door handle to open it.

The memory system is utilised as a major influence on actions. It is suggested that there are three memory systems; short term sensory store, short-term memory and long term memory. The short-term sensory system receives sensory information and stores it briefly until it is processed by short-term memory and working memory and new information replaces it. Short-term memory is thought to be a storage system for information from short-term sensory system and long-term memory and short-term memory has a limited capacity and short duration. Long-term memory holds information more permanently and prevents it being lost.[83]

Maturational, cognitive and information processing theories have contributed hugely to our knowledge base on development. However, maturational and cognitive theories fail to explain the rich diversity, variability and the dynamic, interactive nature of development. They do not explain development in real time or the nature of the process of change. The maturational theorists assume direct and causal relationships between the changes in the evolving and developing CNS and the sequences and patterns of emerging motor skills. A major criticism of information processing and cognitive explanations is simply that it is too cognitive. It details mentalistic processes in a sequential, almost linear manner but does not really explain the motor side. It simply notes that a motor programme is developed and run off. It does not detail how this is done, how limbs are controlled, what variables are involved and assumes tacitly that much of this is planned at a conscious level. Maturational, cognitive and information processing theories are all essentially prescriptive in that they rely on the existence of general motor plans. However these models ignore the exact nature of movement itself in space and time with all its dynamic complexity.[84] In the next section dynamic systems takes up and addresses many of these criticisms.

Dynamic systems and ecological perspectives

The work of Turvey and colleagues has been very influential in shaping dynamic systems theories of motor development.[85] In the 1980s Schner and Kelso[86], Kugler[87] and colleagues starting applying complex dynamic systems approaches, that had been used in a range of other scientific areas, to human development. A dynamic system's approach first principle is that behaviour occurs due to the interaction of multiple subsystems,[65] and dynamic systems theories have been

used to understand a diverse range of phenomena such as weather systems, birds flying in formation and economic behaviour. Dynamical systems theory draws on ideas from ecological psychology proposed by Gibson[88] and ideas from the physiologist Bernstein[89]. When this approach is applied to child development it is viewed as a dynamic interaction between multiple systems such as the developing CNS, the child's motor skills, cognition, motivation and experiences.[90] One factor is not seen as dominating but all contribute in an interactive manner to the eventual outcome of skill acquisition. Therefore the development (or atypical development) of motor skills will interact with, and may affect, the development of the CNS, cognition, motivation and experiences.

The exact detail of dynamic systems theory is beyond the scope of this thesis but there are some key elements that can guide therapy. A dynamic systems approach to motor development emerges from a functional rather than structural framework.[91] Development is not seen as linear and small changes in any subsystem, not only the CNS, can bring about large changes in motor behaviour. Motor skills are seen as being most amenable to change during periods of instability, when a child is attempting a new task and is motivated to achieve it. Newly acquired skills need to be practised in a variety of environments to ensure learning has taken place and generalised to be available in all settings. These ideas are important for therapists because they can guide them in their therapeutic intervention. The key elements in dynamical systems theory are

1. Multiple sub systems operate together to facilitate development (as described above)
2. Motor development is self organised
3. Context and task interaction
4. Attractors and stability
5. Non-linear changes
6. Intrinsic dynamics
7. Collective variables

The first principle of dynamic systems is that the interaction of multiple subsystems can lead to spontaneous changes in behaviour. Changes are not solely generated by the neural system but include motivation, biomechanical properties and extrinsic factors such as task difficulty, amount of support and practice.

The second principle is that development to a large extent is self-organised. There is no central driver that dictates what is happening. The brain does not hold pre-programmed plans for movement patterns such as walking and talking, but these behaviours arise from the cooperation of a range of the multiple sub systems. Thelen and colleagues conducted a classic study that

demonstrated that motor behaviour is self organised and not pre-ordained. The study showed that seven-month-old infants could produce alternating steps when held supported with their feet on a treadmill. This demonstrated that stepping could be elicited in infants through providing environmental facilitators, that is the treadmill and physical trunk support from an adult, which enabled the infants' limbs to self organise into the task of stepping. The steps arose from the interaction of multiple sub-systems within the infant, the sensory receptors in the legs which detect the movement of the treadmill, the nerves and muscles which produce the movement, the treadmill action and the postural support provided to the child. The walking was not simply a reflexive movement as the pattern and speed changed in response to changing treadmill parameters. The findings of this study have huge implications for therapy. From a therapist's perspective the fact that motor development is self-organised should shape the type of intervention. In order for self-organisation to take place the child must have the opportunity to solve movement problems. Working on improving specific component parts of movement does not facilitate self-organisation. Therapy should aim to provide experiences for the child that do facilitate self-organisation. For example Thelen's work on the emergence of the heel strike in walking should inform how gaining heel strike in a therapeutic way is achieved. Her experiment showed that the three types of foot contact patterns of toe first, flat footed and heel first could be elicited in the same child on the same day through manipulating the amount of postural support given and the movement of the treadmill.[77]

Two of the multiple sub-systems that interact to shape behaviour are context and task. Patterns of motor behaviour are assembled in response to the demands of the context and task. Therapists need to consider the variables of context and task interactions when considering what they are trying to change with intervention. Therapy from a dynamic perspective will aim not just to bring about changes within the child but also to consider changing the task or context/environment. Bronfenbrenner's approach to the environment provides a detailed framework for considering context.[92] Bronfenbrenner's theories[92] are explored in more detail below. Law and colleagues have interpreted a dynamic system's model from an occupational therapy perspective as the Person-Environment-Occupation (PEO) model[93], which is discussed in detail in chapter 3. Biopsychosocial models of disability such as the World Health Organisation's, International Classification of Functioning[39], also support this approach as it moves away from an impairment based model, which focuses on the deficit within the person.

The fourth point refers to attractors, which can be described as preferred patterns of behaviour. The system "wants" to behave in certain ways under certain conditions. New behaviours are initially unstable and variable but with practice can become stable with a high probability of

occurring. Attractors form over time in response to changes in anatomy, physiology, experiences and motivation. To replace an old attractor with a new one there needs to be some initial instability in the system to allow the formation of alternative attractors. When a child shifts from crawling to walking as a form of locomotion they will initially revert to crawling readily until walking becomes a stable pattern and then the child hardly ever crawls. Stable attractors may become unstable when a part of the system changes, for example growth of a limb may change reaching patterns.

The fifth point, that changes are non-linear, is also a fundamental principle of dynamic systems. Small changes in any of the multiple sub-systems can cause abrupt, sometimes large changes in behaviour. The stability of attractors decreases as the system approaches a transition and this allows for the system to reorganise to produce new attractors which then in their turn become stable over time.

The sixth point relates to intrinsic dynamics, which are the unique set of variables that an individual brings to a given task. Although behaviour is self organised individuals may come up with a range of solutions to a given task as the problem solving process takes into account the unique make up of the individual solving the problem. Part of the process of skill acquisition is for the individual to learn about their own intrinsic dynamics. It may be that delayed motor development may reflect a difficulty with adapting limb movements in response to the child's intrinsic dynamics.

The seventh point relates to collective variables, which are simple descriptors of behaviour in terms of its attractors. All complex systems have many degrees of freedom. Degrees of freedom refers to the huge number of possible permutations available to organise joints, muscles and cells to act together to perform a motor task. The problem is that the number of permutations is too large to be processed by the brain in the time in which humans respond to movement problems. Bernstein proposed the idea of coordinative structures to explain the degrees of freedom problem. This was touched on earlier when considering the issues with maturational theories. Degrees of freedom are the number of variables free to vary – limbs, joints, muscles and motor units. The degrees of freedom problem notes that it is unlikely that any system tries to specify parameters for every one of these. Humans tend to try and reduce information in order to make meaning of it, not increase it. The multiples of degrees of freedom if stored and programmed individually would make any system untenable, too unwieldy and not parsimonious. Thus the concept of coordination structures is proposed whereby joints, muscles and or limbs in various situations are constrained to act as a single unit. When learning a task, or early in development, the child freezes the degrees

of freedom and has large coarse-grained coordination structures. One can see this in the rather stiff and wide legged stance of walking in the toddler. As the child develops the degrees of freedom are freed allowing a smoother, more flexible walking pattern. This occurs in most skills through development and learning.

The application of dynamical systems theory to motor development by Thelen and her colleagues challenged traditional theories of motor development.[77] Thelen and colleagues demonstrated that the onset of motor skills, such as walking, could be influenced by the child's experiences and immediate context.[94] Thelen and her colleagues concluded that motor development is an emergent process that is self-organised.[81] The child learns through interaction with their environment. The child's initial attempts at an action are very variable with many degrees of freedom. As the skill develops the degrees of freedom are reduced by external and internal constraints. The constraints may be within the child, the environment or the task.[95,96]

An information processing model is often referred to as indirect perception as the environment comes in to the system in modified, processed compartmentalised and selected format. In contrast to the information processing model Gibson presented the concept of affordances to describe how objects are directly perceived in a dynamic systems model.[97] Direct perception in a Gibsonian explanation details how information gets into the system and dynamic system theory explains how this is used to produce action. This challenges the assumption that DCD is due to a disruption in the sequential processing of sensory information that is inherent in an information-processing approach.[98]

Dynamic systems theory and the ecological perspective are closely linked and share many ideas. The ecological approach emphasises the study of movement in natural environments and considers the transactive influence of the environment on the child. The ecological perspective provides a structure for considering the environment and how it may influence the task or the child. In 1977 Bronfenbrenner[92] proposed a new theoretical approach to understanding human development described as an ecological perspective. He proposed that development represents a lasting change in the way in which a person perceives, and deals with, their environment. The relationship between the person and environment is viewed as a progressive, mutual accommodation throughout the lifespan. His concept of environment was broader than had hitherto been used. He suggested that the ecological environment should be "conceived topologically as a nested arrangement of structures, each contained within the next". He famously described much of developmental psychology as "being the science of the strange behaviour of

children in strange situations with strange adults for the briefest possible periods of time" and questioned the validity of this approach.

Bronfenbrenner[92] described four nested structures; the micro-system, meso-system, exo-system and macro-system. The micro-system is the relationship between the child and environment, in an immediate setting. The elements of the setting include the factors of place, time, physical features, activity, the participant and their role(s). The meso-system is a system of micro-systems and reflects the major settings that the developing person operates in e.g. family, school, peer group. The exo-system includes both formal and informal social structures which impinge on the person but do not contain the person e.g. government, mass media, social networks. The macro-system incorporates the institutions and associated ideologies, which make up society as a whole.

All therapeutic interventions occur within a micro-system, often one that is separate from the meso-systems that the child operates in. This is an important factor to consider for transfer of skills acquired in the therapeutic environment to the child's everyday environments. Bronfenbrenner[92] describes the micro-system as "a pattern of activities, roles and interpersonal relations experienced by the developing person in a given setting with particular physical and material characteristics". The child's perception of the environment is seen as important as the objective reality of the environment. The role that the child has in a given situation is also viewed as a potential active ingredient, which may shape a child's response. The child's roles may include being a son, daughter, brother, sister, student, and friend or therapy client. Roles carry with them expectations of a set of behaviours associated with the given role. The child's behaviour will be shaped by their perceived role in a given situation and the expectations of others within that situation.

Bronfenbrenner's[92] ideas have implications for research, as it is usual for research studies to be conducted in contexts that do not form part of the child's every day life. For example, a child may practice a non functional task involving repeated arm movements with no meaningful goal from the child's perspective. The potential influences this may have on the child's behaviour need to be considered. Behavioural change, such as acquisition of skills, cannot be assumed to transfer to other settings such as home and school. Unless this transfer takes place then the new skills are not useful for the child. Whilst it may not be possible to conduct research within the context of the child's everyday life, successful outcomes from therapy need to be demonstrated to occur in the child's natural environment. Being able to tie shoelaces only when you are in the children's centre but not on the school-yard is not a useful functional skill for the child.

In summary current theories of motor development do not view motor development as totally pre-programmed in the brain and therefore pre-ordained, regardless of the child's experiences. Dynamic systems theories, when applied to motor development have showed that human development is governed by the same ideas as all complex systems. Behaviour is self organised, shaped by context and task, has preferred patterns of behaviour known as attractors, is subject to non-linear changes, reflects the unique intrinsic dynamics of the individual and can be described in terms of collective variables. Stable and functional motor behaviours arise as the child discovers the fit between their own capabilities and the task. These ideas suggest that intervention should be task orientated, consider the everyday environmental contexts in which those tasks take place and use knowledge gained from the motor development and control literature.

I favour dynamical systems of motor development for a number of reasons. First, it incorporates neural/maturational changes as well as more cognitive processes, but does not rely exclusively on them. Secondly, it specifies the other variables that potentially influence development. Thirdly, because of the first two reasons, it is an optimistic model providing possible guidelines for therapists.

Summary of key points

- The process of motor development has been the subject of much study alongside other aspects of child development and in reality it can never be considered in isolation from other developmental domains.
- There is no universally accepted taxonomy of movement skills and Burton and Miller's[34] was chosen which identifies three domains
    - Early milestones
    - Fundamental movement skills
    - Functional movement skills
- Favell's[19] classic analysis of the relationships between developmental sequences (addition, substitution, modification, inclusion and mediation) is a useful framework for considering motor development.
- There are two major issues to be considered in motor development
    1. Descriptions of the ages and stages; there are many sources to chose from and those in common current use are Bayley[22], Peabody[27], Schedule of Growing Skills[23], Griffiths[21], Portage Checklist[53]
    2. Explanations of why and how development happens
        - Maturational explanations - considers development to be hierarchical and driven by the CNS. This approach is now considered old fashioned.

    - Cognitive explanations – emphasise the formation of motor plans and the processing of sensory information.
    - Dynamic systems and ecological explanations - considers development to be an interactive complex system embedded within the child's environment.
- Dynamic systems and ecological explanations currently show the most promise in enabling us to understand how children learn motor skills which will enable us to provide more effective intervention for children with movement difficulties.
- The child cannot be viewed in isolation from their physical, social and cultural environment.

CHAPTER 3: Developmental coordination disorder as a condition

This chapter considers DCD as a neuro-developmental disorder. It examines the literature that covers definitions, diagnosis, labels, aetiology, prevalence, co-occurring conditions and prognosis. As much of the literature has emerged over the last 20 years there has been a concentration in the selection of article s and books from this period. However there are classic studies that are available from before this time period and these have also been included. In addition the selection of the literature sourced because of the multi-disc nature of DCD has involved publications from health, psychology and education in order to give a rounded view of the condition.

There have been two consensus statements published on DCD. The first arose from an international meeting in 1994 in London, Ontario and its title "A disability in search of a definition" gives a clue as to the main issue at the time, one of agreeing a suitable name for the condition.[9] At the time there were a number of different labels being used for this group of children and it was felt that this was a barrier to research and clinical practice. On a very practical level it made literature searches difficult as one had to ensure searches covered all of the common labels. It was also unclear as to whether all the labels were inter changeable and simply giving different names to the same group of children or whether there were differences between the groups of children with labels such as dyspraxia, minimal cerebral dysfunction, sensory integrative dysfunction or clumsy. The diagnostic processes for each of these labels tended to be based on clinical decisions without clear guidelines or descriptions of the diagnostic processes and clinical reasoning behind giving the label. This point is expanded below with details of the definitions given for labels used in the past. The imprecise definitions of the labels also made it unclear as to whether a child presented to a number of different clinicians would end up with the same label or a number of different ones. Certain professional groups tended to favour particular labels so if the child saw an occupational therapist they were more likely to get a label of sensory integrative dysfunction whereas a paediatrician may use minimal cerebral dysfunction and an educational psychologist use the term dyspraxia. Parents report confusion over being given a number of different labels to describe their child's difficulties. So the London, Ontario Consensus Statement[9] was extremely helpful in giving us one term to use even whilst accepting that it may not be perfect. Gradually, following the 1995 Consensus[10], clinicians and researchers started using the term DCD and the DSM-IV[8] diagnostic criteria that go with it. This adherence to one diagnostic label has furthered our understanding of the nature of the condition by creating debates about each of the DSM-IV[8] criteria leading to reflections about the nature of the condition. Questions arose about the nature of the motor impairment and at what cut off point it became

significant enough to warrant diagnosis, what was meant by activities of daily living, the meaning of the term "medical condition" and the role of IQ in motor impairments.

The Leeds Consensus Statement in 2006[10] built on the London, Ontario Statement[9] and gave additional guidance on interpreting the four DSM-IV criteria[8]. It is important to remember that the core, essential feature of DCD is the motor impairment and the main focus of assessment and diagnosis should be identifying the specific nature of the motor deficit. The first study presented in Chapter 5 considers the assessment and diagnostic process in detail and therefore it will not be covered in full in this chapter as this is considered as part of the first study. Calculating prevalence rates is dependent on how the diagnosis is made and where cut off points are drawn. In addition whether prevalence samples are collected from clinics or population based could affect the numbers found. The picture is further confused by the number of commonly co-occurring conditions that are associated with DCD. There is generally a resistance to dual diagnosis so once a child is given a label additional diagnoses are not usually considered. In terms of prognosis there have only been a few long term follow up studies, which are reported here, but more are required to get a clear prognostic picture. Furthermore, it is only now that we can find adults who received the diagnosis as children to consider the impact of interventions and the emerging picture of the adult with DCD.

Definitions and diagnosis

The core, essential feature of DCD is the motor deficit. The term developmental coordination disorder implies that the condition is due to disordered development of motor coordination. However, as with many other developmental disorders, there are a number of additional features that must be considered including history and associated features. First the definitions and descriptions in the two major diagnostic manuals will be examined, the Diagnostic and Statistical Manual IV-Text Revision by the American Psychiatric Association 2000 (DSM-IV TR)[8] and the World Health Organisation's International Classification of Diseases 10th edition (ICD10)[7]. The two consensus statements will also be examined; they are the London (Ontario) Consensus Statement[9] and the Leeds Consensus Statement[10].

Developmental coordination disorder (DCD) is defined in DSM-IV-TR[8] by the American Psychiatric Association as having the essential feature of a marked impairment of motor coordination. There are four diagnostic criteria to be considered:

> "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, 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."[99]

The guidance on differential diagnosis states that DCD "must be distinguished from motor impairments that are due to a general medical condition."[100]

Apart from DSM-IV the other international diagnostic manual commonly used is the World Health Organisation's International Classification of Diseases 10th edition, which uses the term specific developmental disorder of motor function (code F82)[7]. It states "The main feature of this disorder is a serious impairment in the development of motor coordination that is not solely explicable in terms of general intellectual retardation or of any specific congenital or acquired neurological disorder (other than the one that may be implicit in the coordination abnormality). This includes: clumsy child syndrome, developmental coordination disorder, and developmental dyspraxia."[101] Specific developmental disorder of motor function (SDDMF) has never been a popular term despite being in ICD 10[7]. The descriptions of the condition are much woollier in ICD 10[7] than those found in DSM-IV-TR[8]. For example ICD 10[7] says "It is usual for the motor clumsiness to be associated with some degree of impaired performance on visuo-spatial cognitive tasks." (p151) The phrase "it is usual" prevents this from being interpreted as a diagnostic criterion. Other examples are "motor milestones may be delayed" and "there is likely to be difficulty learning to tie shoe laces, to fasten and unfasten buttons, and to throw and catch balls". (p151) It is much harder to translate the descriptions, which use terms such it is usual or likely and may be delayed, into diagnostic criteria that can be applied in a clinical setting in a robust way. However, this definition generally agrees with the DSM-IV-TR[8] criterion A, B and C but would not give the diagnosis to children with "mental retardation" criterion D.

The 1995 London (Ontario) Consensus Statement[9] accepted the term developmental coordination disorder (DCD). The use of the term DCD was endorsed again, by an international group of academics specialising in DCD, at the seventh DCD conference in Melbourne in February 2007. In April 2006 the Leeds Consensus Statement was finalised following a series of meetings in Leeds. The Leeds Consensus Statement[10] builds on the London (Ontario) Statement[9] incorporating subsequent research on DCD. This confirms that DSM-IV-TR[8] provides a useful

basis on which to form a diagnosis of DCD but proposed a number of clarifications and amendments.

The main points from the Leeds Consensus Statement[10] include a recommendation that DCD is not diagnosed under the age of five years. This is because we know that up to this age, motor proficiency is quite variable in children and any problems could be the result of something as simple as lack of exposure to certain tasks. A second point from the Consensus is that the 5th percentile should be used as the cut-off for criterion A, while recognising that this is a somewhat arbitrary figure without a statistical basis. For example one could assert that the 15th percentile has a statistical foundation in that it is close to one standard deviation below the mean. One could also argue for the use of the second/third percentiles as this would be equivalent to two standard deviations below the mean. However custom and practice has generally settled on the fifth percentile and as such the Leeds Consensus recommends that for diagnostic purposes. The Leeds Consensus does also go on to recognise that in clinical and educational contexts children below the fifteenth percentile should be monitored for their progress. Geuze et al in 2001 proposed that children with motor skills below the 15th percentile could be regarded as possibly having DCD for clinical purposes.[30] They go on to recommend that the fifth percentile may be a more appropriate cut off for research purposes. Thirdly, a dual diagnosis of DCD and Asperger's or another developmental disorder may be given, if the child is exhibiting the symptoms of a particular condition. Fourthly, children with a presumed or measured IQ below 70 should not be diagnosed with DCD as there is strong literature evidence to show that as soon as IQ falls below this point, corresponding incidences of motor problems increase exponentially[102]. Finally, intervention should be functionally based, include the child's wishes and involve relevant individuals in the child's life whilst being evidenced based and grounded in up to date theories.

Labels

This section aims to describe the different terms and labels that have been given to this condition in the past. The rationale for choosing developmental coordination disorder as the preferred diagnostic label and rejecting the others is explained. The wide range of labels and definitions given to this condition over the years means literature reviews needs to cover all the names used for the condition and therefore it is essential to be aware of the other labels and terms which have been used. These include dyspraxia, clumsy child[103,104] specific developmental disorder of motor function (ICD 10)[5], perceptuo-motor dysfunction[105], sensory integrative dysfunction[106] and Deficits in Attention Motor control and Perception (DAMP) to mention a few. It is often not clear whether these labels/definitions represent the same, different or overlapping groups of children.

The use of a range of different terms to describe a group of children with developmental issues is not unique to the field of DCD. Children with low IQs have been described in various and different ways, often in an attempt to change attitudes. For instance mental retardation is no longer considered acceptable in the UK and "retard" is used as an insult. Professionals have debated whether learning difficulty or learning disability more accurately describes the condition. Terms such as educable mental retardation and trainable mental retardation were used in the USA an attempt to describe sub groups. In the UK the term learning difficulties is used to describe children with general developmental delay but in the USA learning disabilities describes the group of children we would label specific learning difficulty in the UK.

Galen, the early Greek physician 130-200 AD, used the term ambilevous to describe children with impaired motor skill. Dupre[107] in 1911 published a description (in French) of a "problem affecting motor function". Orton[1] in 1937 coined the phrase "minimal brain damage". More recently, attention was drawn to the disorder by Walton, initially in 1961.[108] In 1969 Rutter and colleagues[109] described abnormal clumsiness as a specific developmental disorder. The ICD 9[110] included the subclass "Specific Delays in Development" with a category of specific motor retardation. The term "clumsy" was used by Gubbay in 1975.[81] The DSM III R[111] had a subclass for specific developmental disorders with a category for motor skills disorder. The ICD 10[23] uses the diagnosis "specific developmental disorder of motor function" under the umbrella heading "Disorders of Psychological Development" and the DSM-IV[8] uses the diagnosis "developmental coordination disorder" under the heading "Motor Skills Disorder" and this has not changed in DSM-IV-TR (2000).

Despite developmental coordination disorder having been endorsed by the International Consensus Statement in 1995[9] and the Leeds Consensus Statement in 2006[10], it is necessary to be aware of the other terms, both from an historical perspective and because use of DCD is still not universal. There follows a list of the nomenclature that has been used over the years. Quoted definitions are given where deemed appropriate.

Gubbay used the term **clumsy child syndrome** in the 1970s and defined it as: "Children who display impaired performance of skilled movement despite normal intelligence and normal findings on a conventional neurological exam." [112] Henderson and Hall used the term in the 1980s and defined it as: "Children show deficits in balance and coordination" [113],[114] Publications in the American Journal of Occupational Therapy used this term and defined it as: "Children display deficits in praxis and motor sequencing."[115,116] The diagnosis is based on clinical judgement

without clear, objective diagnostic criteria. The term clumsy child occurs most frequently throughout the English literature published until the mid 1990s. [117,118,119] It is no longer considered acceptable to use the term clumsy due to the pejorative nature of the term and the implication that it is the child's fault that they are uncoordinated.

The term **Deficit in Attention Motor control and Perception (DAMP)** is often, but not always, used by the Scandinavian countries who have published long-term follow-up studies of the condition and produced some of the most robust research into the condition.

- The diagnostic criteria for DAMP[120],[121],[122] are:
- ADD (attention deficit disorder) as manifested by;

a) Severe problems in at least one or moderate problems in at least two of the following areas: attention span, activity level, vigilance and ability to sit still, and-

b) Cross-situational problems in the areas mentioned under (a), documented at two or more of the following: psychiatric, neurological, psychological evaluation and maternal report.

- MPD (motor perception dysfunction) as manifested by marked;-

c) Gross motor dysfunction according to neurological examination, or-

d) Fine motor dysfunction according to detailed neurological examination, or-

e) Perceptual dysfunction according to testing with the Block Design and Object Assembly sub-tests of the WISC III (a discrepancy of 15 IQ points or more on any of these relative overall IQ (Wechsler 1992) or visuo-motor dyscoordination test outlined in Rasmussen et al. 1983

- Problems not accounted for or associated with mental retardation or cerebral palsy.

DAMP is therefore AD/HD plus DCD. In Gillberg and colleagues more recent work they still use the term DAMP but clearly separate out children with DCD only, AD/HD only and those with both.[126] In May 2000 an inaugural European DAMP conference was held in London but there have been no follow up conferences and DAMP is a diagnostic term which is only occasionally used in the UK. It is interesting to speculate that as we become more aware of co-occurring conditions in developmental disorders the DAMP diagnosis may become a more prevalent one.

The term **dyspraxia** is popular with parents, the media and some clinicians, despite the varying definitions given. The term dyspraxia originates from adult literature on apraxia where it is more narrowly defined as the ability to perform gestures and use tools.[123] It has been popular in the occupational therapy literature, especially by those following a sensory integration approach, which tends to use the term developmental dyspraxia. It has been defined as a "developmental disorder of motor planning."[124] For those using a sensory integration approach the term

somatodyspraxia is also used. Somatodyspraxia is a deficit in motor planning ability, which is hypothesised to result from poor tactile and proprioceptive processing. Dewey, a neuro-psychologist defined dyspraxia as "A disorder in gestural performance. It results in deficits in the performance of representational gestures..., non-representational gestures..., and gesture sequences... in children whose basic motor skills are intact."[125] This is a very precise and narrow definition and does not necessarily encompass the whole range of difficulties with motor performance that these children have. Portwood's books and courses have been influential amongst educationalists and some therapists. She defines dyspraxia as "Motor difficulties caused by perceptual problems, especially visual-motor and kinaesthetic-motor difficulties."[126] Her work is widely used for assessment and intervention of children with DCD. However, a review[127] of her more recent publication[128] questions her theoretical assumptions and methods. Use of Portwood's checklists and programmes is popular with many educational psychology services and this was confirmed at a DCD UK teachers meting in November 2006. However dyspraxia has many definitions covering a broad range of symptoms whose assessment is not precisely described. Given the wide range of differing descriptions of dyspraxia and the impossibility of translating them into diagnostic criteria it is difficult to recommend use of the term by professionals. Parents and the media regularly use the term dyspraxia despite efforts of professionals and changing this is likely to be difficult. There is therefore justification for a pragmatic approach that accepts the use of the term dyspraxia on a day-to-day basis, but not for research purposes.

Other labels

There are a group of labels that allude to the aetiology of the condition such as **minimal cerebral dysfunction** (MCD)[129] and **minimal brain dysfunction** (MBD)[130] have appealed to many because of their medical connotations and implied knowledge of the aetiology of the condition. More recently Kaplan has introduced the term atypical brain development and has shown in numerous studies that DCD is just one developmental disorder that commonly co-occurs with conditions such as ADHD and dyslexia. Kaplan suggest that atypical brain development is a better descriptor as it encompasses all possible conditions by describing potential aetiology. My opinion is that atypical brain development, like MCD and MBD is not helpful in the clinical setting as it infers aetiology that we are still uncertain about and the term may be quite off putting or even rather alarming for parents.

Laszlo and Bairstow used the term **perceptuomotor dysfunction** as they believed that kinaesthesia is integral to the acquisition and performance of skilled motor performance and devised intervention programmes that reflected this opinion.[131] Their claim that this approach can

improve motor performance after eight, fifteen-minute sessions has been challenged and the evidence in support of this approach is inconclusive.[3] It is not in vogue in the UK at present.

Sensory integrative dysfunction has been used as a popular diagnosis amongst therapists[3],[132]. The diagnosis is given for children who perform poorly on specific tests of sensory integrative function such as the Sensory Integration and Praxis Tests (SIPT) or the DeGangi-Berk Test of Sensory Integration[115].

General characteristics

Motor-based difficulties come into focus when the child with DCD enters school and there are increased expectations of independence in a variety of tasks many of which require motor skills such as running, using cutlery manipulating buttons and playing ball games.[8] The child with DCD exerts more energy in performing everyday tasks and is more prone to fatigue.[133] They also show higher levels of anxiety, introversion, and lower self esteem and peer rejection.[134] Children with DCD show reduced participation in school, social and sporting activities. The adolescent with DCD has organisational problems and is often frustrated and discouraged.[12] It has been shown that children with poor motor skills have a more passive lifestyle, are less outgoing, emotionally stable, tough minded, self reliant, shrewd and calculating, self-assured and are more introverted with lower self-esteem and poorer peer acceptance.[135] Child development is a complex dynamic process in which the development of motor skills is but a part and in turn motor skills can be seen as a 'practical' outcome of an integrated and comprehensive developmental process. Some children have problems with their development generally and others with specific aspects. Children who have specific difficulties with the development of motor skills are diagnosed as having developmental coordination disorder (DCD).

Aetiology and prevalence

The aetiology of DCD is unknown. There are those, including Kaplan, who claim that the idea of discrete developmental disorders is not supported by the evidence presented by the high levels of co-occurring developmental disorders which suggests a common underlying cause with variable presentations from a range of symptomatology including difficulties with motor skills, attention, speech, language and reading disorders.[136] Others have ascribed the aetiology to specific deficits such as visual perception, motor planning or sensory processing but the evidence is not conclusive.[137] Some consider it to be at the end of the cerebral palsy continuum.[138] The prevalence of this condition is variously reported to be 4-6%. The Royal College of Paediatrics and Child Health quote an estimated prevalence of 5%[139] whilst DSM-IV quotes 6%. Wright and Sugden

using their two-step approach reported a prevalence of 4-5%.[140] The male to female ratio is at least 2:1.[141] Rasmussen and Gillberg found evidence of significantly increased risk of poor social, emotional and educational functioning, at 22 years of age people diagnosed with DCD as children were more likely than matched controls to be unemployed, criminals, alcohol or drug users or have mental health difficulties.[142] Children with DCD have been shown to be at an increased risk of coronary vascular disease due to factors such as decreased cardio-respiratory fitness and low levels of physical activity.[143] They have been shown to be at risk of passive lifestyles and therefore increased body fat.[109] Cantell, Smyth and Ahonen[144] followed a group of Finnish adolescents from age 5 years to 17 years and showed two distinct pathways for children identified at 5 years with perceptual motor problems; persistence of the difficulties and "catch up". The children in the original DCD group feel into two categories those with continuing perceptual motor deficits and those who performed generally better than the DCD group but not as well as the control group. The adolescents with persistent DCD performed significantly more poorly on the perceptual motor tasks, had shorter school careers, lower perceptions of athletic and scholastic competence and were at a different stage of identity development. This study replicated the results found at two years earlier when the participants were 15 years suggesting the earlier improvements made by the intermediate group were maintained but those in the DCD group did not make improvements between 15 and 17 years. Many professionals from child health, child and adolescent psychiatry, neuro-psychology, educational psychology and education are involved in assessing, treating and studying this condition. This disorder affects many children and can severely limit school performance, self-esteem and age appropriate activities of daily living.

Co-occurring conditions/associated difficulties

The extent to which DCD is clearly distinguishable from other developmental disorders has been questioned[88] given the fact that it is more usual for several developmental disorders to occur together than any one separately[145],[146]. Co-occurring conditions such as attention deficit disorder, autistic spectrum disorders, speech and language disorders, and dyslexia/specific learning difficulties is commonly reported.[147] This could challenge the notion of coordination difficulties as a discrete condition rather than a symptom and makes it imperative for any study to consider any other diagnoses that a child may have. The co-morbid conditions described in the literature are, attention deficit/hyperactivity disorder, dyslexia and speech language impairments. Gillberg and colleagues have also described autistic features, conduct/oppositional – defiant problems, depressive and anxiety symptoms, personality disorders, drug & alcohol abuse, accidents, Tourettes and tics as co-morbid conditions.[148] Kirby has shown that benign joint hypermobility syndrome also occurs both with and without DCD.[149] Other associated, secondary conditions have

been described such as behaviour problems, educational under achievement, difficulties with peer relations, social immaturity, low self esteem and reduced participation in physical activites.[2,4,150]

Ideally children should be screened for known, common co-occurring conditions once a diagnosis of DCD is being considered. The diagnosis of specific learning disorders needs to be made by an educational psychologist, diagnosis of specific language disorders should be made by a speech and language therapist and medical and autistic spectrum disorders need diagnosing by a paediatrician. In this study I had to rely on the information provided by other professionals concerning co-morbid conditions, as it is not within the remit of an occupational therapist to make these diagnoses as a full multi-disciplinary assessment was not available in Gwent at the time of the study. Reports were requested from all other professionals that the child had seen and any identified co-morbid conditions noted. I view motor coordination difficulties as a developmental disorder, which can co-exist with other developmental disorders. It has been shown that co-morbidity is particularly high for motor coordination when compared with attention deficit and dyslexia[58].

Attention deficit /hyperactivity disorder (AD/HD)

There is a very strong co-morbidity between DCD and ADHD. Gillberg and colleagues found that 49% of children with DCD have AD/HD and 50% of children with ADHD have DCD.[151] He also states that the majority of children with AD/HD have some motor control problems even if they do not meet strict criteria for a DCD diagnosis. Kaplan and colleagues found that of 81 children identified with DCD 41% (n=33) also qualified for a diagnosis of AD/HD.[119] Miller and colleagues found that of 115 children diagnosed with DCD 41.1% also had AD/HD[152]. Children with AD/HD may often appear uncoordinated due to their inattention i.e. they do not look or listen, and care must be taken when assessing these children to ensure their difficulties are correctly attributed either to attention or motor difficulties or both where appropriate.

Dyslexia and speech & language impairments

There is a recognised link between specific learning disorders and DCD. Kaplan and colleagues found that 45 (56%) out of 81 children with DCD also had a reading disability.[115] Fletcher-Flinn and colleagues found that out of a group of 28 children with DCD 68% had a reading disability with 28% having a reading age two years or more below their chronological age[153]. Dyslexia can be viewed as lying on the continuum of developmental language disorders. The earliest

manifestation of developmental concerns in children with DCD is often delayed speech and language. Children with DCD have been shown to score worse on tests of speech, phonology and reading compared to matched controls.[154] Children with specific language impairments have been shown to be at an increased incidence of difficulties with coordination.[155]

Autistic spectrum disorders

Children on the autistic spectrum typically demonstrate dysfunction in perceptual and sensory processing[156] Gillberg also includes coordination difficulties as one of the six diagnostic criteria for Asperger's syndrome, with five of the six criteria being required for diagnosis. Children with DCD, who do not meet the criteria for a diagnosis of Asperger's, have more Asperger symptoms.[59] Green and colleagues found that the motor difficulties experienced by children diagnosed with Asperger's are not inherently different from those of children with DCD[157]. Children with a diagnosis on the autistic spectrum cannot be given a diagnosis of DCD when following the DSM-IV criteria as coordination difficulties are seen as a common part of the clinical picture of autism. However Geuze and colleagues, who suggest that Asperger's and DCD could be co-occurring conditions, have called this into question.[30] More recently the Leeds Consensus statement[10] noted that although the DSM-IV says a dual diagnosis of Pervasive Developmental Disorder and DCD could not be given this was felt to be inappropriate. Many children who have Asperger's syndrome also have coordination difficulties and where this is found then a dual diagnosis of DCD and Asperger's should be given in order to usefully capture both these aspects of the child's difficulties. Many children with Asperger's syndrome are referred to occupational therapy due to the functional impact of their coordination difficulties on activities of daily living.

Joint hypermobility syndrome

Children with DCD often present with hypermobile joints[140] particularly the interphalangeals, metacarpal-phalangeal, wrist, elbows, knees and feet. Joint hypermobility syndrome (JHS) is defined as "the presence of a degree of joint hypermobility measured by a prearranged and validated scoring system, associated with musculoskeletal symptoms and signs, and other connective tissue problems likely to be attributable to it".[158] It has been known as benign joint hypermobility syndrome but the benign has been dropped as the long-term consequences become more apparent. The associated clinical features are skin elasticity, easy bruising, slow tissue healing, joint dislocation/subluxation and/or arththraglia.[149] Diminished proprioception and

nocturnal leg pains or "growing pains" have been associated with JHS.[159] The scoring systems used are the Beighton and the Brighton (which incorporates Beighton).[160] However more research is required on applying these to children although they are used in clinical practice with variable amounts of rigor. Delayed motor development has been reported in some children with JHS.[140] Difficulties with functional skills such as sports, physical activities and handwriting have also been reported.[140] JHS is one of a group of genetically based hypermobility conditions including Marfan Syndrome, Ehlers-Danlos Syndrome Vascular Type and Ehlers-Danlos Hypermobile Type.[150] It has been suggested that JHS and Ehlers-Danlos Hypermobile Type may be one and the same thing.[146] A diagnosis of Marfan's or Ehlers-Danlos Vascular Type may be considered sufficient to exclude children from a diagnosis on the basis of criterion C.[150] However whether the same could be said of JHS, that it excludes a DCD diagnosis, is unclear. I consider a dual diagnosis to be appropriate when criteria for both conditions are met assuming Marfan Syndrome and Ehlers-Danlos Syndrome Vascular Type have been excluded. Making these exclusions is not always possible in clinical practice as it is dependent on the medical examination and work up. Not all children who meet criteria for JHS (using a score of 4/9 on the Beighton) meet the diagnostic criteria for DCD in my clinical experience. Where this is the case a diagnosis of JHS only should be given.

Prematurity and low birth weight

There are a number of studies that link prematurity and low birth weight with perceptual motor deficits in later childhood. Abel Smith and Knight-Jones[161] studied 43 children with low birth weight and compared them with matched controls. They found that the low birth weight children had significantly lower mean scores on the McCarthy Scale, which includes a measure of motor performance. Marlow et al[162] studied 51 children with birth weights of 1250g or less and compared them with matched controls. They found the very low birth weight group had significantly lower scores on the Test of Motor Impairment, an earlier version of the Movement ABC[41]. Hall et al[163] studied at total population of 324 Scottish very low birth weight children (below 1500g) and compared them with matched controls and found they performed overall less well than their controls. Foulder-Hughes and Cooke [164] studied 151 males and 129 females born before 32 weeks gestation and attending mainstream schools and compared them with matched controls. They found the pre-term group to score significantly lower on the Movement ABC[41].

Clearly low birth weight and prematurity are risk factors for motor impairment even though there is not a clear one to one relationship as not all low birth weight premature children have motor difficulties. The studies all excluded children with known diagnoses such as cerebral palsy so

these children would meet criteria for a DCD diagnosis. There is debate about whether these children can be said to have a medical condition because of their prematurity and low birth weight. However in the absence of any other medical diagnosis it would seem appropriate to give a diagnosis of DCD when all the other diagnostic criteria are met.

Socio-emotional behavioural difficulties

Children with DCD commonly have additional difficulties with social interaction and participation, emotional issues such as anxiety, depression and self-concept and behaviour such as organisation, attention and aggression. Children with DCD have been shown to have difficulties with social interaction and participation. Children with DCD commonly have reduced social status compared to their peers. Skill in sporting activities is an important factor in determining children's social status.[165] Therefore children with poor motor skills are likely to have reduced social status and are less likely to participate in play activities. This has a double-edged effect of reducing their time spent practising motor tasks and the amount of time they socialise with other children. Much of children's socialisation is built around motor activities. Children with DCD have been observed to participate less in playground activities, 27% of the time compared to 84% for control children.[166] Most of the studies looking at participation of children with DCD have focussed on participation in physical activities rather than social situations not requiring motor skills. At home children with DCD are less likely to participate in household chores, which denies them a helping role within the family.[167] Parents report that they have to adjust daily activities to accommodate the child's needs and may avoid situations where they think the child will struggle, often reducing opportunities for social interaction.[126] Longitudinal studies have shown that adolescents with DCD participate in fewer social activities during their leisure time.[188] Children with DCD are reported to have fewer friends and may be subjected to teasing and bullying at school.

Children with DCD have been shown to be at risk of emotional issues. Depression, anxiety and conduct disorders have been associated with DAMP.[168] Children with movement problems show significantly more signs of anxiety both in general terms and when faced with the prospect of performing a motor task. Children with DCD are more introverted.[188] They also perceive themselves as less competent at athletic and scholastic tasks nor do they rate their physical appearance or social acceptance highly.[188] Children with poor motor coordination have been shown to have poor self-concept at 16 years of age. Children with DCD have also been shown to perform poorly on measures of the ability to recognise facial expressions of emotion even when visuo-spatial processing was controlled for although they were able to understand emotions and

recognise vocal emotion cues.[21] The reduced ability to read facial expressions will impact on their social relationships. Therefore there is much evidence for children with DCD having secondary psychological issues, which may actually become more important than the motor deficit as the child grows up. Teachers report that children with DCD have more behaviour problems than their peers such as poor concentration and organisation.

In relation to educational achievement there have been few longitudinal studies of the cognitive and academic achievement of young people with DCD. However the majority suggest some degree of educational under achievement in adolescents with early diagnosed DCD. Gillberg and Rasmussen's study found that people with DCD were much more likely than controls to have less than twelve years in school and less likely to go to university. Adults with DCD were also more likely than controls to be unemployed. Cantell found that adolescents with DCD were likely to make less challenging educational choices and consequently to have reduced employment opportunities.[169]

Physical fitness

Children with DCD generally perform poorly on fitness tests. There are two aspects of overall physical fitness, health related and skill related. Health related components of fitness include cardio-respiratory endurance, muscular strength and endurance and body composition. Health related fitness is considered to be achievable by all, not just those with high motor proficiency. It can be assumed that children with DCD will have difficulties with measures of fitness that require the motor skills of agility, speed and power. It has been shown that children with DCD have lower levels of aerobic fitness than controls without DCD.[170] A study comparing the cardio-respiratory fitness of children with (n=44) and without (n=542) DCD found that children with DCD showed significantly lower levels of aerobic fitness than controls.[161] They questioned whether the reduced aerobic fitness of children with DCD was due to lower aerobic capacity or negative perceptions of ability and concluded that 34% of the difference could be attributed to low perceptions of adequacy.[161] Children with DCD have been shown to have much higher levels of fatigue than controls, which increased with age in children with DCD but decreased with age in controls.[161] Children with DCD have inefficient movement patterns that increase their physiological load for a given task.[161] This can be assumed to contribute to them experiencing fatigue earlier than controls. The fatigue may also explain their reduced levels of participation.

The condition of DCD more often than not has co-occurring conditions such as those described in the previous paragraphs. There are the co-occurring developmental disorders such as AD/HD,

dyslexia and autistic spectrum disorders and there are the secondary associated features such as low fitness levels and socio-emotional behavioural difficulties. However it should be remembered that the core characteristics of the DCD condition involves significant motor impairment such that activities of daily living and/or academic achievement are adversely affected. The co-occurring conditions are not part of the definition but they are hugely significant factors in any intervention programme.

Motor development of children with DCD

DCD is a movement disorder and therefore the development of motor skills in children with DCD over time is of interest. Our knowledge about the early development of children with DCD is gained through asking parents to remember how and when their child developed specific motor skills, because it is rare for young children (under five years) to be referred to movement specialists for assessment. Many researchers, in an attempt to understand the nature of the condition and in order to guide and inform intervention have studied the nature of the motor control deficit.[171, 170] The role of sensory systems such as vision, kinaesthesia, proprioception, tactile and vestibular systems has all been explored.[172] Balance, posture, memory and attention have all been shown to play a part in movement skills.[173] The nature of errors in terms of speed accuracy and variability of performance made by children with DCD has been compared to typically developing children. Given that children with DCD are a heterogeneous group some have searched for the existence of sub groups.

Early development

What we know about early movement skill development of children with DCD is usually from retrospective recollections of parents. DSM-IV[8] states that children with DCD may have delays in achieving developmental motor milestones such as walking, crawling, sitting, tying shoelaces, buttoning shirts and zipping trousers and parents often confirm this. There is evidence that suggests parents of children with DCD felt their child was different from an early age[174]. Problems of a DCD nature can effect the child's development in a number of important ways[175, 176, 177, 178] and in this respect important interactions between motor skills, psychological self assessments, emotional and social progression are all inter linked. These are linked for children of typical development as outlined by Smith, Cowie and Blades[179] and for children whose development is compromised by a variety of factors by Herbert[31]. Children with DCD have poor self-efficacy beliefs about tasks requiring motor skill and this influences their choice of activities, persistence and skill acquisition.[180] Proficiency in motor skills is an important

determinant of the status afforded children by their peers. It therefore has an impact on children's self esteem and social peer relationships.

Motor control difficulties

From an information processing viewpoint it is suggested that children with DCD have deficits with specific sub systems such as the kinaesthetic or visual system, and/or with processing sensory information as the main processes that underlie motor skills. Deficits in the execution of motor skills are seen as having their roots in these underlying processes. Many researchers have explored areas such as kinaesthesia, visual perception, balance, posture, memory and attention in order to identify the specific deficit area. They then compare children with DCD with typically developing children. Studies comparing children with DCD to typically developing children do not always give a clear picture but generally find that children with DCD perform poorly as a group compared to their non-affected peers. In addition, on a range of motor tasks, there is evidence to suggest that certain features related to motor control are commonly observed. Children with DCD have been shown to have high variability of performance that is their errors are not consistent.[181] Children with DCD have been noted to have difficulties with posture and balance control, that is, the preparatory phase that directly precedes the execution of a movement.[182] It has been shown that children with DCD have increased amplitude of sway, a determinant of postural integrity.[183] They also have greater difficulty responding to postural perturbations. Getting the correct timing of motor actions has also been shown to be a difficulty for children with DCD. These include slow reaction or response times. Children with DCD tend to over use vision probably in order to compensate for postural and proprioceptive deficits. Children with DCD use visual feedback rather than proprioception to control force.[184]

More recently studies have used a dynamical systems viewpoint and compared children with DCD and typically developing children on various tasks. For example from a dynamic systems view spatio-temporal organisation is an emergent property arising from the dynamic interaction of the task, environment and child. Timing is not controlled by a central timekeeper but arises from dynamic interactions. For example Volman and Geuze[185] compared children with and without DCD on a rhythmical tapping task and found that children with DCD had less stable coordination patterns and required more time to restore their initial pattern after perturbation. This latter finding may have ecological relevance as it suggests that children with DCD may have more difficulties responding to environmental changes. Volman and Geuze[142] suggested that children with DCD may be slower simply in order to maintain coordination and control by remaining in a stable state.

Information processing and dynamic systems approaches view motor control and coordination from different perspectives and both offer potential insights into understanding children both with and without motor deficits. Dynamic system approaches are more likely to make us consider environmental influences relating to specific tasks and take us to a more ecological perspective.

Sub groups

Over the last decade or so various attempts have been made to identify stable sub-groups within the broad category of DCD. It is thought that if this were accomplished then it would be possible to target intervention more specifically according to the type of sub group. Approaches to identifying sub-types have included grouping by descriptive or clinical categories and statistical cluster analysis. A range of descriptive sub types have been considered based on the skills groupings of the assessment used. The range of sub groups found includes factors such as fine motor, manual dexterity, visual, visual motor, visual spatial, gross motor, balance, coordination, speed, catching, gestural performance, motor sequencing and kinaesthesia. These factors have been found singly or in cross modal groups.

Clinicians often make the distinction between children with a planning deficit and those with difficulties with execution.[186] However support for these sub groups is equivocal, Conrad, Cermak and Drake found evidence of a group of children with motor planning problems due to sequencing deficits and another group with visual spatial deficits which goes part way to support the planning/execution split.[187] Dewey and Kaplan compared children with and without motor difficulties with a battery of tests and found four definite sub groups; deficits in balance coordination and gestural performance, deficits in motor sequencing, severe deficits in all areas and no difficulties.[188] Although Dewey and Kaplan's results did not present a planning and execution split they did show that some children had generalised motor difficulties i.e. both planning and execution and others had difficulties with specific execution problems whose planning appeared to be fine. This second group presented with deficits in balance and coordination. The distinction between those with planning and execution deficits may be appealing but studies to date do not fully support these sub groups enough to be able to recommend them for use in clinical practice.

Hoare's study in 1994 identified five sub-groups of movement difficulty that she called manual dexterity, gross body coordination, vision, balance/hop and active kinaesthesis. Hoare's study was virtually replicated by Macnab and colleagues in 2001 with similar findings. Wright and Sugden used results from the Movement ABC[41] assessment and checklist and found five factors; fast

hands, catching, control of self in changing environments, generally poor scores but not severe in any and generally poor scores.[189] Further cluster analysis revealed four clusters, children with little impairment in any area, children who adapted poorly to external factors particularly catching, children who adapted poorly to a changing environment and finally children who had slow hands and poor dynamic balance. They concluded that their results confirmed the heterogeneity of DCD. Wann and colleagues investigated postural stability with their "swinging room" and found children with DCD fell into two groups on the basis of their postural stability.[140] One group relied heavily on the use of vision to maintain posture in the swinging room (much like younger children) and the other group who did not differ from age matched controls in the swinging room experiment.

In summary the efforts to identify sub groups has met with limited success. All the attempts to find sub groups are inevitably influenced by the choice of assessment and the terminology used but there does not appear to be consistent groupings emerging but the studies do suggest that sub groups may exist.[190] Several studies have found a group of children with deficits in all areas and then other groups with deficits in one or two areas. The studies reported in the previous paragraphs have focussed on the motor deficits and considered components of motor skills as potential cluster groups. This type of sub grouping does not take into account co-occurring conditions that could also be used to put children into sub groups such as those with additional attention or social communication impairments. Green and Baird compiled a comprehensive table of 26 studies and grouped the results according to motor impairment, psychopathology (emotional, conduct, attention deficit/hyperactivity and social), learning and developmental issues.[191] The studies show overlaps with DCD and psychopathology, learning and developmental issues but Green and Baird conclude that vague inclusion/exclusion criteria and inconsistent terminology make it difficult to establish the extent to which these overlaps occur. It may be that agreement and use of a definitive taxonomy of movement skills as discussed in the previous chapter could define the sub groups that are being considered. It may also be informative to look for links with specific movement skill deficits and co-occurring conditions. It is possible for instance that there are links between attention and particular movement skills.

Prognosis

Long-term follow up studies have shown that many children with DCD do not "grow out of it".[111, 133] Rasmussen and Gillberg's study[133] found that at 22 years of age these research participants were more likely than their matched controls to be unemployed, to have had problems with breaking the law, to be alcohol or drug misusers or to have mental health difficulties. Fifty-eight

percent of the participants with DCD had poor outcomes compared to 13% in the comparison group without DCD ($p<0.001$). The Table below summarises the findings from Rasmussen and Gillberg's study.[133]

	22 year olds with DCD	Matched controls
Alcohol abuse	24% (13)	4% (n=2)
Personality disorders	33% (18)	7% (n=3)
Charged with criminal offence	19% (n=8)	0% (n=0)
Less than 12 years in school	80% (n=44)	26% (n=12)
Attendance at university	2% (n=1)	30% (n=14)
Reading/writing disorder	58% (n=32)	15% (n=2)

Table 3: 1 DCD group compared to matched controls at 22 years of age

Children who had been diagnosed at seven years with DCD were followed up in a controlled, longitudinal, community based study and were found to have health problems at a rate considerably above that of children in the general population. They have been shown to have a significantly increased number of fractures and other accidents requiring admission to hospital. [142]

Studies of the adult prison population have shown that attention deficit hyperactivity disorder is common (25.5%) amongst inmates.[192],[193] Gillberg found that 50% of children with attention deficit hyperactivity disorder also have DCD and therefore half of the adults in prison with ADHD are also likely to have DCD. Adolescents with DCD have a greater risk of a passive lifestyle due to their difficulties with activities requiring motor skills.[194] Low activity levels are a known health risk in several areas and there is a tendency for height and weight problems to be more common. Children with DCD are at high risk for developing factors associated with coronary heart disease at a later age.[195] DCD appears to be a potential predictor/risk factor for poor psychosocial functioning and unhealthy lifestyles in adulthood. A study of ten resilient young adults with DCD has shown that, when they look back on their childhood and adolescence, they do not focus on motor coordination issues. What successful young adults recall are the adaptations that were helpful, at home, school and community as well as the people who supported them.[196]

Summary and key points

In this chapter the nature of children with DCD is considered starting with definitions, diagnoses and labels and moving through the prognosis and long term consequences. The motor development of children with DCD is compared with that of typically developing children and

children with DCD generally perform poorly compared to their peers. They are slower, less accurate and more variable in their motor responses than their typically developing peers. However it has not been possible to identify more specific deficits that identify DCD children individually. The evidence for the presence of sub groups within DCD has been examined and been found to be inconclusive. The current and historical definitions of DCD are presented and the rationale for using DCD as a diagnostic term is explained. Known co-occurring conditions and commonly associated difficulties are described. The co-occurring conditions are attention deficit/hyperactivity disorder, dyslexia/reading disorders, speech and language impairments, autistic spectrum disorders and (benign) joint hypermobility syndrome. Prematurity and low birth weights are risk factors for DCD. Known associated issues are low levels of physical fitness and socio-emotional behavioural difficulties. Finally the knowledge about prognosis shows that children with DCD are at greater risk of educational underachievement, drug and alcohol misuse, criminal behaviour and difficulties with reading and writing. This knowledge suggests that intervention should aim to decrease the known risks associated with having DCD. I draw three conclusions from the literature about DCD as a condition.

Key points

- A range of labels, names and diagnoses has been used for this condition over the years but DCD is now established as the diagnostic term of choice.
- Some ambiguity remains around interpreting the DSM-IV criteria in order to make the diagnosis although since this study was conducted the Leeds Consensus Statement[10] has made it much clearer.
- The aetiology of the condition is largely unknown.
- Depending upon the criteria used the best estimate of prevalence appears to be between 4 and 6% of the childhood population.
- There are a number of co-occurring conditions and associated difficulties including AD/HD, dyslexia, speech and language impairments, autistic spectrum disorders, (benign) joint hypermobility syndrome, prematurity and low birth weight, socio-emotional behavioural difficulties and low levels of physical fitness.
- Children with DCD perform poorly compared to matched controls on a number of motor control tasks. They have a greater number of errors, wide variability in their errors, over use vision, have poor timing and force control. They may have greater difficulties responding to environmental changes.
- Whilst it appears likely that there are sub groups of DCD it is still unclear how these should be defined.
- Children with DCD are at risk of long-term negative consequences.

CHAPTER 4: Occupational therapy and DCD intervention

Occupational therapy services for children are evolving and the number of OTs working with children is growing. The Children, Young People & Families Specialist Section of the College of Occupational Therapists (formerly National Association of Paediatric Occupational Therapists NAPOT) is the largest Specialist Section of the College of Occupational Therapists and currently has in excess of 1,400 members.[197] In November 2003 a survey of all the children's occupational therapy services in Wales found that there were 56.21 whole time equivalent OTs working with children in Wales. The total population of 0-19 year olds was 774,668 at the time of the survey. This is one whole time equivalent occupational therapist for 13,781 children. Throughout the UK the National Health Service employs the majority of paediatric occupational therapists followed by social services.[11] Many social services departments now have a dedicated team for children with disabilities and occupational therapists are often part of these teams and work in collaboration with their health colleagues as required. Some children's occupational therapists are employed by education in response to occupational therapy being written into a child's Statement of Special Educational Needs.[198] There are also independent occupational therapists that parents can employ directly. It was stated in the introduction that waiting times for children to see an occupational therapist are an issue throughout the UK making it more likely that parents will turn to independent practitioners so their child can be seen quickly. The mean waiting time for assessment is 46 weeks with a span that ranged from one week (1 service) to 2-4 years (8 services).[11]

Occupational therapy aims to enable people to achieve health, well-being and life satisfaction through participation in occupation.[199] Occupations are the everyday things that people occupy themselves with, looking after themselves, going to school or work and participating in leisure activities. The College of Occupational Therapy gives the following definition of occupation

> "An **occupation** is an activity or group of activities that engages a person in everyday life, has personal meaning and provides structure to time. Occupations are seen by the individual as part of her/his identity and may be categorised as self-care, productivity and/or leisure."[200]

Children with DCD are frequently referred to occupational therapists because of difficulties with the occupations of handwriting and dressing amongst others. Children with DCD comprise 30% of occupational therapist's caseloads and 62% of the children waiting for assessment and therefore constitute a significant proportion of children seen by occupational therapists. Intervention is the term used to describe the actions conducted by professionals aimed at remediating the difficulties of their clients. Literature published on intervention for children with DCD comes from a number of professional backgrounds including occupational therapy, physiotherapy, psychology and teaching. The literature review is focussed on occupational therapy intervention whilst also reviewing intervention from other disciplines that is considered relevant. Occupational therapists often work closely alongside other professionals when treating children with DCD. Clarity about each profession's role could lead to more effective intervention and avoid duplication of efforts. Therefore, consideration has been given to the role of the occupational therapist. This includes a brief summary of the history of the profession, the models that are used to define occupational therapy practice and the philosophical ideas that the profession has adopted. Children's occupations and activities of daily living are defined with reference to the literature and statements from occupational therapy colleges and associations. In this way it is intended to explore the unique role of the occupational therapist when working with children and how this relates specifically to children with DCD.

Whilst acknowledging the unique role of occupational therapy, intervention for children with DCD also needs to be considered within the broader framework of the World Health Organisation's revised definition and model of disability and function. This model moves away from a solely impairment-based view of health and functioning to one that also considers goals related to activity and participation as appropriate health interventions.[201] There is a body of work relating to participation of children with disabilities, particularly children with cerebral palsy.[202, 203, 204] However, the participation "ceilings" may be too low for children with DCD but these principles may be used in the future, using different tools, for children with DCD.

The development of occupational therapy in the UK

George Barton was the first person to use the term occupational therapy in 1914 at a conference of hospital workers in Boston. A report in *The Lancet* in 1924 stated "The confidence engendered and restored by a course of such occupational therapy is often of striking service in enabling the patient to make the mental readjustment necessary for his cure."[205] In 1924 the *British Medical Journal* published an article about occupational therapy at the Glasgow Royal asylum. Dr. Elizabeth Casson set up the first English training school for occupational therapists in Bristol in

1930. In 1932 the Scottish Association of Occupational Therapists was formed. In 1936 the Association of Occupational Therapists was formed followed by the British Association of Occupational Therapists in 1974. In 1978 the British Association of Occupational Therapists and College of Occupational Therapists were formed. Occupational therapy is still a young profession, born in the twentieth century and is still evolving.

In the early days of the occupational therapy profession the focus was on the person and the activity and did not address pathology or diagnosis but was based on the assumption that engagement in occupation was beneficial to the person. During the first and second World Wars there was a shift from occupation as a means of developing or maintaining health, to occupation as a means of enhancing bio-medical outcomes. In order to achieve bio-medical outcomes many occupational therapists developed skills and knowledge in the component aspects of performance rather than dealing with occupational performance itself. The performance component categories are sensorimotor, cognitive and psychosocial, rather than the occupational performance categories of self-care, productive activity, play and leisure. During the late 1960s and 1970s the medical model predominated the occupational therapy profession. During the 1990s there has been a plea from within the profession to return to our core values and focus on occupation.[206],[207] The British College of Occupational Therapy states that the philosophy of occupational therapy is to promote and restore health and well-being through using purposeful occupation as the process or ultimate goal. It goes on to state "In this context, occupation is the meaningful use of activities, occupations, skills and life roles which enables people to function purposefully in their daily life."[208]

A client-centred approach is embedded in occupational therapy philosophy. However the interpretation of the term client centred is variable. First it is necessary to decide who is the client, the child or their parent/carers? Many practitioners in paediatrics interpret this from an expert practitioner viewpoint where they know what is best for the child. Interventions are child focussed in the sense that they focus on bringing about changes within the child that are decided by the professional.[209] More recently client focussed has come to mean finding out the views of the child and their parents and involving them in making decisions about their intervention. This approach is usually called family-centred. Recent literature suggests that a family-centred approach involving collaboration between the therapist, parents and other family members in programme planning, service delivery and evaluation results in therapy outcomes which are much more relevant and meaningful.[210],[211] Occupational therapy should therefore use a holistic, family-centred, approach to help children develop, restore and maintain those skills, behaviours and relationships necessary for participation in meaningful activities. Functional performance of

activities of daily living can be analysed into specific skills and skill components but it is the uniqueness of a child that holds these components together.[212] Skill deficits should never be considered in isolation from the functional activities that those skills enable a child to perform. Assessment and intervention based on role performance and occupational performance should have priority over skill components.[213] Occupational therapists aim to use their skills to enable children with DCD to increase their ability to perform activities of daily living that are age appropriate, of importance to the child and family and are culturally relevant.

Models of practice

A model provides a broad outline of the basis for practice for a given profession[214]. It should define the professional role and be applicable to all people regardless of age or disability. Occupational therapy models aim to define human occupational performance and thereby establish the central beliefs of the occupational therapy profession. Some countries (e.g. USA, Canada) have a nationally agreed model but this is not the case in the United Kingdom and we generally look to the American and Canadian models for guidance. There follows a synopsis of the major occupational therapy models from reviewing the literature.

The **Model of Adaptation by Reed and Sanderson**[215] states "the study and management of the purposeful occupations in which humans engage is the unique feature of occupational therapy that separates the knowledge base from all other professions" (page 12). It places great emphasis on the environment. Occupations are considered under the headings of self-maintenance, productivity and leisure. The environment is considered from physical (inorganic), psychobiological (organic) and societal-cultural perspectives. The occupational therapist's role is seen as promoting a facilitating environment. Performance skills are described as motor and sensory skills abilities, intra and interpersonal skills/attitudes and cognitive skills/knowledge. This is a popular model with many therapists working with people with physical disabilities.

The **Model of Human Occupation by Keilhofner**[216] assumes that "man" is an open system, and an occupational being. It also assumes that occupation has a positive effect on the life style of the individual and that the physical and social environment can influence behaviour and actions. Keilhofner divides occupation into four categories, self-care, leisure, work and rest. Keilhofner's model is unique in its emphasis on man as an open system and the inclusion of rest as an occupation. The Model of Human Occupation is popular with occupational therapists working in

mental health settings. Recently the Child Occupational Self Assessment (COSA) was published which is based on this model.

The **Canadian Occupational Performance Model**[217] assumes that people have an innate need to be occupied and that their environment shapes an individual's occupational performance. There are three interacting categories in this model, environment (physical, social, cultural, institutional), performance components (affective, physical, cognitive) and occupational performance (productivity, leisure and self-care). In this model spirituality, defined as our own individual belief systems about ourselves, is regarded as central to the human and needs to be considered in an holistic approach. This model is commonly used in the UK and has been used by at least one service as a common framework for services which span children's occupational therapists in health and social services. Bringing health and social services occupational therapists together through use of a common model may have a unifying effect on the services. The Canadian Occupational Performance Measure[217] is a popular outcome measure based on this model.

The **Person-Environment-Occupation Model (PEO)**[84] has been developed in Canada and sits alongside the Canadian Occupational Performance Model[217]. It uses theoretical foundations from the Canadian Guidelines for Occupational Therapy,[218] environmental-behavioural theory and the theory of optimal experience described by Csikszentmihalyi.[219] This model views occupational performance as a dynamic, transactive relationship between the person, environment and occupation and therefore sits comfortably with dynamic systems and ecological approaches.[220] The extent to which three PEO[93] areas overlap represents the goodness of fit to optimise performance.

The American "Occupational Therapy Practice Framework: Domain and Process"[221] also provides what could be considered as a model. This document states "Engagement in occupation to support participation in context is the focus and targeted end objective of occupational therapy intervention." It considers the domains of occupational therapy as

- Performance in areas of occupation – activities of daily living, instrumental activities of daily living, education, work, play, leisure, social participation
- Performance skills – motor, process and communication/interaction skills
- Performance patterns – habits, routines, roles
- Context – cultural, physical, social, personal, spiritual, temporal, virtual
- Activity demands – objects used and their properties, space demands, social demands, sequencing and timing, required actions, required body functions and structures

- Client factors – body functions, body structures

This model is not commonly used in the UK but is included as it is more detailed in its structure and descriptions of the domains, which provides useful guidance.

All of these models, apart from the American Occupational Therapy Practice Framework, are known to be used within the UK from informal discussions at workshops and conferences with occupational therapy colleagues from England, Wales, Scotland and Northern Ireland. All of the models view the environment as a key factor to consider with a range of headings used to define the environment. Distinctions are made between physical and social environments. An environment is seen as both a concrete and abstract place, as having location as well as physical and social characteristics. The models also all include the occupations of self-care/self maintenance, leisure and productivity/work. They all comment on performance skills or components which reside within the person. Only Kielhofner has "rest" as a separate heading and the Canadian Occupational Performance Measure (COPM)[217] puts a big emphasis on spirituality. The Canadian and PEO models are favoured with their strong focus on occupation and the transactive nature of the variables of person, task/occupation and environment. Using these models guides occupational therapists to think in terms that are compatible with a dynamic systems and ecological approach to motor development and learning described in the previous chapter.

The **World Health Organisation's International Classification of Functioning** (WHO ICF)[222] is a trans-disciplinary, multi-professional classification of health. It represents a move away from traditional models that focus on disease and impairment toward models that are more focussed on a bio-psychosocial approach to health. The language used is more neutral using terms such as body function and structure, activity and participation rather than impairment and handicap. It describes how people live with their conditions and considers the impact of the disease or impairment from the unique perspective of each individual. Disability is seen as an umbrella term that represents the dynamic interaction between the person and the environment. The WHO ICF[204] uses the following headings to define activities and participation:

1. Learning and applying knowledge, including purposeful sensory experiences such as watching and listening, basic learning such as reading, writing, calculating (arithmetic) and applying knowledge through solving problems.
2. General tasks and demands including undertaking single and multiple tasks, carrying out a daily routine, managing one's own behaviour and handling stress and other psychological demands.

3. Communication including receiving and producing spoken, unspoken and non verbal messages, conversation and use of communication devices and techniques.
4. Mobility including changing and maintaining body positions, carrying, moving and handling objects, lifting and carrying objects and fine hand use (picking up, grasping), walking and moving around including using equipment (wheelchair, skates, etc), moving around using transportation – (car, bus, train, plane, etc) and driving (riding bicycle and motorbike, driving car, etc).
5. Self-care including washing oneself – bathing, drying, washing hands, caring for body parts – brushing teeth, shaving, grooming, toileting, dressing, eating, drinking, avoiding potentially dangerous situations and harm to self and looking after one's health.
6. Domestic life including acquisition of necessities – goods and services (shopping, etc), household tasks – preparation of meals (cooking etc), doing housework (cleaning house, washing dishes, laundry, ironing etc) and caring for household objects and assisting others.
7. Interpersonal interactions and relationships including general and particular interpersonal interactions such as relating with strangers, formal relationships, informal social relationships, family relationships and intimate relationships.
8. Major life areas including education – informal, play, engaging in play, pre-school education, school education, higher education and economic life – remunerative employment, basic economic transactions and economic self sufficiency.
9. Community, social and civic life including school life and related activities, recreation and leisure – play, sports, arts and culture, crafts, hobbies, socialising, religion and spirituality, human rights and political life and citizenship.

The ICF aims to describe how people live with their health conditions, it views body functions and structures and activity and participation as health related domains. They are viewed from the perspective of the individual and society within the context of the environment. The ICF is proving influential in changing thinking and approaches to disability. The ICF also sits comfortably alongside the occupational therapy models described above and is suggested as the multi-professional framework with the Canadian and PEO models describing the occupational therapy specific role.

Children's occupations, activities of daily living and participation

The terms occupation, activity of daily living and participation are often used synonymously. The definitions of each of these will be considered and it will be seen that they are often defined in terms of each other. Occupations are daily activities that reflect cultural values, provide structure to living and meaning to individuals. These activities meet human needs for self-care, enjoyment

and participation in society. In other words children's occupations are the things that they need to, want to, or are expected to be able to do to live their lives; to play, look after themselves, be part of a family, make friends and go to school. Ilott suggested in 1995[223] that occupational therapists should use the word occupation and not activity but this has been slow to take place even amongst occupational therapists. There is a possibility that others will not understand the way occupational therapists use the term occupation. The term activities is more generally understood and therefore accessible, however if occupational therapists can articulate their views about occupation then this will contribute to a greater understanding of the profession and its name.

The DSM-IV uses the term "activities of daily living" but it goes no further to specify which activities are covered by this term. The specific activities covered by the term "activities of daily living" are not well defined.[224] The on-line Medical dictionary defines activities of daily living as "The things we normally do in daily living including any daily activity we perform for self-care (such as feeding ourselves, bathing, dressing, grooming), work, homemaking, and leisure."[225] Pedretti classified activities of daily living into five areas: Mobility, self-care, management of environmental hardware and devices, communication and home management.[226] Children with DCD have significant difficulties with performing many activities of daily living such as self-care activities, household chores, schoolwork, sports and social activities, due to poor motor coordination.[227,228] It is not known whether there are particular activities of daily living that present problems for children with DCD. Children with DCD may consistently present with the same list of daily activities that are problematic. It may be that specific impairments cause specific activity restrictions but this has not been evaluated in DCD. Should this prove to be the case then this would inform the diagnostic process and may be of use in screening tools.

Participation is defined as involvement in a life situation and is seen as the ultimate outcome for people with disabilities. Occupations and activities of daily living are used interchangeably with participation being the act of being engaged in occupations or activities. The person-environment-occupation (PEO) model has been adapted (with Mary Law's permission). It has been used as an evolving theoretical framework for the model of practice which guides and shapes the studies described in the subsequent chapters. It was chosen, as it was developed to deliver a family-centred, functional approach to intervention that viewed occupational performance as a dynamic interaction between the person, their environment and the occupation to be performed. This method will attempt to combine occupational, ecological and dynamic systems based approaches. In this thesis the PEO model has been interpreted in combination with reference to the International Classification of Functioning, the American Association of Occupational Therapist's Domain and Practice paper (the British College of Occupational Therapy does not have an

equivalent paper) and an ecological perspective[71]. Each aspect of this model will be presented and interpreted for children aged 5-11 years. Children's occupations and the person and environment domains are each presented with reference to how these are interpreted during assessment. This is seen as fundamental to applying diagnostic criterion B "interferes with academic achievement or activities of daily living" in DCD.

Children's occupations

A top down approach to intervention starts by considering the daily tasks or occupations that the child needs to perform. It has already been established that children's occupations are self-care, productive activity, play and leisure tasks and activities. Occupational therapy aims to enable children/young people to achieve a balance between self-care, productivity, play and leisure. Occupational imbalance can lead to secondary deprivation. The occupations relevant to children aged 5-11 years are listed under the three headings below. To a certain extent these distinctions are arbitrary as it is the person's perception of the activity that defines it for them. For example children can perceive self-care tasks as work rather than self-care in certain circumstances. Children tend to view self-care tasks as work when they are directed to do the task by an adult, if the skill is thought to be too difficult or when the self-care task inhibited play.[229] When evaluating the performance of tasks Coster and Haley note it is important to consider the ability to initiate tasks at the correct time, in the correct situation and with the required frequency.[230] In addition tasks must be completed in sufficient time, without being distracted or losing the ability to stay on task, to ensure independence and success in performance.

Self-care occupations are tasks that the child needs to be able to do in order to look after themselves. There is not universal agreement on the specific tasks included as self-care activities of daily living. Self-care is sometimes divided into personal care activities and domestic or instrumental activities e.g. by the American Association of Occupational Therapists. The American Association of Occupational Therapists [231] defines basic or personal activities of daily living as those that are orientated to taking care of ones body and instrumental activities of daily living as those that are orientated toward interacting with the environment and are often complex. According to the American Association basic or personal activities of daily living are, bathing, showering, bowel and bladder management, dressing, eating, feeding, functional mobility, personal device care, personal hygiene, grooming, sexual activity, sleep/rest and toilet hygiene. Instrumental activities of daily living are care of others (including selecting and supervising caregivers), care of pets, child rearing, communication device use, community mobility, financial management, health management and maintenance, home establishment and management, meal

preparation and cleanup, safety procedures, emergency responses and shopping.[216] These activities have clearly been written with adults in mind and their relevance to children needs to be considered. In this thesis personal care of one's body is considered to be part of self-care and instrumental activities (e.g. domestic care and home management) to be part of productivity. Studies of adolescents from around the world found that the amount of time spent on personal care activities varied very little across cultures. A range of 0.5-0.8 hours per day spent on personal care activities was found across adolescents in 12 European countries. The average amount of time spent sleeping is in the range of 8-9 hours across populations, with younger children sleeping more than adolescents. The amount of time spent eating shows greater variation due to cultural mores with French adolescents spending 1.9 hours per day at meals compared with a norm of 1.2 hours per day across other European countries.[232] Therefore an average of 10.35 hours a day (41% of the whole day) is spent in self-care activities including sleep. The samples were based on adolescents rather than younger children, which are the focus of this study, but it was felt that they serve as a useful guide in the absence of any other data. A definitive list of self-care occupations for children does not exist. The list below was drawn up with reference to the ICF and American Association of Occupational Therapist's Domain and Practice paper and consideration of the relevance of activities for 5-11 year olds.[216]

- Eating
- Drinking
- Toileting
- Bathing/showering/washing
- Oral hygiene
- Nose care
- Nail care
- Hair care – brushing, styling, cutting
- Dressing
- Rest and sleep
- Sexual expression
- Personal device care
- Medication routine
- Health maintenance
- Avoiding dangerous situations
- Emergency response
- Functional communication
- Functional mobility

This is a fairly broad interpretation of self-care tasks including managing basic bodily functions, personal hygiene, grooming, avoiding danger or harm, expressing needs and asking for help. More long term caring for oneself through adopting healthy lifestyles is also considered to be part of self-care under the category of health maintenance. Home management and household chores are seen as productivity occupations rather than self care in contrast with some models such as The American "Occupational Therapy Practice Framework: Domain and Process".[161]

Productivity occupations are the things that a child is expected to do like going to school, doing chores around the house and caring for others. Productivity includes school/educational activities, domestic activities e.g. home management/household chores, meal preparation, shopping, handling money, care of others e.g. siblings, playmates, pets as well as vocational activities. European children aged 10-16 years were found to spend 0.2-0.7 hours per day in household labour. Girls were found to spend more time on household chores than boys across all populations but the boys were more likely to be paid.[220] Children in the UK spend 3-6 hours per day in school plus homework time. Some school time is spent in play and leisure activities. Expectations of productivity at school are defined by the National Curriculum in the UK and are further shaped by the unique culture of each school and classroom. Handwriting is a key school based productivity occupation and difficulties with handwriting are a common reason for referral to occupational therapy. Using tools and materials such as scissors, rulers, pencil sharpeners and rubbers are also frequent school based occupations.

Expectations of children to perform domestic activities at home are variable across families and cultures. It is dependent on factors such as whether there are one or two parents at home, whether they work outside the home, the number of siblings and financial resources. Household chores include tidying up, meal preparation and clean up afterwards, laundry, taking out the rubbish, gardening and cleaning. Caring for younger siblings may include playing with them, helping them dress, eat and drink, reading to them and performing simple first aid. Pets may need to be fed, watered, groomed and exercised. When friends come to visit they may need to be shown where things are, given food or drink and toys need to be shared. Children aged 5-11 years are unlikely to perform vocational activities although they may participate in activities such as helping neighbours and grandparents or participating in religious worship and community group vocational activities.

Play and leisure occupations are the things that the child chooses to do with their free time for fun, pleasure and relaxation. Play is recognised as a universal right for every child in the United

Nations convention on the rights of the child (article 31).[233] Play is a primary occupation of childhood and is seen as having a unique value for its own sake beyond acquiring skills.[234] There is no universally accepted definition of play although there are considered to be a number of characteristics that define it. The characteristics are intrinsic motivation, process rather than product orientated, involving toys and objects, pretending, freedom from externally imposed rules and requires the active participation of the player.[235] Play for 5-11 year olds includes construction, crafts and hobbies, games with rules, media and technology use (e.g. CDs, DVDs, computers), organised sport, social and dramatic play. Constructive play is building complex structures with blocks or interlocking shapes including puzzles. Crafts and hobbies include drawing and collecting things such as stamps, cards and stickers. The games with rules that are played include playground, computer, board and card games that require abstract thinking. Media and technology use is common amongst this age group such as watching TV, videos, CDs, DVDs and using games consoles, listening to music on a variety of players and using the internet. The top three sporting activities undertaken outside school by children and young people aged 6-16 years, with and without disabilities are swimming, football and cycling (see figure?). Organised sporting activities are influenced by local cultures such as whether football or rugby is popular. Social play includes talking and joking with peers and simply hanging out. During this time children's play takes on more social and cooperative forms compared to under five year old play.158

The person

When considering aspects of the "person" the child's chronological age and developmental stage must always be considered. Knowledge of typical development is required to understand what are reasonable expectations of children of different ages. When children are not functioning at their chronological age the phase of maturation that they have reached should be established. The child's motor, sensory, cognitive, psychosocial and spiritual make-up should all be considered as part of the person they are.[84, 202, 203, 204, 209] These personal attributes need to include things that can be observed at the behavioural level and/or tested without specialised laboratory equipment. When considering the child's **physical** skills it is helpful to refer back to the taxonomy of movement skills discussed in the previous chapter which included foundations, early milestones, fundamental, specialised and functional skills and movement abilities. Physiotherapists usually assess foundation skills such as strength and range of motion. Ages at which milestones were achieved are established through the use of questionnaires and interview of parent(s). Fundamental movement skills are assessed using standardised assessments such as the Movement ABC[41] that assesses manual dexterity, ball skills and balance. Visual motor integration may be assessed using the Developmental Test of Visual Motor Integration.[236] Specialised and functional

movement skills are assessed in combination with assessing the relevant occupations. Information about the sensory skills of vision and hearing is gleaned by asking the parents whether these have been tested.

Cognitive abilities include a wide range of skills including attention, memory, sequencing, categorisation, concept formation, spatial operations, problem solving, literacy, numeracy, I.Q., learning and applying knowledge and the ability to generalise.[28, 216, 161, 208] Teachers can often give information on the child's attainments such as SATS scores, reading and spelling age. Where the child has seen an educational psychologist there may be results of formal testing such as the Wechsler Intelligence Scale for Children or British Ability Scales that will give further information on the child's cognitive abilities. The child's ability to pay attention can be observed during assessment of other attributes such as their motor skills. Informal observations and information about the child's cognitive abilities are also gathered from the parent and teacher questionnaires.

Psychosocial attributes include the ability to form relationships, manage emotions, communicate, social awareness, character, morals, values, attachment and self-management.[28,208] Each child has a unique temperament shaped by their sense of purpose, internal motivation, confidence and personal beliefs and values. Their identity is formed by self-evaluation, esteem and self-definition. Children's roles are shaped by their gender and relationships. Psychosocial attributes are usually assessed informally through observation and parent and teacher reports and less frequently from the child themselves.

Environment

The child aged 5-11 years operates in various locations including home, school and the wider community. Each of these environmental locations has their own physical, social/cultural, attitudinal, economic and institutional aspects. Physical aspects include accessibility to, and performance within, environments having objects, tools, furniture, space, buildings, visual and auditory aspects, natural terrain, weather and transportation systems. Social/cultural aspects include customs, beliefs, activity patterns, behaviour standards, and expectations accepted by the society of which the child is a member. This includes family, friends and support networks and the norms, roles, sanctions, customs and routines associated with these groupings of people. Attitudes are very powerful environmental forces based on beliefs, judgements and expectations. Economics such as family income, pocket money and resources shape a child's environment as well as institutional factors at organisational, political and legal levels.

In summary occupations and activities of daily living are considered as synonymous terms. Occupation encompasses self-care, productivity, play and leisure activities. The ability to perform occupations is seen as the result of dynamic interactions between the person, the environment and the task or occupation. Participation is the act of being engaged in occupations and activities. The resources of the person include motor, sensory, cognitive, perceptual, psychosocial, temperament and identity. Environmental resources include physical, social/cultural, attitudinal, economic and institutional constraints and supports. The range of occupations that is expected from a child is determined by the school, family and community environments, which comprise micro, meso and exo systems as described in the previous chapter. This thesis aims to focus on the occupations of children aged 5-11 years whilst acknowledging their uniqueness as a person within their environments.

Intervention

The topic of intervention in children with DCD covered in this section is one that is central to the thesis as it follows on from the information in the previous chapters on how children develop and the specifics of the condition of DCD. In order to select the articles, books and other literature that are relevant to the investigation multiple search strategies were employed. Some of these strategies were employed sequentially while others were ongoing concurrently such as the use of Zetoc alerts and attendance at conferences. I already knew of substantial bodies of literature pertinent to the topic. This knowledge came from my previous studies, attendance at national and international conferences and everyday clinical experiences. However it was recognised that this knowledge alone was not comprehensive and also could be classed as narrow and subjective. For this reason additional strategies were employed starting with databases searches. The databases Medline, CINAHL and AMED were searched using the keywords dyspraxia, developmental coordination disorder, motor children and occupational therapy individually and in combinations. Secondly the articles identified through these searches were selected with respect to their direct relevance to the research question at hand. Thirdly articles that were reviews or meta-analyses were examined in detail for their conclusions and recommendations. Fourthly citations of individual articles were noted and although it is recognised that this is a somewhat crude measure it can reveal relevant results. Journal impact factors were also looked at to see how the journal has generally been judged and the frequency of citations but it was the quality of the article that was the determining factor in selection. Fifthly on a more informal level, articles were identified through discussions with colleagues at conferences such as the world DCD conferences at Bamff 2003, Trieste 2005 and Melbourne 2007 and other conferences such as the European Academy of Childhood Disability Conference in Edinburgh 2004. These sources had to be judged alongside

the more formal database searches. Finally several researchers with high standing in the field of DCD were consulted in an informal manner about relevant literature and these included David Sugden, Sheila Henderson and Cheryl Missiuna amongst others.

Intervention is the term used to describe the actions conducted by professionals aimed at remediating the difficulties of their clients. There have been a number of different approaches used to treat children with DCD. These can be broadly divided into bottom up, or process orientated, and top down, or task orientated, approaches.[237],[238],[239] Whilst this division of the intervention approaches into two groups may be an oversimplification, it is a useful categorisation when considering the range of different approaches.[240] The process orientated or bottom up approaches take an impairment based model of intervention which aims to ameliorate the presumed underlying deficit whilst the task orientated or top down, approaches aim to reduce the impact of the impairment on activities and participation.

Traditionally bottom up approaches have been used and have a long history within the occupational therapy profession. Bottom up approaches take a hierarchical, neuro-maturational view of motor skill acquisition, which assumes that treating the underlying motor deficit will result in improvements in motor learning and performance. Bottom up approaches include sensory integration, perceptual motor training, the process orientated approach and neuro-developmental intervention. Top down approaches take a problem solving approach to acquiring specific, functional goals. Recent thinking in the movement science and psychology literature has influenced top down approaches. Top down approaches include task specific interventions and cognitive approaches. The range of therapy intervention approaches used with children with DCD and their evidence bases are discussed below.

Bottom up approaches

Bottom up approaches aim intervention at the presumed underlying deficit. They are aimed at the level of impairment with a view to changing and reducing the impairment itself. For children with DCD the intervention is aimed at the motor impairment or component skills such as sensory processing, bilateral integration, strength, dexterity or balance.

Sensory integration

Sensory integration is a popular method of intervention commonly used by occupational therapists. A survey of 500 UK paediatric occupational therapists in 2004 found that 61% of them

stated they used sensory integration as an intervention technique.[241] Occupational therapists using sensory integration therapy often use the term developmental dyspraxia, which is viewed by some as synonymous with DCD or by others as representative of a sub-group of DCD.[242]

Sensory integration therapy is based on the original work by A. Jean Ayers started in the 1960s.[243],[244] Ayers hypothesised that dyspraxia is not simply a difficulty with the execution of motor coordination but is reflective of inefficiencies in the central nervous system's ability to process sensory information. Ayers defined developmental dyspraxia as a motor planning problem.[245] She did not consider praxis and motor function as the same thing and thought intervention should focus on ideation, concept formation and planning rather than motor execution. Sensory integration therapy is based on the theoretical assumption that there is a relationship between neural functioning, sensorimotor behaviour and early academic learning.[246] Intervention aims to help children to make adaptive responses to their environment through providing proprioceptive, tactile/kinaesthetic and vestibular stimulation. This is achieved by providing a clinic based, therapy environment that provides the opportunity for the child to experience increased intensity of selected sensory experiences. From within this environment the child selects activities designed to provide tactile, vestibular or proprioceptive input that will lead to an adaptive motor response from the child. Intervention is aimed at the proposed underlying sensory deficit rather than at a specific behaviour or skill. It is hypothesised that some children are over or under responsive to sensory input, which results in avoidance or seeking of sensory stimulation. This over or under responsiveness is called sensory modulation. It is believed that sensory modulation difficulties need to be treated before or concurrently with the motor planning problems. Kimball treats the motor planning problems through working on the "functional support capabilities" a phrase coined by himself.[247] Functional support capabilities include suck-swallow-breath synchrony, sensory discrimination, co-contraction, muscle tone, proprioception, balance and equilibrium, lateralisation and bilateral integration. The early empirical evidence was promising[248] but later studies with more robust methodologies question its efficacy.

Several studies have compared sensory integration therapy with other approaches. Densem and colleagues in 1989 compared sensory integration therapy to a physical education programme and a no intervention group. There were no differences found between the groups on measures of language, perceptual motor function, reading or handwriting.[249] In 1992 Humphries and colleagues compared the effects of sensory integration therapy, perceptual-motor training and no treatment. He found that the subjects receiving sensory integration showed an advantage in motor planning.[250] However, they showed no group differences in visual perception, handwriting readiness, copying ability, cognitive, academic, language and attention skills or in self-concept.

Wilson and Kaplan's study compared sensory integration therapy with tutoring. They showed improvements in gross motor function after sensory integration therapy when compared to tutoring. There was no difference between the children receiving sensory integration or tutoring on measures of reading skills, fine motor skills, visual motor skills or behavioural factors[251]. Vargas and Camilli conducted a meta-analysis of sensory integration therapy in 1998[252]. They found that the early studies showing positive effects of sensory integration treatment compared to no treatment were not supported by more recent studies. Further, when comparing sensory integration therapy with other approaches larger effect sizes were found in psycho-educational and motor categories than in sensory integration therapy. Sensory integration therapy was found to be as effective as various alternative methods. The findings that intervention directed at diverse domains such as sensory integration or tutoring can have similar effects suggest that it is not what we do but the fact that we do anything at all that has an effect. Pless and Carlsson[253] conducted a meta-analysis of studies using the sensory integration approach. Meta analyses uses statistics to look at the size of the effect of an intervention. The effect size is calculated by subtracting the mean score of the outcome group(Xe) from the mean score of the experimental group(Xc) and dividing this by the standard deviation of the control group(SDc) i.e.

$$\text{Mean effect size (MES)} = (Xe - Xc) / SDc$$

Therefore the larger the number the greater the treatment effect. Pless and Carlsson's[204] meta-analysis of four studies using the sensory integration approach found a mean main effect (MES) size of 0.21. This does not support use of this approach as mean effect sizes for other interventions are significantly better i.e. specific skill MES = 1.46 and general ability (neuro-developmental and perceptual motor approaches) MES = 0.71. Pless and Carlsson concluded that therapists should dispel the notion that sensory integration improves motor, academic, language or cognitive performance.[239]

Three reviews of intervention for children with DCD, conducted in this century draw similar conclusions. The review in 2001 by Mandich[95] and colleagues concluded that sensory integration is difficult to justify from an evidence based and economic perspective as it is "at best" as effective as any other intervention and is the most expensive. Wilson conducted an evaluative review of approaches to assessment and treatment of children with DCD and concluded that the sensory integration treatment approach does not have empirical support "nor is it consistent with current models of motor control" and he questions whether it should be given the "last rites?".[261] Polatajko and Cantin also conducted a review of intervention approaches for DCD and divided the approaches into the traditional, deficit orientated and task orientated.[227] Polatajko and Cantin suggested that a shift from deficit-orientated approaches to task orientated approaches was appropriate whilst acknowledging more research on the task-orientated approaches is required.[227]

The theoretical basis of sensory integration therapy is not supported by our current knowledge of motor development, learning and control. It is loosely based on an information processing approach with emphasis on the sensory input rather than the motor output. The empirical evidence on the efficacy of sensory integration shows that at best it is no worse than any other methods. However, given that it is the most costly type of intervention, as it has to be delivered individually and over months or even years with specialist equipment, it is difficult to justify its use over and above other approaches.

Perceptual-motor approach

Perceptual motor intervention, sometimes called the general abilities approach, focuses on remediating the perceptual (vision, touch, proprioception) and motor skills (balance, coordination, agility) of children. The rationale is that targeting the presumed underlying foundation skills that contribute to, or caused, the motor deficit will "fix" the root of the problem. It looks similar to sensory integration but focuses more on doing specific motor tasks and can be delivered to groups as well as individuals, making it possible to be a classroom based intervention. A survey of 500 UK occupational therapists found that 75% of them stated they used perceptual motor training as a treatment technique. A meta-analysis of 180 studies examining the effectiveness of perceptual motor treatment by Kavale and Mattson showed that perceptual motor treatment was not effective in remediating children's motor deficits.[254]

Kinaesthetic training

A small, but well designed, clinical trial compared process orientated treatment (Lazlo's kinaesthetic training), with "typical sensorimotor programmes" and no treatment. It concluded that there was no convincing benefit to those receiving either treatment regime.[255] Laszlo and Bairstow[256,257,258] have reported that process orientated training improves motor performance. When others tried to compare the process orientated approach to standard occupational therapy and no treatment they could not demonstrate a clear advantage to being in any of the groups except that the children who received the process orientated approach did significantly better on the ramp test of the Kinaesthetic Sensitivity Test. Mandich and colleagues conclude that there is not conclusive evidence to support the use of process orientated treatment over other treatments and some studies suggest it is not even superior to no treatment.[3]

Neuro-developmental treatment (Bobath)

Neuro-developmental treatment was introduced by Dr.s Karel and Berta Bobath in the 1940s for children with cerebral palsy.[259] The underlying concept is that normal movement requires normal postural reactions and inhibition of primitive reflexes. Whilst it would be very unusual to find an occupational therapist using a "pure" Bobath approach with children with DCD many would claim to combine it with other approaches when treating children with DCD. Seventy-four percent of occupational therapists said they used Bobath as a treatment technique but this did not relate just to children with DCD. Neuro-developmental treatment is not supported by the literature as a treatment approach for children with DCD.

Reviewing the literature on bottom up approaches does not support these approaches for children with DCD although surveys of occupational therapy practice and anecdotal evidence show that these approaches are still commonly used and are believed to be efficacious. This demonstrates a need for improved communication between researchers and clinicians. Researchers need to consider how changes in practice can be facilitated through dialogue with clinicians. The DCD Research UK conferences in Oxford in 2004 and 2006 have been organised with this objective in mind. However a trawl of recent job adverts, by the author, for paediatric occupational therapists in the British Journal of Occupational Therapists and on the NHS jobs website show that knowledge of sensory integration techniques is still seen as necessary whilst knowledge of task orientated approaches is much less commonly cited as a desired or essential.

Top down approaches

Top down approaches are those that consider the actual functional skills that are deficient as the starting point for assessment and intervention. The occupational roles and performance that are problematic are considered and the barriers to achievement identified. Where necessary the functional tasks are further broken down into their component skills or skill patterns. Goals for intervention may be set at this level or where required at skill foundation level. For example the child who wants to learn to skip with a rope may first need to learn to jump with both feet off the floor together, without a rope, as an identified prerequisite goal.

Task specific approach

In this approach the aim is for the child to learn a focal task efficiently while also learning underlying movement principles (implicit learning) that may transfer to other related tasks.[260] This

approach acknowledges the unique set of movement skills required for a particular task. The child is given the opportunity to practice the task and the clinician uses skills of task analysis, modification and adaptation to enable the child to achieve the task. Peters and Wright[261] conducted a study with 14 children with DCD where they attended classes once a week for 10 weeks with activities such as running, jumping, circuits and gym apparatus. The results showed significant improvements in motor scores and lung function (forced vital capacity) following a community based specific group exercise programme but no changes in the children's perceived competence. Revie and Larkin[262] demonstrated significant improvements in performance for three out of four motor tasks with a targeted motor programme. They felt task specific intervention was a practical option for dealing with the range of difficulties amongst children with poor coordination. They also felt that this approach had the additional advantage of dealing with issues that are of cultural relevance and importance to the individual child. However, the gains the children made did not transfer to other tasks. Pless and Carlsson's[263] meta-analysis of motor skill intervention using the specific skills approach found it to be beneficial to children with DCD if conducted 3 to 5 times a week in a group or home setting. In comparison the non-specific motor skills group was only of benefit to the children with borderline (5^{th} to 15^{th} percentile) Movement ABC[41] scores and not the children with definite motor problems i.e. those scoring below the 5^{th} percentile. This finding is not that surprising, that the milder problems can be improved with a fairly general, broad brush, motor programme but that children with more severe difficulties require more specific, targeted input. The specific skill approach was found to have a mean main effect size (MES) of 1.46 which was higher than for sensory integration therapy (MES 0.21) or the general abilities approach (MES 0.71). Pless and Carlsson concluded that children with definite motor difficulties did not change their motor status between 5 –7 years of age and seem to need "active support in joyful motor learning situations to reduce unwillingness and displeasure"[239].

Cognitive approaches

As motor learning and motor control theories have developed the rationale for more cognitive approaches to movement difficulties have been proposed. Sugden and Henderson proposed the cognitive motor approach in the first Movement ABC[41] manual. The emphasis is on the child performing functional tasks in everyday life settings. Movement competence is viewed as a problem solving exercise involving action planning, execution and evaluation. The focus is on the interaction of cognitive, affective and motor competencies and is derived from motor learning and motor development literature. This approach is being endorsed and expanded in the Movement ABC-2 revision. Wright and Sugden[264] demonstrated a significant benefit in improving functional

skills when using the three step problem-solving approach. Sugden and Chambers[265] used the Movement ABC[41] Test and Checklist results to devise individualised intervention programmes using the cognitive-motor approach to intervention. Teachers and parents carried out the intervention programme. Results showed that teachers and parents were able to carry out effective intervention for the majority of children using this approach.

Cognitive orientation to occupational performance (CO-OP) is a new approach to intervention being developed in Canada.[253] It is an individualised, client centred approach focused on strategy based skill acquisition.[266] The approach has four objectives; skill acquisition, which is the primary aim, cognitive strategy use, generalisation and transfer. The authors differentiate between the latter two by defining generalisation as the use of the skill at other times in other setting and transfer as the use of the skill as the basis for learning other skills. A number of fundamental principles underpin the methods, which collectively provide the theoretical base for the approach, and these would appear to be very much in line with those espoused by cognitive psychology. The involvement of the client (child) through the use of client chosen goals is a first principle followed by parent involvement and guided discovery and dynamic performance analysis. A major part of the approach is the use of cognitive strategy in a 'goal-plan-do-check' format.

In a pilot randomised control trial 20 children were randomly assigned to a CO-OP treatment group or a current treatment approach group.[267] ANOVAs were used to compare the two groups across pretest and post-test scores. Results showed both groups had improved scores on the Canadian Occupational Performance Measure (COPM)[217] and Performance Quality Rating following treatment. However, the CO-OP group had significantly greater improvements than the standard or current occupational therapy intervention. These improvements were judged by self-report, blinded observer report and standardised assessment. In another study using the CO-OP approach 20 children with DCD aged 6-16 years used a CO-OP approach to improve their handwriting.[268] Significant improvements were shown on the COPM and Performance Quality Rating Score, rated by blind assessors demonstrating CO-OP as an effective approach for remediating handwriting difficulties. The early evidence suggests CO-OP is an effective approach to improving functional performance in children with DCD with greater support than traditional approaches.[238] However, CO-OP remains a new approach which has not yet been independently evaluated. There have been several training courses on CO-OP run in the UK by Angie Mandich and Sylvia Rodger, which suggest that occupational therapists in the UK are using this approach.

Neuromotor task training

Neuromotor task training has been developed in the Netherlands by paediatric physiotherapists. It is virtually unknown in the UK. This approach is based on motor control and motor learning principles and also takes motor teaching and motivational principles into account. It is an individualised approach with some general guidelines. It uses ecologically valid tasks that have meaning for the child and parents and gives them opportunities to practice these with support from a physiotherapist using task analysis, motor learning and teaching principles.[269]

Family centred functional therapy

Family-centred functional therapy (FCFT) is a comprehensive approach to paediatric occupational therapy that has been developed by the McMaster team in Canada. FCFT is based on concepts from family centred services and uses a systems approach to motor development. It addresses not just the individual capacities of the child but considers the task and environment as potential vehicles for change. It is still an emerging clinical model for children and so far has only been applied to children with cerebral palsy but has the potential to be used with children with other diagnoses such as DCD. This approach examines the specific functional task, the environment where the activity is completed, as well as the functional goals of the child and the family. There are four clinical principles that define this approach

1. Promoting functional performance
2. Identifying periods of change
3. Identifying and changing the primary constraints in the task, child and/or environment that prevent achievement of the task
4. Encouraging practice

Whilst this approach has only been used with children with cerebral palsy to date the framework can equally well be applied to children with DCD and is very similar to the approach taken in this thesis. It is based on current knowledge of motor learning and utilises a functional approach.

Combined approaches

Therapists often claim to use combined approaches rather than following one specific theoretical approach.[270] Whilst combining a number of approaches is a very practical and logical decision in

clinical practice it is extremely difficult to conduct research on combined approaches, as they tend to be so variable. It is the very variability of combining which allows the therapist to respond to children's individual needs. The therapist has a tool kit of skills from a variety of knowledge bases and selects pieces from each one that seem appropriate for the individual child. Whilst this approach can seem eminently practical in clinical settings it makes for very messy data from a research perspective and there is no literature based on this approach in occupational therapy. However the possibility of manualising combined approaches has been explored in other therapies such as speech and language therapy.[271] This type of approach may be more appropriate for evaluating complex interventions such as occupational therapy and requires further investigation.

Summary and key points

Occupational therapy aims to enable children to participate in activities of daily living. Historically, occupation was seen as promoting health and well-being through the simple act of being engaged in activity. The profession became more medicalised over the course of the 20th century and activity was seen as a means of achieving specific biomedical outcomes. Occupational therapy came to be about improving specific skills through the medium of activity, for example pricking out seedlings became a fine motor task rather than related to growing plants, sawing wood became about improving strength rather than cutting wood and making something. By adopting a medical model occupational therapists lost the sense of the value of occupation in exchange for the acquisition of specific skills.

However approaches to health care are changing and traditional, "bottom up", approaches do not have a strong evidence base, including as a method of remediating motor deficits in children with DCD. In the last three decades there has been a call from within the occupational therapy profession to move away from a medical neuro-maturational theoretical (bottom up) approach towards an occupation based approach (top down) within a family-centred framework.[272] This philosophical shift is not confined to occupational therapists; the World Health Organisation published the International Classification of Functioning in 2001 that proposed a social model of disability, which focuses on activity and participation and views impairment from the unique perspective of each individual. There are a number of professional models of practice for OTs to choose from and this thesis is based on the Canadian Model of Occupational Performance and person-environment-occupation models. These models have been used as a framework to consider the relevant aspects for children aged 5-11 years, with reference to the ICF. The term activities of daily living has not yet been adequately defined and described for children but can include self-care, schoolwork, play and leisure activities. Specific activities to be included under each of these

headings are presented. The person-environment-occupation model is expanded to include the activities of daily living within the occupations and a taxonomy for the terms person and environment is described. Recent research has shown that a task specific, functional approach is an effective method of intervention. Traditional methods with focus on promoting motor skills are called into question as there is no evidence for transfer or generalisation of motor skills acquired in therapy to functional tasks or that these methods are very successful in improving motor skills. Many studies call for larger trials incorporating long-term follow up and using outcome measures that provide a more holistic assessment of the effects of the intervention on children.[273] I draw three main conclusions from the literature review on treatment of DCD which all point to a common future direction for occupational therapy. Firstly, occupational therapy needs to reclaim occupation as its focus. In order to do this with children with DCD it is necessary to assess the impact of DCD on daily occupations or activities of daily living. Secondly, treating the impairment (i.e. motor skills deficit) rather than the effects of the impairment, does not yield impressive results, therefore other methods need to be explored. Thirdly, our current understanding of motor learning and control suggest a whole task approach to learning new skills. This treatment approach needs to be evaluated.

Key points

- Occupational therapy has it's historical and philosophical roots in the belief in the therapeutic value of activities of daily living
- ICF supports the focus of intervention on activities and participation with reference to the individual's context in terms of environment and personal factors
- The person-environment-occupation model provides an appropriate occupational framework for incorporating the first two bullet points
- Activities of daily living include self-care, productivity, play and leisure
- The literature supports a functional, task orientated, child and family centred approach to intervention due to the larger mean effect sizes found when compared to sensory integration and general abilities approaches[261, 262, 266, 267]

Aims and objectives

In the light of reviewing the evidence in the previous three chapters and from the clinical evidence that I have encountered in my work, I have identified the following aims and objectives, which are repeated from Chapter One.

The overall aim of this thesis is to identify methods of improving the efficiency and effectiveness of occupational therapy services to children with DCD and their families.

In order to achieve this aim the following objectives are set:

Study 1

1. To identify and describe a method of applying the DSM-IV diagnostic criteria for DCD in a clinical setting.

Study 2

2. To assess the similarities and differences between parent, teacher and child views of the impact of DCD on activities of daily living.

Study 3

3. To develop an intervention method which reflects child and parent/carer identified goals.
4. To conduct a pilot trial to explore how to measure the effectiveness of group occupational therapy intervention for children with DCD using a goal/task-orientated approach.
5. To explore richness of information using individual development and progressions.

Studies 1-3

6. To propose models for service delivery by combining the results of studies 1-3, current practice and the literature.

CHAPTER 5: Study 1: Identifying DCD in a clinical setting

Rationale

The first study examines the first aim of this thesis, namely to describe a method as to how DSM-IV[8] criteria can be used to identify and diagnose DCD in a clinical setting. At the time of this study the use of the term developmental coordination disorder was not universal in everyday clinical practice in the UK and methods of applying the criteria not established even though Geuze has suggested that the term was appearing in the literature from 1992.[30] Even once DCD had been accepted as the diagnostic label, applying the diagnostic criteria is not straightforward. Since this study was conducted the Leeds Consensus Statement has been published which offers more guidance on the interpretation of the DSM-IV criteria and their application in everyday clinical and research practice.[10] This study had a small part to play in contributing to the Leeds Consensus Statement[10] and this is acknowledged in the consensus statement. As noted previously there are four diagnostic criteria in the DSM-IV, which states that children with developmental coordination disorder have significant difficulties with motor coordination, which interferes with academic achievement and/or activities of daily living and is not due to a medical condition or mental retardation.

In this study I set about applying each of the diagnostic criteria for each child referred for coordination difficulties. This required a range of clinical decisions to be made about each criterion. The choices and decisions made for each one are detailed in the methods section. Information on additional educational and medical diagnoses was also ascertained given the known, high level of co-occurring conditions. The diagnostic criteria are difficult to operationalise in clinical practice, as cut-off points had not been established at the time of the study and the criteria are open to interpretation. Following this study the Leeds Consensus Statement endorsed the use of the 5th percentile as a diagnostic cut off point and gave guidance on the interpretation of the criteria.[10] The terms used, such as academic achievement and activities of daily living, are not defined in DSM-IV nor are they well defined elsewhere. The Leeds Consensus Statement suggests that establishing a direct link between academic achievement and motor skills is complex but that handwriting should always be considered. It also states that

> "Assessment should reflect culturally relevant developmental norms relating to activities of daily living tasks and should include consideration of self-care, play, leisure and schoolwork (including handwriting, PE and tool use) and the views of the child, parents, teachers and relevant others." (Page 7)

It is well accepted that DCD commonly co-occurs with attention deficit/hyperactivity disorder, speech and language impairments and dyslexia. Many authors have recommended the need for children with DCD to have a multi-level assessment.[274,275,276,277] Wilson suggests that the levels of assessment should represent motor development at different functional levels - behavioural, neuro-cognitive and emotional.[261] He suggests applying all three levels is particularly important where the child has serious limitations in motor functioning. For others, assessing functional skills at a behavioural level and using a task specific approach to intervention may suffice. In clinical settings most clinicians will only have access to tools that allow assessment at the behavioural level. It has also been suggested that assessment of fitness levels should also be addressed[278] although this would not contribute to the diagnostic process, changes in fitness could reflect effective treatment outcomes. The author acknowledges the importance of fitness in children with DCD but exploration of this does not form part of this thesis. Since the diagnosis is more difficult in children under five years, partly due to the impact on academic achievement being difficult to judge, I studied children aged five to ten years old. There is a legal requirement in the UK for children to start school at five years that means this is the earliest point at which this judgement could be made about a child's academic progress. The Leeds Consensus Statement does not recommend diagnosis of DCD under five years of age.[10] Most children with DCD are referred in their early primary school years.[279] Having a cut off at ten years meant I did not need to consider issues relating to secondary school. This would make the application of criterion B even more complex as the range of activities of daily living broadens and changes with entry to secondary school and the onset of adolescence.

The aims of this study are firstly to identify a group of children with DCD through a consideration of the DSM-IV criteria and secondly to apply them in a clinical setting.

Methods

The initial sample consisted of 67 children aged 5-10 years who had been referred because of concerns about coordination difficulties to an occupational therapy team in Gwent, Wales. This covered a period of six months between June 2001 and February 2002. Referrals were accepted from health and education professionals via a letter or child development team referral form, but not directly from parents. All referrals would then receive parent and teacher questionnaires both of which had to be returned and demonstrate functional difficulties for the referral to be accepted. These referral guidelines were strictly adhered to. Referrals to this study included all children who did not have a clearly identified new or emerging neuro-developmental diagnosis at the time of

referral. The waiting time from referral to assessment was 70-80 weeks. Referrals were received from school health nurses and health visitors (21), paediatricians (19), educational psychologists and teachers (15), general practitioners and orthopaedic surgeons (6) and other therapists (6). During the initial screen, children were seen by a paediatrician to eliminate any other medical causes for their motor difficulties: children with obvious diagnoses other than DCD were excluded (n=9) as outlined by criterion C of the diagnostic criteria for DCD. In order to apply criterion D information on the child's general level of cognitive ability was sought. Where possible this was done by using psychometric data that was available such as the Wecshler Intelligence Scale for Children (WISC) and British Ability Scales (BAS). Those children found to have verbal IQ (WISC), or general cognitive ability level (BAS) within one standard deviation from the norm (standard score of 85) were included (The Leeds Consensus Statement recommends going to 70 IQ but this statement was not available at the time of the study and other work suggested that 85 would be an appropriate cut off.[24] (This point is discussed as a limitation in the final chapter). Verbal IQ was used as it was assumed that the coordination difficulties would have an impact on performance IQ that in turn would reduce the full-scale IQ score. Where children's intelligence had not been measured the teacher's opinion of the child's general academic/cognitive potential was accepted. This was requested on the teacher questionnaire (Appendix 1). Ethical approval was received from the local research ethics committee and anonymity and confidentiality was assured. Each criterion was examined and a method of clinical application proposed.

Criterion A - "...motor coordination significantly below that expected..."

Criterion A requires the clinician to establish if the child's "performance in daily activities that require motor coordination is substantially below that expected given the person's chronological age and measured intelligence." In order to do this first an assessment of motor coordination needs to be selected and secondly a cut off point needs to be established. Coordination is usually inferred from assessing motor skill performance. It may be that motor ability is a more accurate description of what is actually being assessed (see previous chapter for a fuller discussion) with quantitative motor tests. A review of 164 publications reporting investigations of developmental motor problems found that the three most commonly used quantitative motor tests were the Movement Assessment Battery for Children (MABC)[41], the Bruininks-Oseretsky Test, and McCarron's test. The most frequently used was the MABC.[221] Other methods of selection include neuro-developmental examination, examination by a physiotherapist and teacher selection via a checklist. The DSM-IV does not quantify the cut off point for "substantially below that expected" or give guidance on how to relate this to the child's measured intelligence. The cut-off for

selection in other studies ranges from the fifth to twentieth percentile.[221] In this study both the 5th and fifteenth percentile were considered. The Leeds Consensus Statement has subsequently recommended the fifth percentile as the cut off level.

In order to select the most suitable motor test the psychometric properties of the two commonly used quantitative assessment methods for the application of criterion "A" are considered. Both these assessments were available to the author. However, the McCarron's test was not available and therefore was not considered.

Movement Assessment Battery for Children

The Movement Assessment Battery for Children[280] (MABC) is a standardised test of motor coordination for children aged 4-12 years. The norm-referenced data is based on 1,234 United States children and is considered to be satisfactorily representative of children in the United States in terms of gender, region and ethnic origin. The reliability was tested using percentage of agreement of the eight task scores and total impairment scores on 92 children in the first 3 age bands over a two-week period. The scores were classified as falling above or below the 15th percentile and the percentage of children scoring the same on both tests two weeks apart was calculated. For age band 1 (4-6 years) the percentage of agreement ranged from 77-100%, for age band 2 (7-8 years) 62-97% and for age band 3 67-93%. For total impairment scores the percentage agreement was 97% for 5 year olds, 91% for 7 year olds and 73% for 9 year olds. Sixty children in each age band were tested by three experienced testers then retested a month later. Thirty children were retested by the same tester as their first assessment and 30 by a different tester. There was variability from item to item with some being more difficult to judge with the minimum value agreement 75% and maximum 98% with the total scores being similar. The overall reliability for the MABC is therefore considered to be good with test re-test reliability at any age minimum value 0.75 and inter tester minimum value 0.70. Comparing scores with other motor tests and informed professional judgement has tested the validity of the MABC and these studies found acceptable results. However, percentage agreement does not indicate the relationship between error and true scores as scores on the 14th and 16th percentile would be said not to "agree" via this method but scores on the 16th and 98th percentile would fall the same side of the 15th percentile and therefore be in "agreement" using this method. There has been no correction made for chance agreement of scores such as Kappa. It is not known how many children with movement problems were expected in the sample and therefore whether the scores were clustered around and below the 15th percentile or represented a normal population distribution.[223] The validity of the MABC has been tested by comparing scores with the

Bruininks-Oseretsky Test and found a correlation of -0.53 which is statistically significant but low. However, using the Bruininks-Oseretsky as a criterion test is questionable given the criticisms of the Bruininks-Oseretsky cited below. Validity of the Test of Motor Impairment, the MABC's precursor has also been studied by comparing the test results with the views of other professionals such as teachers, therapist and paediatricians and found evidence that the Test of Motor Impairment measured motor impairment in a way that is meaningful to those professionals. Whilst the Test of Motor Impairment is not exactly the same as the MABC it is very similar and these studies therefore provide some support for the validity of the MABC. Burton and Miller state that the reliability and validity of the MABC require further study but acknowledge that it might be useful for screening, planning intervention and clinical exploration[281]. However, it has been suggested that it is a difficult test for children with attention problems[282] and it is known that 41% of children with DCD also have attention deficit/hyperactivity disorder.[283] One of the MABC's strengths is that the test items do relate to everyday tasks. It is also quick and easy to administer once the assessor is familiar with the test material and an experienced assessor is usually able to distinguish between attention and motor deficits using the MABC.

Bruininks-Oseretsky Test of Motor Proficiency

The Bruininks-Oseretsky Test[284] (BOT) is a standardised test of fine and gross motor development for children aged 4-14 years. The normative data is based on a stratified sample of 765 people based on the 1970 US census. The test-retest reliability was examined by testing 126 children within 7-12 days. The coefficients for the sub scores ranged from 0.29-0.89 and for the composite scores from 0.68-0.89. The sub-test scores cannot be considered reliable. Burton and Miller[223] state that test-retest reliability can also be determined from the standard error of measurement. Given the means and standard deviations the standard errors of measurement are at 2.5 for sub-test scores and 5.0 for composite scores; therefore if confidence intervals are quoted the possible range of a given score is extremely wide and could range from impaired to above average. Such large confidence intervals present a major problem for determining the true score. Content validity was examined by comparing the eight sub-tests by comparing them with six cited works that were not directly concerned with motor development and were therefore not a valid measure of validity. Factor analysis of the 46 items in the long form does not support the distinction made between fine and gross motor tasks. [86] Hattie and Edwards[285] in their review of the BOT conclude "The test has little value in providing dependable scores and any decisions based on the test are suspect." They also note that several of the items do not measure skills relevant to everyday tasks. Burton and Miller conclude that the test's popularity is unjustified.[223] Given the unreliability of the scores, poor content validity, lack of functional skills and length of time required to administer the BOT it was not selected as the test of motor ability in this study.

There is no "gold standard" test for the assessment of motor coordination in children with which to apply criterion A.[286] Geuze and colleagues state "our knowledge seems to be insufficient at present to define a set of independent motor domains that fully represents the human perceptual motor function."[30] After considering both the BOT and MABC the MABC would appear to have the least number of flaws and has been selected for the study. It is an internationally accepted test for DCD.[24] The concerns of note are the norm sample not being from the UK. The norm-referenced data is based on a sample of 1,234 United States children and it is assumed that this sample is relevant to UK children in the absence of a test with UK normative data. The reliability is good in terms of placing children in the correct category in terms of above or below the 15th or fifth percentile, which is the purpose it is being used for in this study. The validity requires further study but there is some evidence to suggest this is a valid test of motor abilities and the validity is better for the MABC than the BOT.

The cut off point used to interpret criterion A "motor coordination is substantially below that expected " is variable and ranges from the 5th to the 20th percentile.[221] It has been suggested that the fifth percentile is an appropriate and politically acceptable cut off point.[8, 287] It is recommended in the MABC manual that children scoring below the fifth percentile are considered to have a definite motor impairment and children scoring from the 6-15th percentile are considered to have a degree of difficulty that is borderline. These borderline children are still at risk and require careful consideration of their whole clinical picture and the impact the motor difficulties are having on their development. Both the fifth and 15th percentile were considered for cut off points in this study.

Criterion B - "...interferes with academic achievement or activities of daily living..."

Criterion B requires the clinician to establish whether the motor coordination difficulties are "impacting on academic achievement or activities of daily living." Neither, academic achievement, nor activities of daily are further defined in DSM-IV. Criterion B has been neglected or had scant attention paid to it in many studies.[221] It is claimed that this criterion is difficult to operationalise and may exclude younger children from receiving help because the impact of the motor difficulties may appear minimal in the younger child.[229] However, assessing the impact of impairments on activities of daily living is a core occupational therapy skill within the context of child and family-centred practice. Children with DCD are known to have difficulties with activities of daily living such as self-care, household chores, schoolwork, sports and social activities.[174]

In order to apply criterion B the specific activities of daily living that are problematic for each child need to be identified. When working with children parents are often used as proxies for their children but it is also known that adults and children do not always have the same priorities so it is important to try and ascertain the child's views. Children and young people have also clearly stated a desire to be involved in decisions regarding their health and its management.[288] It was therefore considered important to gain the views of children, parents and teachers to gain the broadest understanding of the impact of DCD on children's daily lives. This type of approach has subsequently been supported by documents such as the Leeds Consensus Statement. Establishing a link between academic achievement and motor coordination is complex and therefore it was decided to consider school based activities of daily living but not to further attempt to assess the impact of DCD on academic achievement.

Activities of daily living for children were assessed in the following three areas:

- Self-maintenance / self care tasks e.g. dressing, using cutlery, bottom wiping
- Schoolwork e.g. handwriting, PE, tool use
- Play and leisure e.g. riding a bike, making friends

These areas were assessed for each child using parent and teacher questionnaires and the Perceived Efficacy and Goal Setting System (PEGS)[289] tool for assessing children's concerns. Parents and teachers were required to complete a questionnaire for each child. Parents and teachers were asked what their main concerns were for each child and also asked to circle areas of difficulty the child had, compared to others the same age, under the headings of self care, schoolwork, play and leisure. See Appendix 1. Eliciting the children's view of their difficulties could not be done simply by asking them and another method needed to be identified. I am extremely grateful to Cheryl Missiuna and colleagues for allowing me to use the research version of the Perceived Efficacy and Goal Setting System (PEGS)[289]. The McMaster Team in Canada was developing this tool at the time of this study. This study used the research version of the PEGS. The final version was published in 2004.[289] The PEGS[289] assesses the child's reported functional abilities and difficulties. It uses pictures to help the child identify functional areas where they do not feel competent and which they would like to improve. This is based on *All About Me* (Missiuna, 1998).[290] It comprises of a set of 24 pairs of cards depicting children performing routine daily tasks. It has a forced choice format where the child is asked to chose which child they are like e.g. the child who thinks he is good at sports or the one who thinks he is not good at sports. The child selects the picture of more/less competent child performing a task. Then, they indicate whether they are "a lot" or "a little" like that child. The cards where they have

identified themselves like the less competent child are then laid out for the child. The therapist says something like "These are the things you told me you found difficult, which are the ones you would like to work on and get better at?" In this way the child chooses their goals for therapy and identifies their areas of most concern. Should the child identify a goal, which falls outside the occupational therapy remit then this is explained to the child, and a referral made to the appropriate agency. Where appropriate the child was asked to demonstrate the area of difficulty: changing into their PE kit to show dressing skills, cutting up play doh with a knife and fork to show use of cutlery.

The psychometric properties of the final PEGS[289] version have been studied with tests of reliability and validity. Reliability was assessed by considering internal consistency, test-retest and goal stability over time. The internal consistency of PEGS is based on the PEGS predecessor *All About Me*. Cronbach's alpha reliability coefficients were calculated for each sub-scale (fine and gross motor) as well as the whole test (n=48). The alpha coefficients for both scales were 0.85 and the coefficient for the total measure was 0.91. The test-retest reliability was 0.77 for the total score (n=24). Investigation of goal stability over time showed that 2 weeks later 32% of children selected the same top four goals, 37% selected three of the four same goals and 23% selected two of four same goals. Therefore 92% of children selected between two and four of the same goals (n=117). Internal consistency of *All About Me*[232] the PEGS predecessor, reported the coefficient for the total measure was 0.91.

Validity was assessed through ascertaining the views of occupational therapists about the PEGS, comparing the PEGS with other tests and comparing PEGS results for typically developing children and those with a range of developmental conditions including DCD. Twenty-five occupational therapists in the standardisation study confirmed that the PEGS[289] were relevant for children due to receive occupational therapy intervention. The correlation between *All About Me* & Pictorial Scale of Perceived Competence & Social Acceptance for Young Children[322] was good r = 0.8. The correlation between the Developmental Test of Visual Motor Integration and the PEGS was moderate r = 0.64. The correlation between the Bruininks and PEGS gave r = 0.73. The correlation between the School Function Assessment[291] and the PEGS was low (r = -0.12 to 0.33) however there were significant relationships between teacher and caregiver reports of participation and task supports on the School Function Assessment and PEGS.[292] Although these two tests both relate to participation in daily activities the difference is that the PEGS measures the child's perception of competency whilst the School Function Assessment is based on teacher report and this is assumed to explain the difference between the tests. Children with disabilities (AD/HD, DCD, motor delays, developmental delay, physical disability, psychiatric) tended to rate

themselves as more competent than did caregivers & teachers. Typically developing Australian children perceived themselves as competent on all motor tasks, with the exception of cutting food (n=53). In the event that neither the child, teacher or parent could identify any age appropriate activities of daily living that the child was unable to perform then criterion B would not be met. The application of criterion B is considered in more detail in Chapter 6.

Criterion C - "...not due to a medical condition..."

Criterion C states "the disturbance is not due to a general medical condition". All the children were seen by a paediatrician to exclude a medical condition other than DCD to explain the co-ordination difficulties. This was usually the school doctor, specialist registrar or consultant paediatrician. It was not possible for me to influence the nature of the examination. Ideally, screening for known co-occurring or associated medical conditions would be made at this point but again this was beyond my influence. Provided the child was examined by a paediatrician, who found no neurological or other disorder to account for the motor coordination difficulties, then criterion C was considered to have been met. Some children had already been examined by a paediatrician prior to referral. Those who met all the other criteria but had not seen a paediatrician were referred to for examination. Medical conditions such as cerebral palsy, muscular dystrophy and autistic spectrum (pervasive developmental disorders) would exclude children from a diagnosis of DCD. Children meeting criteria for Pervasive Developmental Disorders, i.e. those on the autistic spectrum, cannot be given a diagnosis of DCD but many of them may present with coordination difficulties. In this study children with autistic spectrum disorders were excluded in line with DSM-IV criteria. However since this study was conducted the Leeds Consensus Statement has been published which recommends a dual diagnosis is given where appropriate. Conditions such as attention deficit/hyperactivity disorder, specific learning difficulties e.g. dyslexia and speech and language difficulties would not exclude a diagnosis of DCD as these are accepted as overlapping conditions with DCD and therefore children with these diagnoses were included.

Criterion D - "...if mental retardation is present, the motor difficulties are in excess of those usually associated with it..."

The intelligence level of the children in the study was established, where possible, by using psychometric data that was available such as, Wechsler Intelligence Scale for Children (WISC) and British Ability Scales (BAS). Those children found to have verbal IQ (WISC), or general cognitive ability level (BAS) within one standard deviation from the norm (standard score of 85)

were assessed to establish if their motor skills were comparable with their developmental level. Verbal IQ was used as it was assumed that the coordination difficulties would have an impact on performance IQ that in turn would reduce the full-scale IQ score. Where IQs were available these were used but it was not possible to obtain these on all children and not possible to test children with any form of IQ equivalent such as the British Picture Vocabulary Scale due to local circumstances. Because of this there is a reliance on teacher reports and although this is not ideal this approach has been used in many other studies of DCD.[264] The teacher's report of the child's general academic/cognitive potential, via the questionnaire, was accepted when they considered the child to be within the average range of IQ. It is recognised that for a small number of children this meant strict criteria to Criterion D could not be made.

Criterion D states that if mental retardation is present a diagnosis of DCD can be given if the motor difficulties are in excess of those usually expected. Mental retardation is defined in DSM-IV as in IQ score below 70. (In the UK the term learning difficulties is used rather than mental retardation.) However, the relationship between motor and learning abilities has not been established.[229] Some previous studies have used the verbal IQ score as a cut off for inclusion/exclusion purposes.[221] This is because the motor coordination difficulties are presumed to impact on the performance IQ score. It would therefore seem reasonable to rely exclusively on verbal IQ. In this study children with verbal IQs of 85 or above, i.e. one standard deviation from the norm, are included to ensure that the child's cognitive ability is well within the average range and cognitive deficits cannot be contributing to their difficulties. Since DSM-IV says that if mental retardation is present the motor difficulties have to be in excess of those expected I first used the MABC to establish the age equivalent score for the child's motor coordination, which sometimes involved using the tests below their chronological age. I started by using the MABC test for the child's chronological age but if they did not "pass" at this level I used the tests for the age level below their chronological age until they "passed" at an age band, which I then described as their age equivalent motor score. The child's motor skills age equivalent is therefore determined by administering MABCs at *AND* below the child's chronological age to establish their motor skills age. This age equivalent motor score was then compared to their age equivalent for their cognitive level and a clinical judgement made about whether their motor skills were "in line" with their cognitive level. In addition the discrepancy between motor skills and learning was established by considering all children's available attainment and other test scores and profiling them by age. In practice this is often extremely difficult to do as the profiles often have a wide and variable range and more clarity is required about applying this diagnostic criterion. However in this study a clinical judgement was made, using all the information described, as to whether their motor skills were "in line" with their other areas of development or not.

Sixty-seven children aged 5-10 years with a non-urgent referral were assessed for coordination difficulties. Non-urgent referrals included all children aged above five years without a new or emerging neuro-developmental diagnosis. Children with obvious diagnoses, other than DCD, were excluded from the study. Each of the four diagnostic criteria was applied as described above. A description of the 35 children who participated in this study are outlined in Table 5:1

Gender	Age	Totals
Male	Mean (SD) 8 years 0 months (1 year 8 months) Range = 5 years 5 months - 10 years 9 months	29
Female	Mean (SD) 7 years 6 months (1 year 8 months) Range = 5 years 8 months –10 years 6 months	6
Total sample	Mean (SD) 7 years 11 months (1 year 8 months) Range = 5 years 5 months – 10 years 9 months	35

Table 5:1 Description of sample

A Townsend deprivation score based on four variables of deprivation, with positive scores indicating greatest need, represents the socio-economic status of each family. I also examined which professionals were referring the children to occupational therapy, and for what reason, to better understand the care pathway from a multi-agency viewpoint. Given the low numbers of children who actually qualified for the diagnosis the profession of the referrer and their "success" rate in identifying children with DCD was also examined. As it became obvious that so few children were meeting the diagnostic criteria, children who were having their occupational therapy needs reviewed during the study period were also considered for inclusion in the study and a further nine children were recruited into the study.

Results

During the six months study period 89 children, aged 5-10 years, who were referred for coordination difficulties were identified. Thirteen children were excluded prior to assessment due to other identified diagnoses that would prevent them from receiving a DCD diagnosis, leaving 76 children. Of the 13 excluded children nine had general learning difficulties, two had autism, one had epilepsy secondary to right sided temporal infarction and one had neurofibromatosis type I. Of these 76 children, 67 were assessed; the other nine failed to attend for assessment. If the 15th percentile on the MABC is used as the cut off for criterion A, 26 (38%) met all four of the criteria and 41 (62%) failed one of the four criteria. If the fifth percentile is used 21 (31%) met all of the

criteria and 46 (69%) failed one of the four criteria. The results for each criterion are shown in Figure 5:1 and considered in more detail below.

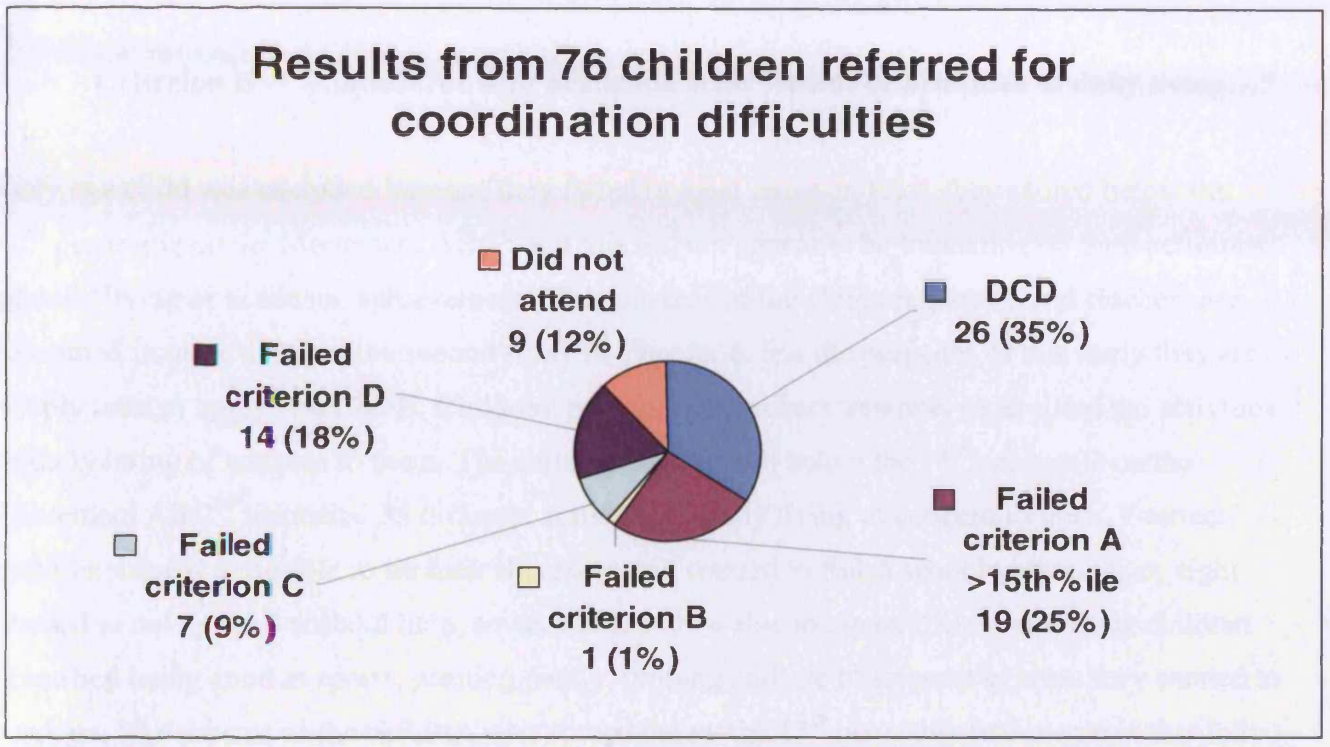


Figure 5:1

Criterion A - "...motor coordination significantly below that expected..."

The largest group of children (28%, 19 out of 67) failed to meet the criteria for diagnosis of DCD because they scored above the 15th percentile on the Movement ABC.[35] Their scores ranged from the 16th to the 98th percentile. It is of great interest to try and understand why the referrers thought these children had motor difficulties when this was not confirmed by formal assessment of their motor skills. Fifteen referrers specifically mentioned poor motor skills and four were referred due to difficulties with handwriting. The fifteen who specifically mentioned difficulties with motor skills in the referral using the words "poor coordination", "poor gross and/or fine motor skills" and "clumsy". These children were all struggling with educational progress in the absence of general learning difficulties and it seems that as the children could not *do* particular tasks the difficulty was attributed to a physical cause. Perhaps this is because there was no overt "educational" reason for their lack of progress then it was assumed to have a physical basis. In some cases there was an admission by educational staff that they just did not know what to do with the child and thought occupational therapy might help. The other four were referred for handwriting difficulties which had been incorrectly attributed to a motor difficulty but appeared to have an educational basis, either language or cognition. If the 5th percentile is used, 24 children failed to meet the criteria. Interestingly the children whose Movement ABC[41] scores were above

the 15th percentile fall close to the curve derived from the normative data and spans the full range. They do *not* cluster at the lower end of the normal distribution curve as may have been reasonably expected and one child scored on the 98th percentile.

Criterion B - "...interferes with academic achievement or activities of daily living..."

Only one child was excluded because they failed to meet criterion B i.e. they scored below the 15th percentile on the Movement ABC[41] but this did not appear to be impacting on their activities of daily living or academic achievement. The concerns of the children, parents and teachers are examined in more detail in the second study in Chapter 6. For the purposes of this study they are simply used to apply criterion B. Children, parents and teachers separately identified the activities of daily living of concern to them. The children who scored below the 15th percentile on the Movement ABC[35] identified 35 different activities of daily living of concern to them. Fourteen children wanted to be able to tie their shoelaces, ten wanted to finish schoolwork quicker, eight wanted to cut up food without help, seven wanted to be able to zip up their coat and six children identified being good at sports, printing neatly, running and use of scissors as areas they wanted to work on. The parents of the children who scored below the 15th percentile had concerns that fell into 14 categories using a simple content analysis. Twenty-two were concerned about academic/schoolwork, 19 about motor skills, 11 about concentration/attention, nine about self esteem, eight about pencil skills, five about speech and language, five because they were different to their peers, five about confidence, three each about social skills, safety and behaviour two each about forgetfulness and dressing and one about wiping after using the toilet. Thirty-four of the 35 teachers of children scoring below the 15th percentile gave consent for the information in the questionnaires to be used in the study. The teachers' concerns fell into nine categories. Twenty-three were concerned about academic progress, 17 about motor skills, 16 about pencil skills, nine about concentration/attention, six about speech and language, five about social skills, three about confidence and one each about behaviour and the need for adult support.

Criterion C - "...not due to a medical condition..."

Seven children were found to have another medical condition other than DCD that had not been reported to the occupational therapy department at the time of referral. These conditions included leg length discrepancy, hearing impairment, cerebral palsy (both mild diplegia) and autism. The 35 children included in the study were all examined by a paediatrician some prior to their occupational therapy assessment and some were referred on. Only those children whose paediatric examination found no other medical condition to account for their motor difficulties were included.

Criterion D - "...if mental retardation is present, the motor difficulties are in excess of those usually associated with it..."

Fourteen of the 67 (21%) children assessed failed to meet the DCD diagnostic criteria because their motor skills were considered to be in line with their developmental level. The methods used to establish whether the child had learning difficulties are presented in Table 5:2.

Child	MABC Percentile	Method used to establish if child has generalised learning difficulties
1	Not done	BAS: General Cognitive Ability = 81
2	Below 1st	BPVS = 84 Educational psychology service: general/moderate learning difficulty
3	13th	Dr. diagnosed developmental delay
4	Below 1st	Dr. diagnosed developmental delay
5	DNA	Dr. diagnosed developmental delay
6	8th	OT clinical decision
7	1st	OT clinical decision
8	Below 1st	OT clinical decision
9	Below 1st	WISC: VIQ = 55, PIQ = 85
10	10th	WORD: reading 76, spelling 82, reading comprehension 66. WOND: maths 80 numeracy 69
11	Below 1st	Attends special needs unit teacher says understanding limited
12	Below 1st	BAS: General Cognitive ability = 74
13		Unable to find notes
14	3rd	WISC: VIQ = 79, PIQ = 61

BAS, British Ability Scales, BPVS, British Picture Vocabulary Scales, WISC Wechsler Intelligence Scales for Children, VIQ verbal intelligence quotient, PIQ performance intelligence quotient, WORD Wechsler Objective Reading Dimensions, WOND Wechsler Objective Numerical Dimensions.

Table 5:2 Children who failed to meet criterion D

Four of the children who failed to meet Criterion D were referred by a school health nurse, four by an educational psychologist, three by a teacher and one each by a paediatrician, speech and language therapist, and health visitor. These children were referred for one or more of the following concerns: nine for motor skills (64%), four for handwriting (29%), two for function (14%), two for visual perception (14%), one for behaviour (7%) and one for organisation and planning (7%).

Children who failed to meet DCD diagnostic criteria

There were many children (n=41) who were referred for possible DCD who did not meet the DSM-IV diagnostic criteria. An additional nine children with known moderate and severe

learning difficulties (i.e. IQ below 50 and/or attending special needs unit or special school) were initially excluded from the study prior to assessment as this information had been provided with the referral. Occupational therapy referrals are screened for appropriateness by sending out parent and teacher questionnaires. The acceptance criteria are that there needs to be a clear picture of functional difficulties with activities of daily living for the referral to be accepted. Given that 73% of the children accepted and assessed were discharged following assessment I felt it was worth considering whether the concerns of the parents and teachers of the DCD and non-DCD children were different to establish whether the screening had been applied correctly.

It was decided retrospectively to look at the parent and teacher concerns for the group of children who failed to meet the DSM-IV criteria. The PEGS[289] assessment was not used with these children so the children's concerns were not known. It was possible to locate 34 of the 41 files of the non-DCD children and compared them with the 35 DCD children. It must be remembered that not all of the children were inappropriate referrals to occupational therapy because they did not qualify for a DCD diagnosis. However since the majority were assessed and discharged and not referred for further OT intervention they could be deemed inappropriate referrals. However it is possible that for these children the assessment may have contributed to part of a multi agency diagnostic assessment process, which included excluding motor deficits as a cause of the child's difficulties. The benefit of the assessment to the child and family was not examined but parents were often given advice as part of the assessment process even if they did not receive further input. Thirty (73%) of the 41 non-DCD children were discharged after assessment. Fourteen were above the 15th percentile, 12 had general learning difficulties, two had a medical condition, one had autism and one did not fit criterion B. Eleven (27%) children received some form of occupational therapy intervention, of these three had a medical condition, one had autism, two had general learning difficulties and five were above the 15th percentile. It would be useful to clinicians to know how to identify the children who do not need treatment at the point of referral and therefore I compared the concerns identified by parents and teachers of the children with and without DCD.

The parents' concerns for non-DCD children fell into 21 categories. Sixteen were concerned about motor skills. Thirteen had concerns about academic/schoolwork, 13 about pencil skills, 12 about speech and language, eight about behaviour seven about concentration/attention, seven about social skills, three each about dressing, cutlery, confidence, being different to their peers and sports, two each about scissors and eating and one each about self-esteem, frustration, safety, sequencing, pain, bowel problems and hearing.

The teacher's concerns for non-DCD children fell into seventeen categories. Motor skills (n=19), academic/schoolwork (n=19), pencil skills (n=10), speech and language (n=17), concentration/attention (n=12), social skills (n=6), behaviour (n=3), confidence (n=2), spatial awareness (n=2) and one each about dressing, cutlery, being different to peers, scissors, self-esteem, safety, need for adult support and following rules.

A comparison was made of the parent and teacher concerns of the children with and without DCD. The top three concerns for parents of DCD and non-DCD children are the same; motor skills, academic/schoolwork and pencil skills. The top three concerns for teachers of DCD and non-DCD children were also the same; motor skills, academic/school work skills and pencil skills. It is therefore not possible to identify children with DCD just from parent or teacher concerns.

Profession of referrers

Children were referred by both health and education professionals including school health nurses and health visitors (21), paediatricians (19) and educational psychologists and teachers (15). Of the major groups of referrers school nurses made the most accurate referrals with 48% meeting the criteria and 32% of paediatrician's referrals meeting the criteria. The least accurate referrals came from educational psychologists and teachers with only 20% of children referred actually having DCD. The numbers are small but General Practitioners did well with four out of five being identified correctly. The Fisher's Exact Test was used on the data to establish if there was a statistically significant difference between the different referring professionals. The chi-squared test should not be used as 40% of cells have an expected count less than 5. The resulting p value was 0.0736. This just failed to reach statistical significance. See Table 5: 3.

Referrers	**DCD**	**Not DCD**	**TOTAL**	**Success rate**
School Health Nurse and HV	10	11	21	48%
Paediatrician	6	13	19	32%
Educational Psychologists & Teachers	3	12	15	20%
General Practitioner and Orthopaedic Surgeon	5	1	6	80%
Other Therapists	3	3	6	50%

Table 5: 3 Profession of referrers

Further analysis considered which diagnostic criteria the children by profession of the referrer. This has the potential to inform the focus for future training of different professional groups should there be a certain criteria, which is consistently being referred incorrectly by a particular professional group. The results are presented in Table 5:4.

	>15th %ile	Criterion B	Medical condition	Autism	GLD	Total
School nurse or HV	6				5	**11**
Paediatrician	7	1	4		1	**13**
EP & Teachers	6		1		5	**12**
GP	1					**1**
Other therapists				1	2	**3**
Total	**20**	**1**	**5**	**1**	**13**	**40**

Table 5:4 Profession of referrers by reason not DCD

This data suggests there is a need for training in identifying motor difficulties for nurses, paediatricians and education staff and the potential use of suitable screening questionnaires will be explored. This is discussed further later on. There is also a need for training about the relationship between general learning difficulties and motor skills. The fact that paediatricians referred four children with other medical conditions was due to a lack of understanding about how Criterion C was applied in three cases and due to another diagnosis being made subsequent to the initial referral in one case.

Comparison across three centres

The data for the children who did not qualify for a DCD diagnosis was sorted by centre and examined to see if there were particular issues in certain centres. The numbers of referrals across the centres 1, 2 and 3 were 14, 46 and 16 respectively. The reasons are shown in Figure 5: 2. Whilst no clear pattern emerges the information was fed back to each centre to guide future in service training events.

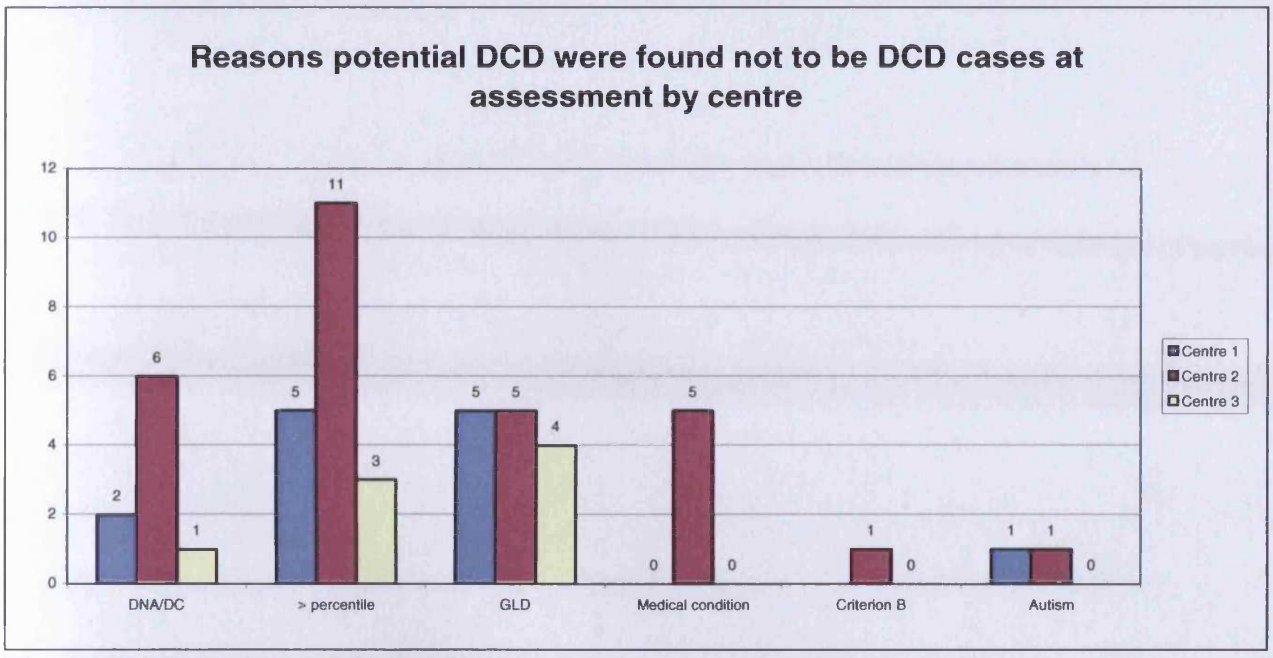


Figure 5: 2 Reason not DCD by Centre

Co-occurring conditions

Eighteen (51%) of the children had no identified co-occurring conditions. Thirteen (37%) had identified speech and language difficulties, four (11%) had specific learning difficulties and one (3%) child had AD/HD. This is well below the findings in other studies and suggests that co-occurring conditions are not being routinely considered, particularly attention deficit hyperactivity disorder, which others have shown to be present in roughly half of the cases of DCD. See Figure 5: 3.

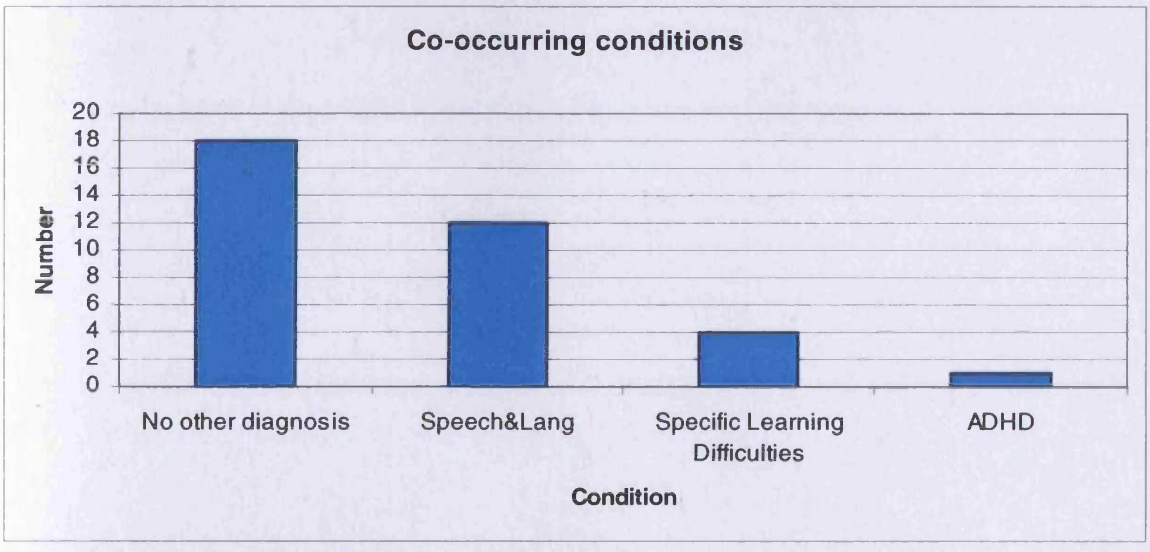


Figure 5: 3 Co-occurring conditions

Socio-economic status

The socio-economic status of each family is represented by a Townsend[293] deprivation score. The Overall Deprivation Index is based on four variables, unemployment, car ownership, home ownership and overcrowding. The postcode was used to calculate the Townsend deprivation index for each child. Positive scores indicate the greatest level of need. The scores ranged from -6 to 6 showing that the children came from a wide range of socio-economic backgrounds.

Intelligent quotients (IQ)

IQ scores were only available for nine children and only six of those had verbal, performance and combined scores. The verbal IQ scores were higher in five of these six children as one would expect because the performance components of the test require motor coordination. There is also the possibility that children with additional conditions such as dyslexia and handwriting difficulties may perform poorly in IQ tests. Since IQ tests were only available for a minority of children the ideal solution would have been to use a test such as the British Picture Vocabulary Scale (BPVS) but this was not possible due to local agreements with education colleagues. This meant that the teacher's opinion and/or SATs scores were used as a proxy for IQ with this information being gathered via the teacher questionnaire. This approach is less than ideal but is typical of clinical practice in many areas.

Visual motor integration scores

The ICD 10 states that "It is usual for motor coordination difficulties to be associated with some degree of impairment on visuo-spatial cognitive tasks" in its definition of specific developmental disorder of motor function. Twenty-nine of the 35 children were assessed using the Developmental Test of Visual Motor Integration. Six (21%) of the children had standard scores below 85 i.e. more than one standard deviation from the norm, with the remaining 23 (79%) children scoring within or above average range. This does not support the statement that DCD is usually associated with visuo-spatial difficulties.

Discussion

The large number of children referred for possible DCD creates long waiting lists for occupational therapy services across the UK and Gwent is no exception. However, less than a third of the referrals to occupational therapy actually met the DSM-IV formal, diagnostic criteria for DCD. First it must be considered whether the diagnostic criteria had been applied appropriately. The

most common reason children failed to meet the criteria was because they scored above the 15th percentile on the Movement ABC[41] (Criterion A). Given that the 15th percentile is a generous cut off; it was surprising to find that as many as 19 of the children failed to meet this criterion. Could children have motor coordination difficulties not detected by the MABC? The MABC is accepted as the most suitable test for applying criterion A but may still not represent the motor domain to its full extent.[221] Fifteen of the 19 children who scored above the 15th%ile received no treatment and were discharged. It is reasonable to assume that they would have been given intervention if they presented clinically with coordination difficulties. Examination of these children found that they presented with poor educational progress, which could often be attributed to language or attention difficulties but had, incorrectly, been attributed to coordination difficulties. Some children can appear poorly coordinated, when it is really their lack of attention that makes them trip and bump into things. Other children may appear poorly coordinated because they have not understood the instruction for the task; i.e. they have a language-based difficulty. The four children who were not discharged scored on the 29th, and two on the 32nd and one on the 79th percentiles. Three of these received treatment for functional difficulties which were not considered to have a motor basis and the other one was referred on to a paediatrician with a possible inflammatory joint condition. This analysis supports the notion that the MABC is an appropriate test for applying criterion A in as much as it concurs with clinical judgement in these cases. However I would accept that there may be occasions when clinical judgements may decide that the MABC score does not appear to be identifying motor deficits apparent in specific activities such as handwriting or gross motor sports skills. In my experience of clinical practice these children would receive treatment for their difficulties but would not be given a diagnosis of DCD.

The next largest group of children (14 out of 41, 34%) failed to meet the DCD criteria because their motor skills were in line with their developmental level (Criterion D). Children with IQs below 85 excluded in an attempt ensure that cognitive deficits are not an issue. This may suggest that referring professionals have a lack of understanding about learning difficulties and their impact across the range of developmental domains. However, this is the most difficult criterion to apply and the relationship between general developmental delay and motor development is complex. Sugden and Wann's study found that 50% of eight-year olds with moderate learning difficulties had motor problems compared to 5% in a "normal population".[294] This makes interpreting DSM-IV as to whether the child's motor difficulties "are in excess of those usually expected" difficult given that half of the children with moderate learning difficulties had motor problems and half did not. What then is it usual to expect in terms of motor skills in children with moderate learning difficulties? The publication of the Leeds Consensus Statement, subsequent to

this study, has resolved this issue by recommending that children with IQs below 70 should not be given a diagnosis of DCD.

Five children were found to have a medical condition at assessment (Criterion C) and in addition two were found to have autism. This demonstrates that referrals are not always accompanied by all the relevant information. Children with autism, or another medical condition, may benefit from occupational therapy services however the diagnosis needs to be made before a referral and the therapy needs for that condition assessed. The occupational therapists should not be establishing what is *not* wrong with the children in the first instance. In conclusion, inappropriate referrals are made because referrers do not

- Consider the DSM-IV criteria when making referrals.
- Have reliable methods for establishing when coordination skills are the primary cause of a child's difficulties.
- Have reliable methods for establishing when motor skills are in line with the child's developmental level.
- Obtain, or provide, all the other relevant information from other professionals.

In this way children are passed on to the occupational therapist without considering the whole picture of the child. It is possible that occupational therapists are perceived to be good at doing a holistic assessment but it must be questioned if this is the best use of the occupational therapy resource. Referrals on to occupational therapy are a quick solution for the referrer but create huge problems for therapy services. This analysis suggests that referrers need further training and guidance to ensure they make more appropriate referrals. This includes a knowledge and understanding of the DSM-IV criteria and their interpretation. This would reduce the number of time consuming, unnecessary assessments being done. A triage procedure, to guide referrers to consider each of the diagnostic criteria, would be a way forward. There are already two questionnaires available the DCDQ[295] and Movement ABC Checklist[296] to aid in screening for motor deficits and this represented the most children who were inappropriately referred. The very poor success rate of referrals to occupational therapy from education for this condition raise the question whether referrals to the occupational therapy service for children with possible DCD should not come directly from education professionals.

In addition it does not appear that children with DCD are being assessed for the known co-occurring conditions such as attention deficit hyperactivity disorder (AD/HD), dyslexia and speech and language disorders. Others have reported that 49% of children with DCD have AD/HD and in this sample only one child had a diagnosis of AD/HD. Kaplan and others[111] have

found that over 50% of children with DCD also have dyslexia whereas in this study only had four children diagnosed with dyslexia (19% with cut off at 5th percentile). Speech and language disorders have been shown to commonly occur in children with DCD.[118, 119] As with many other conditions it seems that dual diagnosis is not popular and once a suitable diagnostic category is found then others are not considered. It was a surprising finding that only 21% of children with DCD had Visual Motor Integration scores below one standard deviation below the mean. This calls into question the idea that DCD and visual perceptual deficits always go hand in hand. Assumptions should not be made that children with DCD have visual motor integration deficits without formal testing to support this.

There is a need for clearer guidelines on applying the DSM-IV criteria. The Leeds Consensus Statement provides some greater clarity on how to apply DSM-IV but this was not available at the time of this study. However the results of this study were used to inform some aspects of the Leeds Consensus Statement. In clinical practice criterion D is difficult to apply and the recommendations of the Leeds Consensus Statement have removed the necessity for clinicians to make the judgement as to whether motor deficits are of the level to be expected when a child has a learning difficulty. Establishing cut off scores for IQ and motor skills removes the need to apply the discrepancy notion and an IQ cut off of 70 has been suggested. This study has shown that in order to apply criterion B the views of parents, teachers and children should be gathered on which activities of daily living are difficult for each individual child. The PEGS[289] is a promising tool for helping children identify their concerns. Assessing the impact of coordination difficulties on activities of daily living requires further thought. This study identified a need to define which activities of daily living are of importance to children, parents and teachers at different ages with reference to developmental and cultural norms. It also established that children, parents and teachers have different ideas about which activities of daily living are important to them.

This study has focused on the clinician's use of the DSM-IV criteria and has, to some extent, clarified the criteria. The MABC has been demonstrated to be an appropriate tool for the application of Criterion A whilst acknowledging that it does not cover the full range of motor abilities that could be assessed. Taking a detailed look at the application of criterion B when combined with the MABC not only provides a means of making the diagnosis but also gives valuable information for planning intervention. Criterion C is in the hands of the medical profession and at present appears to comprise ruling out of neurological conditions. There is possible under diagnosing of common co-occurring conditions such as AD/HD once they have a DCD label. Alternatively children with AD/HD may not be referred for consideration of DCD. Some doctors see diagnosing AD/HD as the province of child psychiatrists whilst some paediatric consultants are willing to make this diagnosis. Criterion D presents difficulties to most clinicians

as many children present with "messy" profiles. However since publication of the Leeds Consensus Statement clinicians are guided to use an IQ cut off of 70 removing the need for criterion D. Given the wide range of activities of daily living identified by children, parents and teachers this data warrants more analysis. The clinical application of criterion B cannot be made with a simple checklist of a few activities and I need to consider how to manage the differing views of children, parents and teachers. Managing these different views is explored in Chapter 5.

Summary and key points

- Over a third of children referred for coordination difficulties fail to meet the DSM-IV criteria.
- The MABC is a suitable test for the application of criterion A.
- If the 15th percentile on the MABC is used as the cut off for criterion A, 26 (38%) met all four of the criteria and 41 (62%) failed one of the four criteria. If the fifth percentile is used 21 (31%) met all of the criteria and 46 (69%) failed one of the four criteria.
- Fourteen (21%) children failed criterion D.
- Seven (10%) failed criterion C.
- Only one child failed criterion B.

The study presented in this chapter has been published in Archives of Disease in Childhood.[297]

CHAPTER 6: Study 2: Analysis of the perceptions of the impact of DCD on activities of daily living

Rationale

This chapter addresses the second aim of the study, namely to assess the similarities and differences between parent, teacher and child views of the impact of DCD on activities of daily living. Health professionals have traditionally focused on bringing about changes in the child separate from the family with the professionals seen as experts. Parents were passive initially then this changed to parents being trained to follow treatment programmes.[158] There has been a move towards child and family centred services that are flexible and responsive to family needs, concerns and priorities. This study builds on this idea and whilst recognising the importance of parent and teacher views it also aims to hear the voices of children about activities of daily living that are important to them. Ascertaining the impact of the motor impairment on activities of daily living (ADL) in DCD is required to apply criterion B and make the diagnosis. Criterion B has not had much attention paid to it in the past[221] and the term activities of daily living is poorly defined, particularly for children.[171] In order to explore the meaning of activities of daily living it was decided to ask children, parents and teachers which self-care, schoolwork, play and leisure activities were of concern for them. This would enable the identification of specific activities relevant to children with DCD and to see whether children and adults had shared or different perspectives. It was also important to find out if there was a specific list of ADL that children with DCD had difficulties with. This was considered important as part of the diagnostic process but in addition to give a greater understanding of the everyday impact of DCD on children's lives from their point of view. Since the literature on intervention appears to be guiding us towards a task oriented approach it is important to know which tasks we need to consider and learn more about. This will enable methods of assessing and remediating these tasks to be developed.

Methods

The sample was the same children as those used in the first study described in Chapter 5. In summary the children were aged 5-10 years and met the DSM-IV criteria for DCD (n=28), or were in the borderline range scoring between the sixth and fifteenth percentile on the MABC (n=7). A paediatrician had seen them all. Those who had a psychometric assessment had IQs within the average range (i.e. + 85) and those without such an assessment had reports from the teacher that they were within the average range on their academic achievement (see Appendix 1). They all also had difficulties with activities of daily living. Methods of ascertaining which activities of daily living were of concern had to be established for children parents and teachers.

Instrument for children: There were very few assessments available to assist in helping the children to identify their concerns. Children's ability to self-report on areas of competence have been shown to be most accurate in the physical domain, particularly for younger children.[298] Harter's extensive work has shown that children can report on perceived competence but require pictures showing observable behaviours.[298, 299] I was very grateful to Cheryl Missiuna and her colleagues for being so willing to share the Perceived Efficacy and Goal Setting System (PEGS). The measure that was used with children to help them report their perceptions of competence is the research version of the PEGS. The PEGS is based on the *All About Me*[232] and uses a forced choice format described by Harter[300] The psychometric properties of the published version of the PEGS are outlined in the manual and summarised in the previous Chapter's methods section. The PEGS consists of a set of 24 pairs of cards that depict children engaged in typical self-care, school and leisure activities. Each pair of cards shows a child who is more competent in the activity and one who is less competent. For example "This child needs someone to help cut up the food" and "This child is good at cutting up food". The PEGS items are all listed in Table 6:1. The child is asked to select the card that is more like her/him. S/he is then asked if s/he is "a lot" or "a little" like that child. After the child reviews the 24 cards, s/he is asked to add any other additional items that are difficult for her/him. The therapist then selects all of the cards in the pile that show the activities the child believes they are not performing competently and moves on to goal setting. The therapist lays out these cards and discusses each item with the child. The child is asked which of these activities s/he would like to work on in therapy. The child is entirely free to indicate that, although he or she cannot perform the task competently, he or she does not wish to work on that task in therapy. The whole process, including understanding the child's perceptions of their efficacy and determining priority goals for intervention, takes between 15 and 20 minutes to complete. The PEGS[289] was administered individually to each child by the author. Parent(s) were present but sat behind the child so that they were less likely to influence the child's response. It was explained to parents that the purpose of the PEGS was to elicit the child's perspective about their strengths and weaknesses. If the parent(s) disagreed with the child's perception, they were free to discuss this afterwards with the therapist.

Instrument for parents and teachers: The views of parents and teachers were collected simply by asking them, via a questionnaire "What are your main concerns for your/this child"? Parents and teachers were asked to complete, independently, a questionnaire for each child, prior to the assessment, on which they identified their main concerns. At this time they were unaware of any diagnosis. At the beginning of the questionnaire the question asked was "What are your main concerns for your/this child?" The responses were given in free text and a simple content analysis grouped the concerns. There is further information requested of parents and teachers on the

questionnaires but only the information about the main concerns is included in this data analysis. The questionnaires were devised by the Gwent Occupational Therapists and Physiotherapists as part of routine clinical practice and have not been subjected to formal piloting see Appendix 1. The responses of both adults and children were grouped using a simple content analysis. The data analysed here includes the 35 children who scored below the 15th percentile on the Movement ABC.[41] There are seven children who scored from the 6th to 15th percentile, which is not enough to make comparisons between the two groups. Therefore the two groups are represented separately on the graphs for comparison. There were 29 boys and six girls aged 5 years 5 months - 10 years 8 months.

Results

The results are considered from children's, parents' and teachers' perspectives separately and then comparisons are made between the different views. The goals could be grouped in a variety of ways in order to present the results. The simplest would be to consider them under the usual ADL categories of self-care (dressing, laces, buttons, zips, cutlery, bottom wiping), productivity (school based activities, household chores) and play and leisure (sports, painting, drawing). Most of the children's concerns fall easily into these categories but some required interpretation. For instance if the child had identified cutting with scissors I categorised it as productivity if it was for schoolwork and leisure if it was for craft activities at home. Painting and drawing I categorised as productivity as they are school based activities although they could be considered leisure activities as well. All but two goals could be categorised as occupational therapy goals. The two that could not be categorised were, being better at spelling and frustration with a stammer. These were categorised as speech and language goals, see Table 6:1. Whilst useful for general analysis the ADL categories are quite broad and as the parent and teacher concerns did not fall so easily into these categories another set of categories was drawn to enable comparison across the groups in a more meaningful way. These categories were grouped as academic/schoolwork, motor skills, pencil skills, self-esteem/confidence, attention/organisation, social skills, speech and language and other. The results are presented in these categories.

Children's goals

The children were very clear about what activities they found difficult and which ones they wanted to work on and why. There are 24 items on the PEGS and all items were chosen at least once except "being better at building things with their hands". The 35 children identified 10 additional goals that were not on the PEGS cards, although some items seemed similar. For instance the child might not select the card representing neat printing but would say they wanted

their writing to be better or would not select the PEGS card about being poor at kicking but may still say they want to be better at football. I wondered if being good at kicking just meant kicking a ball really hard! The additional goals were being independent in bottom wiping, writing (faster or with better spacing), football, opening door handles, stammering, falling over, tennis, spelling and going high on the swing. One boy did say he wanted to be better at hitting his brother but I was not willing to help him with this.

The children's concerns and goals identified via PEGS are shown in Table 6:1. In this table the mean number of goals was 4.4 per child with a range of 1-11 goals. Four children only identified one goal and two children only identified two goals. Those with more than five goals were encouraged to prioritise which ones to work on first. There was only one child who struggled to identify any areas of difficulty but was able to tell me he wanted to be better at playing football and begged me to let him keep coming for occupational therapy. In agreement with his parents we decided an additional goal for him was to be able to admit to having difficulties. All children identified at least one goal relating to writing, dressing or sports.

PEGS items	ADL category	No. times selected as goal
Catching balls	Leisure	5
Cutting food	Self-care	9
Sports	Leisure	9
Video games	Leisure	5
Finishing work on time	Productivity	10
Making things	Leisure	2
Play not watch games & sport	Leisure	3
Ties shoes	Self-care	18
Skipping	Leisure	7
Scissors	Productivity	9
Trying new things on the playground	Leisure	1
Buttons	Self-care	3
Working on the computer	Productivity	2
Building things	Leisure	0
Riding a bicycle	Leisure	8
Getting dressed quickly	Self-care	7
Playing ball games	Leisure	3
Printing neatly	Productivity	10
Kicking balls	Leisure	1
Doing up zips	Self-care	7
Keeping desk tidy	Productivity	4
Painting	Productivity	2
Running	Leisure	6
Drawing neatly	Productivity	2
Additional goals added by children		
Cursive writing	Productivity	5
Football	Leisure	2
Falling over	Leisure	1
Tennis	Leisure	1
Going high on swing	Leisure	1
Bottom wiping	Self-care	2
Speech & language	Other	3
Opening door handles	Other	1

Table 6:1 Children's concerns and goals identified from PEGS

Self-care activities

Eighteen children wanted to be able to tie their shoelaces and made comments about wanting to do it "by themselves" "because everyone else can" and wanting to wear a particular type of footwear e.g. trainers, bootleg shoes or shoes that had laces. The age range of these children was 5 years 5 months - 10 years with a mean age of 7 years 5 months. Griffiths[21] states that 6 year olds are able to tie a single knot and 7 year olds can tie a bow. The PEDI[301] normative profile (N=412 American children) found that 25% of five-and-a half year olds could tie their shoes and 75% of six-and-a-half year olds could do it. Eight of the children were under six-and-a-half years (five were only 2 months away from six-and-a-half years). The two children under six years were reassured that many others their age could not do this but if they were still keen to work on this then just the initial knot tying was the goal.

Nine children wanted to be able to cut food up with cutlery because "mummy has to help", "can't cut up meat, rips", "won't have to have help at home and school" and "because I don't need help all the time" and "when I'm older and go to restaurant I won't need mum". The age range of these children was 5 years 5 months - 10 years 2 months, mean age 6 years 8 months. Griffiths[21] states that 5-year-olds "use knife and fork at table fairly well and seven year olds "uses knife and fork neatly: cuts own meat". The PEDI states that 75% of five-and-a-half year olds use a knife to cut soft foods.

Seven children said they wanted help to be able to get dressed quicker because "be quicker for PE and at home", "so can finish quick for mum", "getting ready for school and changing for PE" and "then I don't have to hurry at home and school". Seven children wanted to be able to do up zips because "wants to be good", "have to ask teacher for help", "my zip gets stuck", "because I need help" and "I can't get it started, teachers and dinner ladies help". Three children wanted to be better at doing up buttons because "wants to be good", "could be quicker getting dressed at home and school" and "needs help". Two children wanted help to be better at wiping their bottoms after the toilet "so I could go to scout camp" and "so I could do sleep-overs". The children found it embarrassing to talk about this activity and I feel a PEGS card with it on would have helped. This was fed back to the McMaster University team.

Productivity activities

Productivity activities are the jobs or chores that we all have to do. For children this includes schoolwork and household chores. Ten of the children said they would like to be able to finish

schoolwork on time because they do not like "being last and having to stay in and finish work", "so I get more time playing out on the yard", "so I can go on the computer and go out to play", "because I'm slow", "gets left behind", "I get it wrong lots of times" and "cos I won't have my behaviour book back". Ten children said they would like to have neat printing/writing because "I get more time playing out on the yard", "wouldn't have to go to special help", "to give me house points", "so work won't be untidy, don't like the way it looks", " so it looks better and can't read own writing", "want writing to be good and neat" and "it goes all over the place".

Nine children said they wanted to be better at cutting out with scissors because "would like to be better", "wants to be good at cutting for mum, gets cross" (child not mother), "likes cutting and making things", "so I can make stuff with paper" and "have to cut out pictures to go with work, jagged edges". It could be argued that the children who liked cutting and wanted to make things might view this as a leisure activity. The others were clearly motivated by demands made on them in school to use scissors.

Five children said they wanted to be better at writing not clearly related just to neatness or finishing schoolwork - "writing a lot of words - would like to be better at it", "faster and tidier", "good and neat, spelling as well" and "the spaces". Four children said they would like to have a tidy desk - "wants clean desk", "gets left behind and can't go out to break" and "messy desk - would like it to be tidy" and "can't get to bin to throw paper away so puts it in my desk". Two children wanted to be better at working on the computer - "if could do would be able to work quicker". Two children wanted to be better at spelling. This would not be considered to fall within the occupational therapy remit and has been categorised as a speech and language goal. Two children wanted to be better at painting - "be much better". Two children wanted to be better at drawing - "do it properly and quicker" and to "give me house points". One child wanted to be better at opening door handles as she "got stuck in rooms".

Play and leisure activities

Nine children wanted to be good at sports because "not really good, other children nasty", "to try and win", "would like to be better at ball games", "would like to play sport more", "like to be good at football -to play in school", "to join in" and "everyone beats me and laughs at me". Eight children wanted to be better at riding a bike because "stop falling off", "has mountain bike - some days good, some days bad", "go out with friends on bike instead of using scooter", "people wouldn't have to get the ball from the bushes" and "so I can go on bike not scooter". Seven children wanted to be better at skipping - "would like to join in with friends", "can play with

friends and ask them to swing rope", "can play with friends" and "everyone else can do it". Six children wanted to be better at running - "if in a race always last", "don't want to come last", "would like to be faster", "like to run fast - knee hurts" and "like to be first". Five children wanted to be better at playing Nintendo, Play Station or other computer games - "wants to be better", "takes ages to complete all games" and "to be good". Playing computer games was clearly separated from working on the computer, which was represented by a different PEGS card and is reported in the productivity section. Five children wanted to be better at catching balls - "people wouldn't have to get the ball from the bushes", "play better" and "for football when people shout".

Three children wanted to play games and sports rather than watch - "wants to play" "would like to play more" and "to play at playtime". Three children wanted to be better at ball games (the PEGS picture is of a child hitting a ball with a baseball bat) - "to be better in PE". One child wanted to be better at table tennis and tennis. Two children wanted to be better at making things - "using glue, sellotape, using a ruler, craft things". Two children wanted to be better at football generally and one at kicking a ball. One wanted to be better at "going high on the swing". One child wanted to be able to try new things on the playground. One child said he wanted to stop falling over as it "makes me sad".

Other goals - speech and language

There were only two goals that did not fall into an ADL category, spelling and stammering. The child that wanted help with spelling had it explained that this was not within the remit of occupational therapy. The child's concern was passed on to education who were already aware of this. The other child said she was frustrated by her stammer. Although this was not considered an occupational therapy target interestingly it did improve with subsequent occupational therapy intervention as she became more confident. However, follow up of these children was not part of this study.

In summary the children demonstrated wide ranging concerns with the top seven being tying shoelaces, finishing schoolwork on time, printing neatly, cutting up food, being good at sports, cutting with scissors and riding a bike. This demonstrates concerns across the spectrum of ADL, self-care, productivity, play and leisure. When asked why they wanted to be able to do these things many children identified the desire to be independent and not need adult help, to be able to do things that their peers could and to "be good". The children clearly valued independence in self-care activities such as tying laces, dressing and using cutlery. Many of them identified that they wanted to be able to finish schoolwork on time and to have tidier, neater or faster

handwriting. Play and leisure activities also featured with activities such as being good at sports, riding a bike and skipping with the motivation often related to being able to join in games and activities with their peers.

Parents' concerns

All parents were able to identify concerns for their children. The number of concerns ranged from one (one parent) to five (one parent). The mean number of concerns was three (26 parents) but this may have been influenced by the fact that there were lines numbered 1-3 in which to write their concerns on the questionnaire.

Twenty-two parents had concerns about academic or general school related activities. Parents' comments about academic/schoolwork included statements like "He will fall behind in school if he cannot write properly", "Having the answers for things but not being able to write them down" and "getting left behind in her peer group". Eighteen parents had concerns about their child's motor skills. Comments about motor skills included "Gross and fine motor skills", "clumsiness" and "coordination difficulties affecting his ability to join in play activities with his peer group". Eleven parents had concerns specifically about pencil skills. Comments about pencil skills included", "His writing is untidy, he finds it difficult", "handwriting can be illegible, has not really developed from reception – Year 2" and "I am concerned that his work does not reflect his understanding". Nine parents had concerns about concentration or attention. Comments about concentration/attention included "Concentration from a very young age. Unable to sit and do homework", "listening skills/concentration span" and "poor listening skills – consequent frustration and loss of temper".

Six parents had concerns about their child being different to their peers. Comments about being different to peers included "will be unable to keep up with his peers", "the gap is widening between him and his peers – he is noticing this now", "falling behind", "getting left behind" and "far behind all the children in his class". Five parents had concerns about their child's self-esteem. Parents' comments about self-esteem included "self-esteem could be dented badly, she cannot deal with teasing and bullying" and "as he gets older may lose self esteem because of his writing ability".

Five parents had concerns about confidence. Parents' comments about his included" we want him to have confidence in himself, not feeling he has a problem", "lack of self confidence and feeling insecure" and "lack of confidence in herself and everyday things". Five parents had concerns

about speech and language. Parents' comments about this included "speech", "he can't sound all of his words properly", "stammering" and "doesn't understand things first time and panics".

Four parents had concerns about social skills. Parents' comments about this included "social behaviour", "appears to be socially isolated" and "is a loner and likes to play with younger children". Four parents had concerns about sports. Parents' comments about this included "finds basic physical tasks difficult i.e. sports", "can't ride a scooter/riding a bike is hard for him" and "has difficulty with gross motor skills i.e. climbing, balancing, riding a bike" and "riding a bike". Three parents had concerns about dressing. Parents' comments about this included "has trouble with fastenings on clothes – and easier alternatives are harder as he grows" and found it difficult to learn to dress" and "laces". Three parents had concerns about behaviour. Parents' comments about this included "gets very aggressive on times with his brothers, sisters and myself", "behaviour deteriorating due to his difficulties and his awareness of his problems" and "poor listening skills: consequent frustration and loss of temper".

Three parents had concerns about frustration. Parents' comments about this included " frustration for * to achieve his goals", "frustrated by difficulties" and "he gets frustrated with himself and gives up". Two parents had concerns about heir child's toileting. Parents' comments about this included "will not use toilet in school" and "finds basic physical tasks difficult: i.e ...personal hygiene". One parent had concerns about cutlery. Parents' comment about this was "finds basic physical tasks difficult: i.e. ...cutting food...". One parent had concerns about scissors. Parents' comment about this was "scissors grip is rather awkward". One parent had concerns about the fact that their child was "beginning to dislike attending school". One parent had concerns about their child's safety "doesn't see danger during physical activity". Another parent had concerns about the lack of follow up for their child's visual problems. This information was passed on to the relevant professional. The parents' concerns are presented in Table 6:2.

Concern	ADL category	No. times mentioned as concern
Motor skills	NA	22
Academic/school	Productivity	22
Pencil skills	Productivity	11
Self-esteem/confidence	NA	10
Attention/organisation	NA	9
Other	NA	9
Social skills	NA	7
Speech & language	NA	5
Dressing	Self-care	3
Scissors	Productivity	1
Cutlery	Self-care	1

Table 6:2 Parents' concerns (NA = not applicable)

The parents' concerns tended to be general and related to overall concerns about poor motor skills, schoolwork and pencil skills. There were some concerns also about psychosocial aspects such as confidence, self-esteem and social skills.

Teachers' concerns

Thirty-four of the 35 teachers gave consent for the information they had provided on the questionnaires to be used for this study. Teacher consent was only sought once parental consent had been given. One teacher did not note any concerns. The teachers' concerns fell into nine categories. Twenty-seven were concerned about pencil skills, 18 about motor skills, 15 were concerned about academic progress, 10 about speech and language, nine about concentration/attention, five about social skills, one each about confidence, use of scissors and the need for adult support.

Twenty-seven teachers were concerned about pencil skills and included statements like "presentation of handwriting", "not exerting much pressure on pencil", "letter formation poor", "legibility of writing", "great discrepancy between reading and writing ability", "pencil control", "inability to record work due to poor motor skills", "lack of progress with writing", "poor writing skills" and "legibility and tidiness of school work". Eighteen teachers were concerned about motor skills. Teachers' comments about motor skills included statements like "fine motor skills", "fine motor control at all times", "large motor skills under developed i.e. using apparatus, controlling movements", "poor coordination", "lack of coordination, poor control", "gross and

fine motor skills" "difficulty using apparatus in PE" and "poor coordination" and "can seem awkward e.g. in PE lessons".

Fifteen teachers' were concerned about academic/schoolwork and included statements like "Very little progress in literacy and numeracy", "Not producing sufficient work in time allotted" and "Requires small group/individual attention to grasp concepts – repetition is extremely valuable to her." Ten teachers were concerned about the child's speech and/or language and included statements like "speech", "poor articulation and volume for speech" "understanding language" and "lacks communication skills, speech-written". Nine teachers were concerned about the child's concentration or attention and included statements like "short attention span. Very poor concentration", "poor concentration, daydreams", "concentration when working independently" and "poor concentration – resulting in lack of recorded work". Five teachers were concerned about the child's social skills and included statements like "relationships with others, especially adults", "social skills" and "mostly plays outside in a solitary detached manner, not mixing with others". Three teachers also identified concerns about individual children regarding scissors, confidence and the need for adult support.

Not surprisingly teacher's concerns were focussed around schoolwork although like the parents they voiced many general concerns about motor skills. The teacher's concerns are shown in Table 6:3

Concern	ADL category	No. times mentioned as concern
Pencil skills	Productivity	27
Motor skills	NA	18
Academic/school	Productivity	15
Speech & language	NA	10
Attention/organisation	NA	9
Social skills	NA	5
Scissors	Productivity	1
Self-esteem/confidence	NA	1
Other	NA	1

Table 6:3 Teacher's concerns (NA = not applicable)

Comparison of parent/child/teacher concerns

There are a number of methodological difficulties with comparing the adult and child concerns due to the different methods used to collect these concerns. The adults were asked an open question "What are your concerns for this child?" whilst the children were asked in a structured way about specific daily activities. Whilst acknowledging that the children's concerns were collected differently from the parents' and teacher's I believe there are interesting observations to be made from comparing the concerns. Comparing the concerns will allow discussion of the

usefulness of collecting information from these three sources. In future studies the PEGS parent and teacher questionnaires would be used but this was not possible, as local arrangements required the use of the locally devised questionnaires that were used by a number of other professionals. I used the headings from the simple content analysis of the parents' and teacher's concerns and applied these to the goals the children had set. Given the fact that the parent and teacher data was collected differently from the child's the validity of comparing the concerns could be questioned. Parents and teachers were asked an open question "What are your main concerns for this child?" whereas the children were asked about specific activities using the PEGS, although they could identify concerns not on the PEGS cards. The grouping of the child concerns, riding a bike, ball skills, making things and sports into a motor category is not exactly the same as the parents and teachers general comments about motor skills. However, it is unlikely that children will use the words such "motor coordination" but are more likely to relate their difficulties to specific tasks. Therefore this comparison does have value. This may also be helpful in planning treatment goals as the parent and teacher concerns about motor skills can be addressed through using the specific motor tasks the child has identified. It can be seen that children, parents and teachers share concerns about motor skills that the children identify in terms of sports or gross motor play activities. Children, parents and teachers also share concerns about academic/schoolwork and pencil skills. However, the children show many more concerns about their dressing skills than either the parents or teachers who were not unaware of the child's difficulties but did not see them as a main concern. The children's goals were grouped by parent and teacher categories and matched them to the children's goals as shown below.

Parent/teacher	Child
Motor skills	Riding a bike, ball skills, making things, sports
Dressing	Tying shoelaces, taking longer to get dressed, doing up zips, buttons
Academic/schoolwork	Finishing work, working on computer, painting, drawing
Pencil skills	Neat printing, writing
Scissors	Scissors
Cutlery	Cutlery
No parent equivalent	Video games: Being better at computer games: Nintendo, Play Station
Speech and language	Stammer, spelling
Attention/organisation	Keeping a tidy desk
Self esteem/confidence	No child equivalent
Social skills	No child equivalent

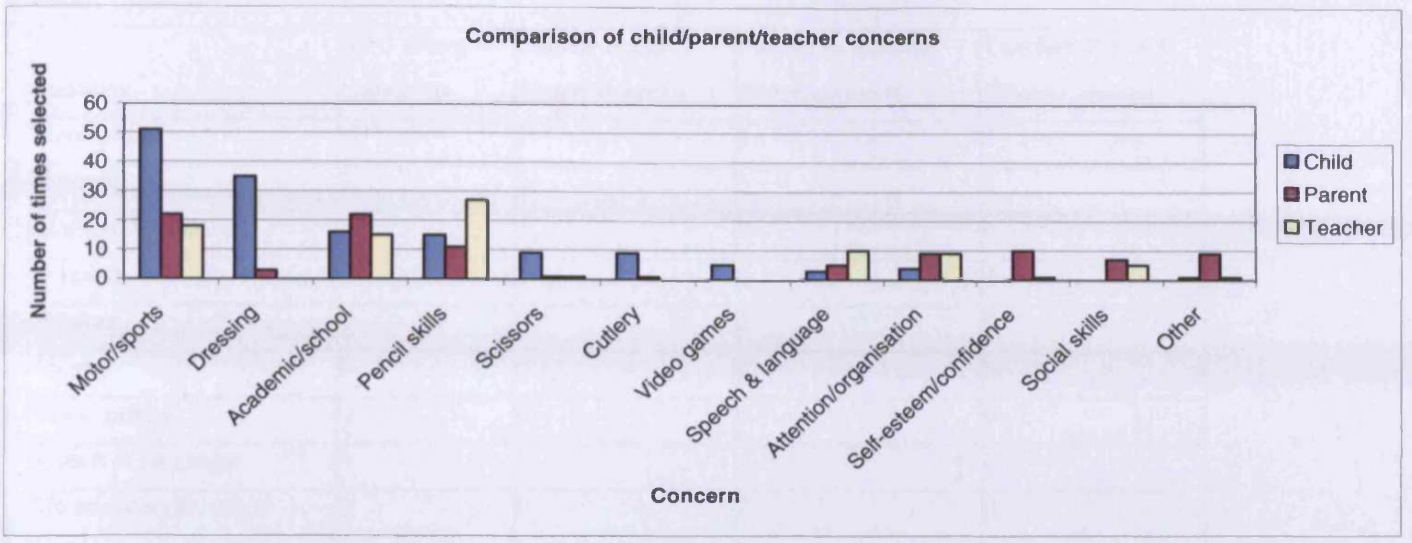


Figure 6: 1 Comparison of child/parent /teacher concerns

Comparisons of the group data are shown in the Figure 6: 1. This Figure shows how many parents, teachers and children identified the activities listed along the base of the figure. There are clearly some shared concerns around motor skills/sports, academic/schoolwork and pencil skills. However, the most striking result from this Figure is how often the children have identified concern with self-care issues (dressing and cutlery) compared to the adults.

Table 6:4 breaks down this data further by taking each individual child and considering whether the concerns noted were shared by all three, by parent and child only, by parent and teacher or teacher and child only. There were only three areas where all 3 people shared the concerns, pencil skills (10), motor skills/sports (7) and academic schoolwork concerns (3). There were 5 areas where the parent and child shared concerns academic/schoolwork (3), dressing (3), motor/sports (2) and speech and language (1). There were seven areas where parents and teachers shared concerns, academic/schoolwork (5), pencil skills (4), speech and language (4), motor sports (3), attention/organisation (2), scissors (1) and social skills (1). There were only two areas where the teacher and child shared concerns, pencil skills (3) and motor/sports skills (2). See Table 6: 4

Concern	All 3 share Concerns	Parent & child Share concern	Parent & teacher Share concern	Teacher & child Share concern
Pencil skills	10	1	4	3
Motor/sports	7	2	3	2
Academic/school	3	3	5	0
Dressing	0	3	0	0
Scissors	0	0	1	0
Cutlery	0	0	0	0
Video games	0	0	0	0
Speech & language	0	1	4	0
Attention/organisation	0	0	2	0
Self-esteem/confidence	0	0	0	0
Social skills	0	0	1	0

Table 6:4 Comparison of child, parent and teacher concerns

Another way to analyse this data is to calculate how many concerns two or more people shared. Seventeen of the children had two shared concerns, 10 children had one shared concern, four children had three shared concerns, two children had four and two children had no shared concerns (see Figure 6:2). Since there were only two children where there were no shared concerns it can be seen that for the majority of children there is some shared common ground with which to start setting goals.

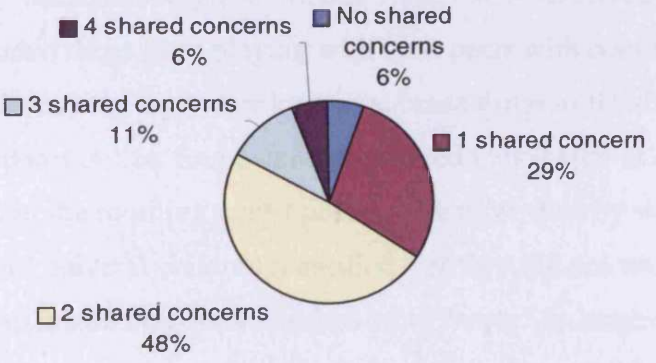


Figure 6:2

Discussion

This data shows that there is a broad range of activities of daily living that may be affected by DCD and these are unique to each child reflecting the range of contexts in which the child

functions. Young children with DCD were able to demonstrate their perception that they were not as competent performing many daily activities as were their peers. They were further able to identify which of these activities were of greatest concern to them and to select and prioritise those that they wished to work on in therapy. These findings are consistent with studies conducted in other countries with young children with DCD.[302, 303] The specific choices that children made indicated not only the impact of DCD on daily activities but also the fact that these very young children were aware of its impact. For example, 18 children wanted to be able to tie their shoelaces "by themselves" "because everyone else can". The normative sample from the Pediatric Evaluation of Disability Inventory[261] indicates that 75% of typically developing six year olds can tie their shoes so the expectation that these older children had of independence seems to be reasonable. Other authors have reported substantial percentages of the DCD population to have continued difficulty with tying shoes, using utensils and dressing tasks, well beyond the age at which these skills are normally acquired.[174]

It is interesting to note that some items that children selected as additional goals seemed quite similar to the PEGS items, suggesting that the child was not able to generalise from the picture on the card to a related item. For instance, the child might not select the card representing neat printing but would set a goal of wanting their writing to be better. Many of these items have been revised in the final version of the PEGS. The rationale that the children gave for wanting to achieve their selected goals provided useful insights into their motivation and the contexts in which they wanted to achieve these goals. The children were motivated to be the same as their peers with comments like "because everyone else can". They also perceived that their lack of competence in skills excluded them from playing with their peers with comments like "to join in with friends". Several children said they were kept in at break times to finish their work, which also reduced social play opportunities. Some children wanted to be better at dressing so they could get ready for school in the morning whilst others were motivated by wanting to be quicker at changing for PE at school. Several children identified that they did not want to need help from adults. Some of the children stated that other children were "nasty" or laughed at them. Some children were motivated by not wanting to be last all the time and one child said they would like to win in races.

Parents' concerns have been demonstrated to be useful and reliable in identifying developmental and behavioural difficulties in children.[304] In this study, parents' often voiced quite general concerns about the children's motor skills or on the perceived impact this was having on schoolwork, specific activities and/or school behaviour. In contrast with the children, they did not identify many self-care issues or leisure activities as concerns. Self-care issues have been

documented as a primary feature of DCD since the very earliest descriptions of children with coordination difficulties[1, 305, 81, 171] so it is likely that the children in this study were actually experiencing the impact on self-care tasks that they identified on the PEGS. Because these children were young, it is possible that parents did not perceive their continued dependence in self-care areas to be a cause for concern. Participation in sports and physical activities appropriate for the child's age has social, emotional and physical health consequences[306] so it is important for clinicians to be aware of children's desire to improve skills in these areas and promote greater involvement.[307] Parents may not perceive leisure interests to be an appropriate focus for intervention so the relationship between participation in physical activity and long-term health may need to be explained. It has also been shown that working on specific leisure based, and other, tasks can have an impact beyond the task itself as the children become more open to new learning and are willing to participate in a broader range of activities.[308]

Teachers see children on a daily basis in the school environment and therefore have much to contribute to our understanding of the impact of DCD on school productivity and academic achievement. Teachers seemed to raise general concerns about motor skills and, not surprisingly, focused on the impact that this was having on the child's school life. Handwriting issues were frequently raised and teachers often commented on discrepancies between the child's written work and other academic skills. Missiuna and colleagues conducted a similar study in which teachers completed a questionnaire that listed items which were identical to the PEGS items.[238] Even when presented with numerous self-care and leisure interests to select, teachers focused consistently on printing, scissor use and finishing schoolwork on time.

The children identified 55 leisure goals, 47 self-care goals, 44 productivity goals and two speech and language goals see Table 6:2. This demonstrates that children have concerns about tasks across all aspects of activities of daily living. In order to ensure that the child's concerns are covered in the assessment (and as an outcome measurement) then the occupational therapist needs to take a holistic approach and consider activities of daily living in the areas of self-care, productivity and leisure. By only listening to the parents and teachers the focus of occupational therapy is in danger of becoming biased towards productivity tasks. General concerns about motor skills raised by parents and teachers should be considered in the context of sports and leisure activities that the child identifies. It is evident that all three groups of respondents were indicating quite clearly that the motor coordination difficulties of these children were impacting on daily activities and on academic achievement so the simple methods used to ascertain this information appear to have been effective.

Given the fact that the parent and teacher data was collected differently from the child's, we did not have the ability to do a direct comparison of stated adult concerns with child concerns for each activity. Parents and teachers were asked an open question "What are your main concerns for this child?" whereas the children were asked about specific activities using the PEGS (although they could identify concerns not on the PEGS cards). However it is still clear that the children identified many more self-care and leisure goals compared to the parents and teachers. The only areas where all three respondents shared concerns were pencil skills, motor/sports and academic/school-based areas. There was no child where all three respondents had exactly the same concerns showing that each respondent has their own unique contribution to make. Several authors have advocated a move to an occupation-based or top-down approach to therapy in which the starting place in assessment is in understanding the client's perceived challenges in daily occupations.[309, 310] The PEGS is a vehicle that assists the young child in expressing to the therapist what is important to him/her. Awareness of the child's perception will ensure that difficulties with self-care and leisure activities that are important to the child are not overlooked. Collaborative goal setting can then occur because parents and teachers realise that these areas are important to the child.

Agreeing goals collaboratively requires negotiation skills as it is unusual for children, parents and teachers to set exactly the same goals. The children's goals were taken as the starting point. The parent was asked if they were happy to go with the children's goals, or at least some of them. Some of the parents or teacher's goals could then be added and the child was asked to agree to the additional goal or goals given that their goals had been given priority. Sometimes goals can be combined or reframed. The adults might have general concerns about motor skills whilst the child may say they want to play football. It is easy to meet both these goals through working on the child's football skills. Parents are usually happy to focus on the children's goals but frequently want a goal related to handwriting if the children have not selected this themselves.

Key points

- Children with DCD have difficulties with a wide range of activities of daily living
- Children, parents and teachers do not always select the same activities of daily living
- Parent and teacher concerns can easily be elicited by simply asking "What are your main concerns?" but children require something more concrete and structured such as the PEGS[289] in order to express their concerns
- Children are much more likely to select self-care and leisure activities than parents and teachers

- Parents and teachers have similar concerns about coordination generally and schoolwork
- Gaining the views of children ensures that self-care and leisure tasks are addressed as part of intervention

The data presented in this chapter was published in an article in the British Journal of Occupational Therapy.[311]

CHAPTER 7: Study 3: Exploring a range of outcome measures for assessing group intervention for DCD: Methodology and group data.

Rationale for methodology

The thesis has as its background a general goal of improving occupational therapy practice for children with DCD by looking at the evidence for various parts of the process by which a child gets identified, diagnosed and helped. The first two parts of the thesis have examined identification and diagnosis leading through to goal setting. The evidence for the recommendations that have emerged has been derived from a range of sources including various forms of documentation, examination of clinical practice, OTs, parents and children. This is not surprising considering the complex nature of the condition, the agencies and partners involved and the procedures that are necessary.

This, third part of the thesis, follows on logically from the first two parts and examines parts of the intervention process. Intervention is a complex process and it is not possible to cover all aspects of it. For example, in a totally quasi-experimental mode, one would be using an experimental group and at least one or two control groups with blind and double blind procedures. However, this was not possible for a variety of reasons. Firstly there were difficulties recruiting enough children for a control or comparison group despite attempts to recruit from neighbouring children's centres. Secondly, as a lone researcher without funding, it was not possible to engage another OT to do more than one blind test. Gwent Healthcare did fund an additional experienced OT to run the intervention groups but this was the limit of what could be offered. In addition, this thesis is aiming to examine a seamless progression from identification, through assessment and goal setting through to intervention in settings that are as close as possible to clinical experience yet are controlled in a manner that allows close examination of the variables involved. It is accepted that this does not allow for complete control of all variables and for this reason this study could be labelled as a pilot for future work. Only an experimental group was employed and the disadvantages of this are well known.[312, 313] the most important being that there is no way of knowing for certain whether it was the intervention that had an effect or some other variable such as attention.

However, by using a small experimental group, there are a number of positives. First, using quantitative data, it does allow for close statistical analysis of individual progression over a period of time using each participant as their own control. There are small numbers in the group but if statistical differences are found with such numbers, one can make tentative conclusions. These conclusions would be cautious and pointing more towards further work confirming or otherwise

the findings. Of particular value is that this small-scale pilot allows for detailed qualitative analysis of individual case studies thus providing a richness of data that cannot be obtained through statistical group analysis. This method of analysis is extremely common in the social and behavioural sciences into which this particular thesis would probably reside.

One could argue that in a population such as children with DCD this dual approach to analysis is more useful than only quantitative data, particularly when examining and producing guidelines for individual intervention. As support of this, de Vauss (2001) in his book on research methodology, lists four types of research design with both experimentation and case studies as two of them noting that each gives a particular and important slant on any research question and it is whether the design is fit for purpose that is the overall decision to be made.[314] In this last part of the thesis, experimental design is employed with the cautionary note that no control was available. In addition, case study is employed to take the results of the experimental design and elaborate them in a qualitative manner thus providing a total rich data picture of the children and the intervention process. Current research into DCD supports this and researchers are now starting to use case studies as their main focus when examining the progression of children from identification to intervention.[315, 324]

The first two studies considered the issues of making the diagnosis, and the perceptions of the impact of the condition of DCD on activities of daily living. This study considers the issue of how these children, and their families, can be helped through intervention once the diagnosis has been made and the daily issues identified. More specifically, it addresses the third aim of conducting a trial to explore how to measure the effectiveness of group occupational therapy intervention in children with DCD using a goal/task-oriented approach. This study also examines different ways of working with children, in this case in groups rather than individually and finally examines how the scheduling of practice could be structured.

Goal setting in occupational therapy

Traditionally occupational therapists have set goals for interventions based on the motor deficits identified for each child for example, to improve manual dexterity or balance.[95,188,190,222] This relates to DSM-IV diagnostic criterion A "motor coordination is substantially below that expected". This approach focuses on remediating the motor impairment, with the therapist seen as the expert practitioner who identifies the motor deficits in the child and bases the intervention on improving motor skills. This study takes a different view; the goals for intervention are based on the specific activities of daily living which the motor deficit impacts on rather than the motor deficit itself. The activities of daily living are identified, not by the therapist, but by the parent(s),

teacher and child and follows on from the second study in the previous chapter. This reflects the issues raised by DSM-IV diagnostic criterion B which states that the motor impairment "significantly interferes with academic achievement or activities of daily living". This approach is also in line with client centred, occupation focussed practice and a bio-psychosocial model of disability as outlined in the International Classification of Functioning by the World Health Organisation.[67] The model is based on facilitating activity and participation and teaching skills rather than remediating the impairment. Identifying activities and participation relevant to individuals requires goals to be set and therefore a goal setting process needs to be identified.

In this study goals for intervention were identified from the information gained by applying DSM-IV criterion B, to determine the impact of the coordination difficulties on activities of daily living. In this way the process of assessment and diagnosis is directly related to intervention. The previous study in Chapter 6 found that the parents, children and teachers all identified different activities of daily living that presented difficulties and this study includes the children's as well as adults' identified goals. Goal setting with children requires them to judge their self-efficacy, which includes the ability to judge whether one can perform a task in a satisfactory way. When children identify areas of difficulty and set goals they feel empowered and their motivation is assured.[316] Using this child and family-centred approach to setting occupational therapy goals means that the therapist could be asked to help with a wide range of activities and would not ignore an area of concern because it is unusual. Rather, diversity should be acknowledged and celebrated. This presents a difficulty in finding outcome measures that can respond to any type of activity.

There is also a more fundamental question to consider which is whose opinion should be sought - the child's the parents' or the therapist's? It is felt that all three opinions of the outcome of intervention were valid and relevant and sought to identify outcome measures for each. The data on the perceptions of the impact of DCD on activities of daily living (ADL), in Chapter 6, showed that the adults and children shared some, but by no means all, of the views of the impact of DCD on ADL. This suggests that adults and children's views on the impact of intervention may also be different and therefore all views should be considered. The occupational therapist also wants some methods of measuring the effectiveness of intervention in an objective, structured way in addition to eliciting the views of parents and children.

Outcome measures

Three existing outcome measures have been chosen that cover the different perspectives, all of which are part of the DCD context. The Movement ABC is an objective measure of motor

coordination that informs the therapist's perspective. The Canadian Occupational Performance Measure[217], is based on the parent's perspective and can also be used with children from around nine years of age and asks the responder to rate performance and satisfaction on a scale of 1-10 for each goal set. The children's views on their competence are assessed using the Self Perception Profile for Children by Harter[321] (for children who are eight years or over) or Harter and Pike's Pictorial Scale of Perceived Competence[322] (for children six to eight years). The use of specific multiple measures to evaluate effectiveness of occupational therapy intervention has already successfully been used by Wright and colleagues to look at the effects of Botulinum toxin and OT intervention.[317] In the light of the above this study investigated methods of intervention based on activities of daily living identified by the child and parent/carer. Outcome measures were selected which reflected the views of children, parents/carers and the therapist. Within person change is measured for specific activities. Goal attainment scaling (GAS) was also considered as a potential and useful outcome measure.[318] Whilst this would have been used ideally as an additional outcome measure it was not possible to manage introducing so many new measures at once and the COPM[217] and clinical observations had to suffice as the goal based outcome measures.

Grouping and occupational therapy

Traditional occupational therapy is often an individual pursuit with therapists working one to one with individual children and addressing their individual needs. However, there is a difference between working individually with children and working to an individualised programme. In the former, the therapist works one to one with the child whereas in the latter the child's needs are individualised but the therapy can be in a group situation. This practice is being seen more and more in speech therapy and in the motor domain there is growing evidence that this can be an effective alternative method.[222] The benefits of group work are not simply cost effectiveness, in terms of therapy time, although this is a consideration. A greater number of children can be seen in a given time span, potentially reducing waiting times. Working in groups is functional in that this occurs in daily life and it helps the child to work in a contextual situation that is not divorced for their everyday life thus making generalisation and transfer easier. Thus in this study, children are working in groups and hopefully the results can add to this growing body of literature.

Scheduling and occupational therapy

A final part of the study examines the role of scheduling in intervention studies. When we look at the motor learning literature we find vast bodies of information on scheduling most of them boiling down to two methods: do we mass practice or do we distribute it? The difficulty with this is that for some tasks massing of practice may be conducting three hours worth of trials straight after each other with distributed being on successive days using the same amount of time. In this

study it was thought advisable to look at what occupational therapists normally engage in to determine what to call it. A scheduling that is used often is a session once a week by the occupational therapist; this under any circumstances would have to be called distributed practice. Massed practice on the other hand would be on successive days. What does the literature say about the pros and cons of massed and distributed practice? Schmidt and Lee[319] note that massed practice tends to inhibit performance whereas distributed practice enhances it but there seems to be no real difference in learning. This means that at the end of a massed practice set of sessions the performance may not be as good as for distributed practice but after a short period of time say a few days there will be no difference. These types of findings have huge implications for the practice of OT not only in the production of the most effective methods for learning but also to give some flexibility to a service enabling the OTs to work in different ways according to their own schedules and the needs of the child and families. Thus in this study it was decided to give practices on successive days four times a week for two weeks, and this has been labelled as massed practice. Evidence from research and some clinical work would suggest that 3-5 sessions a week would be optimal for the learning of these skills.[222] The corollary to this would be eight sessions over eight weeks, which would have been distributed practice.

There are a number of models that can be employed when conducting trials. In an ideal world it would have been optimal to have three groups of children with DCD: one group receiving therapy once a week, one receiving therapy 3-5 times a week and a control group who receive, say, an art session with each session lasting 50 minutes in all of the groups. This would have enabled comparisons to be made across groups and help to pin point where and why any differences occurred. However, it was not possible to obtain enough children to do this and thus an alternative model was produced. In this there was one group with each individual acting as his/her control through periods of intervention and non-intervention. In this way the effect of any intervention can be extrapolated. In addition, having one group does allow group statistics to be used but also allows for individual analyses to be conducted so crucial for the planning of individualised programmes. The individual single subject analysis is shown in the following chapter and the limitations of one group are discussed in the final chapter.

Aim of the study:

This study aims to explore new ways and approaches of providing intervention for children with DCD with a view to informing clinical practice. This aim includes the following objectives:

1. To develop an intervention method that reflects child and parent/carer identified goals.

2. To conduct a trial to explore how to measure the effectiveness of group occupational therapy intervention for children with DCD using a goal/task-orientated approach.
3. To explore the utility of an alternative practice schedule for delivering intervention.
4. To explore individual development and progressions through the richness of information obtained from case studies.

Method

Participants

The sample was selected from an occupational therapy waiting list. Children aged 7-11 years who had been referred with coordination difficulties, to the occupational therapy team, over a period of a year were considered for inclusion. The referrals to this study included all children who did not have a new or emerging neurodevelopmental diagnosis. Referrals were received from GPs, teachers, school health nurses, a consultant paediatrician and a health visitor. The first children at the top of the waiting list who consented to take part in the study and met all the inclusion criteria and none of the exclusion criteria were selected.

All children were:

- Aged between 7 years 0 months and 11 years 11 months at the time of assessment.
- Referred to occupational therapy because of coordination difficulties.
- At or below the 5th percentile on the Movement Assessment Battery for Children[41].
- Having difficulties with activities of daily living (identified by referrer, parent and/or teacher questionnaires and child using PEGS[289]).
- Of average IQ e.g. verbal IQ of 85+ or Standard Attainment Test Scores (SATS) results at expected levels for age. The IQ cut off is high to ensure that cognitive ability is not a potential outcome variable.
- Examined by a paediatrician to eliminate any other medical condition.

Twenty-four children were identified and assessed and nine children met the inclusion criteria. One child was unable to attend treatment sessions leaving eight children in the study.

Exclusions

Fifteen children did not meet the inclusion criteria. Eleven children were excluded because they scored above the 5th %ile on the Movement ABC[41] (range 11th-89th). Table 7:1 shows the

Movement ABC[41] scores of the sample plus exclusions. In addition, one child had a medical condition (lipoma of the corpus callosum) and three children did not attend for assessment.

Since the recruitment numbers were low I decided to look at a neighbouring children's centre's waiting list to see if I could match children to those I had already recruited in order to have another intervention group and a control group. There appeared to be 14 potential matches for age and gender on an initial trawl of the list. Through further examination of the case notes and in some cases a full assessment it was found that none of these children met the inclusion criteria. Seven children had generalised learning difficulties, three scored above the 15th %ile (6th, 11th and 32nd) one child had a diagnosis of Asperger's Syndrome, and three failed to attend for assessment. It was therefore not possible to have a comparison group as had been intended.

The description of the eight children in the study in terms of age and gender are outlined in Table 7:1

Gender	Age	Totals
Male	Mean (SD) 9 years 5 months (1 year 7 months) Range = 7 years 8 months - 11 years 11 months	7
Female	10 years 9 months	1
Total sample	Mean (SD) 9 years 6 months (1 year 7 months) Range = 7 years 8 months - 11 years 11 months	8

Table 7:1 Description of the sample

There were seven boys and one girl ranging in age from 7 years 8 months to 11 years 11 months with a mean age of 9 years and six months.

A Townsend deprivation score was derived from the children's postcode to determine the socio-economic status of each family. The Townsend Score includes four variables: unemployment (lack of material resources and insecurity), overcrowding (material living conditions), lack of owner occupied accommodation (a proxy indicator of wealth) and lack of car ownership (a proxy indicator of income). The Townsend Score is a summation of the standardised scores (z scores) for each variable (scores greater than zero indicate greater levels of material deprivation). The average score is zero with a possible range from +9 to –9. The children's scores in this study ranged from -3.28 to 4.84 showing that the children came from an average range of socio-economic backgrounds, with no really affluent or socially deprived children and therefore there were no obvious socio-economic factors influencing the selection of children. The total score for each child shown in Figure 7:1.

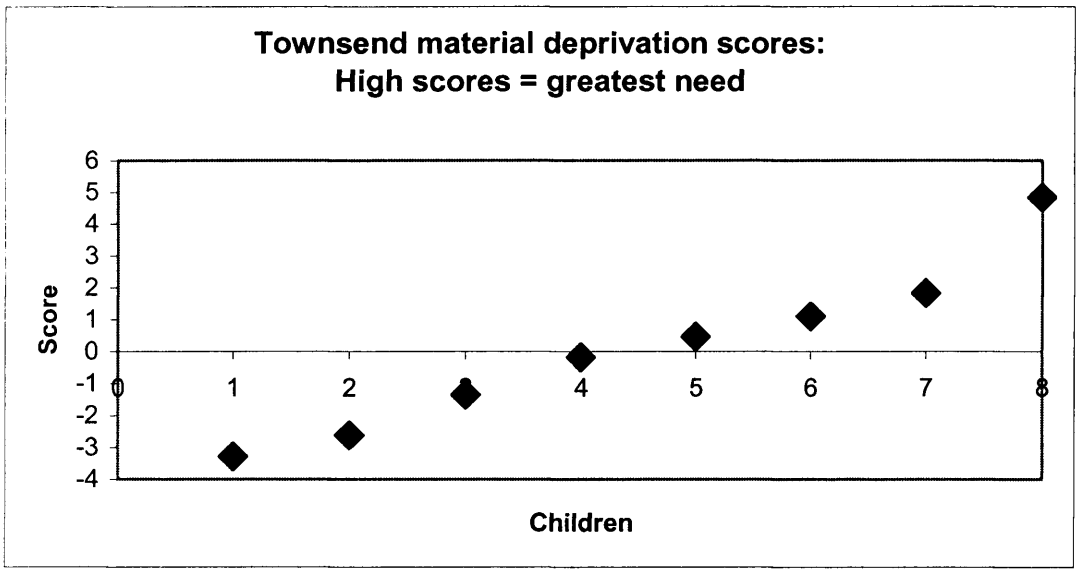


Figure 7:1 Townsend Deprivation Scores

Another variable of note is the co-occurring conditions. Children with known conditions such as cerebral palsy or autistic spectrum disorder were excluded but conditions such as specific learning difficulties, joint hypermobility or AD/HD would not exclude children from inclusion. Five of the children had additional specific learning difficulties, three had joint hypermobility identified by clinical examination using the Beighton scoring system[320] and one child was referred on to a paediatrician for consideration of a diagnosis of attention deficit disorder but this was not confirmed.

Test instruments/outcome measures

The test instruments used were the Movement ABC[41], the Perceived Efficacy and Goal Setting System[288], The Canadian Occupational Performance Measure (COPM)[217], Harter's Self Perception Profile for Children[321] or Harter and Pike's Pictorial Scale of Perceived Competence[322] for the younger children and clinical observations of specific goals. The rationale for selection of these instruments is presented considering the child, parent/carer and therapist's perspective.

The child's perspectives were gained at the initial assessment the child by using the Perceived Efficacy and Goal Setting System (PEGS)[289] to identify the goals for therapy. However the PEGS is not intended to be used as an outcome measure and therefore another measure was required to evaluate outcomes from the child's perspective. Many therapists believe that children's self-esteem is increased by intervention so a tool that could measure changes in self-esteem was required. The Self Perception Profile for Children by Harter[319] is suitable for children eight years old and over and examines their perception of scholastic competence, social acceptance, athletic competence, physical appearance, behavioural conduct and global self-worth. The Pictorial Scale of Perceived Competence and Social Acceptance for Young Children by Harter and Pike[320] is

suitable for children aged 6-8 years and uses pictures to measure the child's perception of cognitive competence, peer acceptance, physical competence and maternal acceptance. Scores in the range of 1 to 2 are typically negative and correlated with depressed affect. This has been documented in clinical and normative samples. Scores in the range 2 to 2.5 indicates the child has serious doubts about his or her adequacy. Scores in the range 2.5 to 2.8 indicates the child has moderate doubts about his or her adequacy. Scores in the range 2.8 to 3 indicates the child has a few doubts but feels moderately adequate. Scores in the range 3 to 3.5 indicates the child feels good about his or her adequacy Scores in the range 3.5 to 4.0 indicates the child feels extremely adequate (Harter personal communication). Three of the children were also able to use the Canadian Occupational Performance Measure[217] described below.

The parent's perspectives were gained by using the Canadian Occupational Performance Measure (COPM)[217]. COPM is recognised world wide as a method that assists clients to identify daily occupational performance issues that are of concern to them. The COPM is an individualised outcome measure designed for use by occupational therapists. The measure is designed to detect change in a client's self-perception of occupational performance over time. A score change of 2 is considered to be clinically significant. There were three children who were able to use the COPM scoring as well. The parent/carer or child was asked to rate their performance and satisfaction of each selected gaol on a rating of 1-10 where 1 is unable to perform/not satisfied at all and 10 is able to perform well/very satisfied.

The therapist's perspectives were gained using standardised and other tests. Since DCD is a disorder of motor coordination then an objective standardised test of motor coordination was used to enable the OT to judge if changes in motor coordination had occurred. The Movement ABC[41] was the obvious test of choice. The rationale for selecting the Movement ABC[41] rather than other standardised tests of coordination is described in Chapter 5. There are benefits to the therapist in observing the child repeating motor tasks in a standardised way allowing them to make additional qualitative judgements of change. There are also dangers in repeating any test with the obvious risk that children learn the test. However both empirical and logical evidence suggest this is not the case with the MABC. Sugden and Chambers examined whether the test could be trained over a much shorter time span than used in this study.[325] Sugden and Chambers tested 10 children twice within a week and found no significant effect. They go on to state

"Finally it is unlikely that single instances could induce such changes when prolonged intervention in other situations has been found to be the key to improvement." (p524)

These reasons do not exclude a possibility of a training effect but do make in seem unlikely.

Since all the children had tying shoelaces as a goal a simple method of recording progress with this skill was devised. Handwriting speed was measured by a two-minute timed speed test where handwriting faster was a goal. Other handwriting goals, sitting position, stabilising the paper, neatness, letter formation, spacing and letter size were judged by a visual assessment of the same copying task. Throwing and catching ball skills were tested using the Movement ABC[41]. Football skills, skipping and use of scissors were tested by therapist observation and clinical judgement.

In summary a range of outcome measures was identified to ensure children, parents and the therapist could evaluate their perspectives of the effectiveness of the intervention. The children's perspective is examined with The Self Perception Profile for Children and The Pictorial Scale of Perceived Competence and Social Acceptance for Young Children, the parent's with COPM and the therapist's with the Movement ABC[41] and some goal specific measures.

Tests and Intervention

The schedule of tests and intervention is shown in Table 7:2. The therapists were not blinded for any of the interventions but the assessor at test 4 was blinded to all previous results.

Test 1
8-11 weeks no intervention
Test 2
Intervention: 8 group sessions of 50 minutes each over 2 week period
Test 3 week following intervention
4-6 weeks no intervention
Test 4 by **blind** assessor

Table 7:2 Schedule of tests and intervention

There were eight intervention sessions offered to each child. Four children attended all eight, one attended seven and the other three attended six sessions. There were a total of 64 sessions (eight children x eight sessions) with 57 sessions (89%) attended. There was 100% attendance for all outcome measurement testing sessions.

Test 1

The initial test (Test 1) comprised of the Movement ABC[41], Harter's Self Perception Profile for Children[259] or Harter and Pike's Pictorial Scale of Perceived Competence[256], the Canadian

Occupational Performance Measure (COPM)[217], Perceived Efficacy and Goal Setting system (PEGS)[289] and clinical observation of the identified areas of difficulty with activities of daily living. First the goal setting was done with the child using the PEGS. Then the parent was asked if they were happy to agree with these goals and add any others. A set of three to four goals was agreed for each child. These were identified as the COPM[217] goals. Where the child and parent had different goals, or the goals could not be met by the group intervention, the therapist negotiated the goals to be addressed.

No intervention period followed by test 2

Following the initial assessment all children had a period of 8-11 weeks with no intervention and were then reassessed (Test 2) with the Movement ABC, Harter's, COPM and any specific measure related to their goals e.g. timed writing test, observation of tying shoelaces. This period of no intervention was intended to identify any changes which may take place over this time due to maturation as well as identifying the stability or otherwise of the scores for each of the outcome measures.

Test 3

The author reassessed all the children, in the week following intervention. The test included the MABC, Harter's, COPM and any specific observations related to the child's goals e.g. a timed writing task if writing faster was a goal. This test aimed to identify any immediate intervention effects.

Test 4

The children were all reassessed 4-6 weeks after intervention by an experienced occupational therapist who was **blind** to any of their previous scores. She repeated the MABC, Harter's, COPM and any specific observations related to the child's goals as done at test 3. This test had two aims, firstly to reduce the risks of bias inherent in having the author carry out all the tests. Secondly test 4 aimed to see if any learning that had taken place was relatively permanent (it is argued that a period of 4-6 weeks represents relative permanency) and remained once intervention had stopped.

Intervention

The group occupational therapy intervention sessions were aimed at the specific activities of daily living goals e.g. handwriting, tying shoelaces, ball skills that the children had identified using the PEGS and the parents agreed (and could add goals) using the COPM. The evolving, eclectic, cognitive-motor approach (initially described in the Movement ABC[41] manual) was used to help

children achieve their functional goals. The two occupational therapists used their dynamic performance analysis skills to break down the tasks and help the child discover methods of achieving their goals. This cognitive-motor approach aims to enable the child to learn to use problem-solving techniques to achieve their goals, with guidance from the occupational therapist. Children were encouraged to identify specific sub-goals for themselves. For example if they had chosen skipping as a goal they would decide how many consecutive jumps they were aiming for. Children who had chosen handwriting for a goal identified which aspects they were going to work on with the help of a checklist (see appendix 7:1). The approach to intervention was also influenced by the model of interacting variables in motor skill performance first presented by Keogh and Sugden in 1985[323] see Fig 7: 2 which has influenced many other models including the person-environment-occupation occupational therapy model presented by Law et al in 1996 see Figure 7: 3.

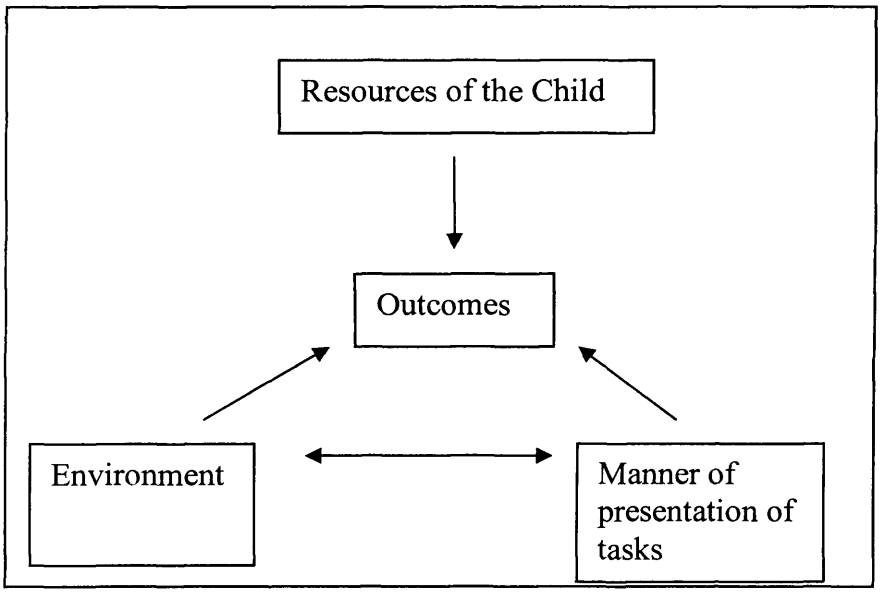


Figure 7: 2 Keogh & Sugden 1985[68] (with permission)

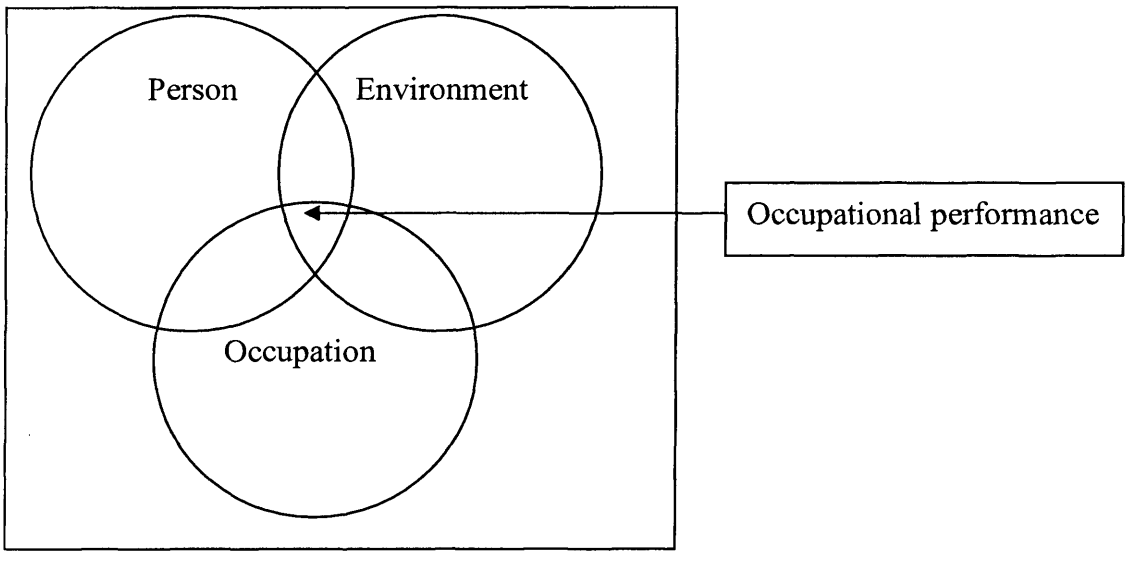


Figure 7: 3 Person-environment-occupation Law et al 1996[66] (with permission)

Use of these models led to intervention focussed on changing constraints within the task and/or environment rather than just the child. This is an inevitable outcome of acknowledging the dynamic, interactive nature of the relationships between the child, task and environment. Therapy did not focus on improving motor skills as an intended outcome e.g. to improve manual dexterity but on teaching children tasks/occupations. This is described as an occupation-focussed approach grounded within the fundamental philosophy of OT.

This is an attempt to examine the efficacy of an alternative scheduling procedure. Some specific knowledge from motor learning theories also shaped the intervention. This included knowledge of conditions of practice, stages of learning and choice of coaching/learning strategies employed. The condition of practice variable known to have the biggest influence is the amount of practice. It is known that the more appropriate practice the better. Children were given opportunities for practice during the group. They worked on the same goals at each session and kept practising them even when they had achieved the goal, to continue improving their skill. The other practice condition for consideration relates to scheduling of intervention. Traditionally occupational therapy intervention is delivered for an hour once a week. The rationale for this seems to be ease of service delivery rather than based on any evidence that this is the best time frame for delivering intervention. In terms of scheduling practice there is evidence from Pless and Carlsson's meta-analysis[204] that 3-5 times per week is effective for children with DCD. Based on this information the group was scheduled to take place eight times over a two-week period. Another significant condition of practice is ensuring that the child is motivated to perform the task well. Motivation was assured as the goals had been selected and agreed with the child.

The motor learning literature supports a whole task approach whenever this is possible and appropriate.[324] There is always the risk that when a task is broken down into parts that can be practised the parts cease to relate to the actual task in a meaningful way for the child. Practice on the part in isolation can change the motor programming such that for all practical purposes it is no longer the same action as that required when the whole task is performed. For example practising jumping may not transfer to the task of skipping with a rope even though jumping is clearly closely related to the movement required to be able to skip with a rope. The whole task itself was practised during the intervention rather than motor skill areas assumed to be necessary for the task. For example the child did not work on component skills such as manual dexterity to improve tying shoelaces or postural control to improve writing. Task analysis was used however to break

the task down into learnable chunks. Shoelace tying was broken down into tying the knot and then he bow. It was further broken down into crossing the laces over then wrapping one around the other to tie the knot. Each of these parts could be practised separately but was always related to the whole task. Modelling of tasks by other learners rather than an expert has been shown to be effective and the group intervention provided peers as models. Knowledge about stages of learning indicates the initial stage is cognitive i.e. the child has to have an idea of what is required by the task. Since the child chose their goals they clearly had idea of what s/he wanted to do. Verbal instruction was given plus modelling by therapists and other children. Feedback and knowledge of results were achieved by encouraging the child to reflect on whether the goal had been achieved and if not why not? The associative stage is where the learner has worked out what needs to be done and works on refining the skill. The children kept practicing goals in the group even once they were achieved. Therapists often move on to next goal once a goal has been done successfully once but this intervention allowed children to practice tasks once they had been mastered. This ensures permanent learning has taken place. The autonomous stage was intended to happen outside of therapy sessions once the child had mastered the skill. The coaching style/therapeutic approach was a co-operative one within a supportive environment with an appropriate peer group. Different learning approaches were used including visual, auditory, kinaesthetic and cognitive. The motivational climate created was one that celebrated personal achievement and improvement rather than competition. The children were divided, by age, into two groups of four children. They were all offered 8 intervention sessions over two weeks.

The groups were run by two occupational therapists one of who was the author. Each group started with ball skill activities that included dribbling, toe tapping, passing ball around body or feet, passing, shooting, throwing and catching. Group 1 was then followed by skipping starting with jumping over a rope 5-10cm off the ground, running through a rope that two others were turning and skipping on their own. On their own they started with swinging the rope over their head then stepping over it whilst moving forwards progressing to a smooth turning movement and jumping on the spot rather than moving forwards. Group 2 did not do skipping but a range of tasks aimed at improving organisational skills including page layout organisation, this included tasks such as packing a lap top case to go on a "business" trip, packing a school bag to timetable, sandwich making, puzzles, making a poster, maths worksheets, RoboDoc game and form filling. Both groups then sat down at the tables to work on their specific table-top tasks such as writing, drawing or using scissors. At the end of the group they all made a sandwich to enable practising use of cutlery and organisational skills.

The first group consisted of four boys ranging in age from 7 year 8 months - 9 years 4 months, at the time of assessment. Three children attended all 8 sessions and one attended 7 sessions. There were seven different goals that the group aimed to address plus bike riding which could not be addressed in this group, they are shown in Table 7:3

Goals	Number of children with goal
Laces	4
Writing	3
Ball games	2
Drawing	1
Cutlery	1
Skipping	1
Bike	1
Scissors	1

Table 7: 3 Group 1 Goals

The structure of the group was designed to ensure all the individual goals were addressed (except bike riding) whilst creating a cohesive group atmosphere. The format is shown below.

Group 1 sessions

Football skills	All 8 sessions
Skipping	All 8 sessions
Writing/drawing	4 sessions
Laces	5 sessions
Scissors	2 sessions
Sandwich making	2 sessions

Group 2 consisted of four children including three boys and one girl ranging in age from 10 years 4 months - 11 years 11 months at assessment. Two children attended all 8 sessions and the other two both attended 6 sessions.

Goals	Number of children with goal
Laces	4
Writing	2
Faster schoolwork	1
Football	1
Running	1
Organisation	1

Household chores	1
Tidier maths	1
Tidy desk	1
Scissors	1
Bike	1

Table 7: 4 Group 2 goals

The goals were all represented in the group format at some stage. The goals relating to organisation, tidier maths and tidy desk were grouped under an "organisation" heading.

Group 2 sessions

Football skills 8 sessions

Organisation task/page layout 6 sessions

Laces (+ buttons & zips for 1 child) 6 sessions

Bike 4 sessions one child (2 sessions for child who could already ride to help)

Writing 6 sessions

Scissors 2 sessions

Sweeping up 7 sessions (for 1 child with household chores goal)

Data analysis

I am very grateful to David Sugden, Mary Chambers (Leeds University) and Patrick Doherty (York St. John University) for their advice on statistics and data analysis. The data were analysed in three ways, using descriptive statistics, inferential statistics and individual case studies. Descriptive statistics using group means and standard deviations are calculated for the Movement ABC[41], Canadian Occupational Performance Measure[217], Self Perception Profile[321], Pictorial Scale of Perceived Competence & Social Acceptance[322]. The data was also examined to see whether the children moved out of the DCD category or not. Ideally for a change of category a non-parametric statistic such as Chi squared should be used but as a number of cells had less than five in them this was not possible. In order to establish whether any group differences were significant inferential statistics were used to calculate analysis of variance (ANOVA) were computed using Statistical Package for the Social Sciences (SPSS). Finally individual progressions using case studies are presented in the next chapter.

Results

Based on the literature and the study design the following hypotheses were made

1. There would be no difference between tests 1 and 2 as there has been no intervention and the traits are stable over this 8-12 week time period.
2. There would be a difference between the first two tests and the second two tests demonstrating an intervention effect.
3. There would be no difference between tests 3 and 4 indicating any intervention effect has been maintained and is relatively permanent i.e. over a 4-6 week period.

These hypotheses have been considered for each of the outcome measures, Movement ABC[41], Canadian Occupational Performance Measure[217], Self Perception Profile[321], Pictorial Scale of Perceived Competence & Social Acceptance[322] and clinical judgement, using the range of data analysis techniques described above.

Movement ABC

The Movement ABC[41] tests motor impairment, which is fundamental to the definition of DCD and therefore changes in these score following intervention are of interest. The Movement ABC scores were used to see if there were any changes in the children's coordination that could potentially be ascribed to the intervention. Cautions about interpreting these results and the potential confounders have already been noted on page 144. There are potential issues with a practice effect from repeated tests but this has been explored by Chambers and Sugden and found to be an unlikely effect.[324] The test-retest reliability is acceptable for the Movement ABC particularly as the same tester performed all tests except the blind test 4. Descriptive statistics were used to look at means and standard deviations and also whether the children moved out of the DCD category. Inferential statistics to calculate analysis of variance were used to detect any significant differences between the four tests. To recap on the schedule of testing, Test 1 is the initial test and is followed by 8-12 weeks of no intervention before Test 2 is given. Following Test 2 there is the two-week group intervention, which is immediately followed by the first post-test at Test 3. A further post-test is given at Test 4 after 4-6 weeks with no intervention (see Table 7:2).

Descriptive statistics of the four tests are shown in Table 7:5. Total impairment scores are presented with a higher score indicating greater difficulty. To give some indication of what the scores mean the total impairment score for the 5th percentile is 13.5 and the first percentile 17.5. The eight children in the study had a mean score of 20 at test 1 and 20.4 at test 2 showing no changes for the better or worse without intervention. Following intervention at test 3 the mean

score drops to 12.75 indicating improved coordination. The mean score rises slightly at test 4 to 15.63 but is still below the pre-intervention levels of 20 and 20.4.

Test	Mean	Standard deviation	N
1	20.0	4.58	8
8-11 weeks no intervention			
2	20.4	8.93	8
Intervention 8 x 50 minutes over 2 weeks			
3	12.75	8.94	8
4-6 weeks no intervention			
4	15.63	7.84	8

Table 7: 5 MABC descriptive statistics

Inferential statistics were calculated using analysis of variance (ANOVA) which revealed an overall significant difference at $F(3) = 8.25$, $p<0.05$. When examining where, specifically, the differences occurred the following significant differences came to light:

Test 1 to Test 3 and 4 (as hypothesised)

Test 1-3 $p<0.01$ Test 1-4 $p<0.05$

Test 2 to test 3 and 4 (as hypothesised)

Test 2-3 $p<0.01$ Test 2-4 $p< 0.01$

No differences were found between the following

Test 1 to Test 2 (as hypothesised) $p>0.05$

Test 3 to Test 4 (as hypothesised) $p>0.05$

The results confirm the hypotheses by finding no differences between Tests 1 and 2 indicating that without intervention the abilities of the children remained stable over a period of 8-11 weeks. Following intervention there were differences between Tests 1 and 2 and Test 3 indicating that the intervention had an effect and between Tests 1 and 2 and Test 4 indicating that the intervention effect lasted over 4-6 weeks with no intervention. Finally, as would be expected from the preceding results, there were no differences between Tests 3 and 4 again indicating no significant deterioration after 4-6 weeks without intervention. These should be viewed with some caution as there is a wide degree of variability in the baseline scores between Test 1 and 2 ranging from minus 7 to plus 11. This means the Movement ABC scores may not be stable over time or have a wide range of variability. Following intervention the range was minus 11.5 to minus 1 (between Tests 2 and 3). The difference in scores between Tests 1 and 4 ranged from minus 10.5 to plus 10.5.

Further descriptive statistics are presented looking at whether the children moved out of the category of DCD either into the borderline category or the typical range category. It is generally accepted that Movement ABC scores in the 5th to 15th percentile range are borderline and those above the 15th percentile are within the typical range.[38] At the initial assessment all eight children scored below the fifth percentile on the Movement ABC as this was one of the inclusion criteria.[6,8] Five of these eight children scored below the first percentile. At Test 3, immediately after intervention, five children no longer qualified for a DCD diagnosis (11th, 26th, 29th, 32nd, 54th percentiles) see Table 7:6. The three other children stayed below the fifth percentile, of these one child moved from below the first to the second percentile, one child moved from below the first to the first percentile and one child remained below the first percentile. However, at Test 4 only three children no longer qualified for the diagnosis demonstrating a fall off of gains without intervention, although there was now only one as opposed to five children who scored below the first percentile indicating reduction of the severity of the condition. This raises the question as to whether the three children now scoring above the fifth percentile are still appropriately given a DCD diagnosis. Longer-term follow up of these children would be required to answer this question. It also raises the issue of how long intervention should last to ensure optimal effects. These results must also be viewed with caution due to the lack of control group, however these results are explored alongside clinical judgement of the children's coordination in the next chapter looking at individual children.

%ile band	Test 1	Test 2	Test 3	Test 4
Below 1st	5	4	1	1
1st-5th	3	3	2	4
6th-15th	0	0	1	1
> 15th	0	1	4	2

Table 7: 6 Number of children scoring in each percentile band at each test

Canadian Occupational Performance Measure (COPM)[217]

The COPM data has been analysed using descriptive statistics with means and standard deviations. The authors of COPM state that a change of score of two or more is clinically significant and therefore this was taken as the important measure of change for this test. All eight parents and three of the children completed the COPM at the four test times. Changes in goals were evaluated by testing the differences in COPM performance and satisfaction scores following the period of no intervention (8-11 weeks), immediately after intervention and four to six weeks later by a blind assessor as before. The hypotheses were also the same as before:

1. There would be no difference between Tests 1 and 2 as there has been no intervention and the goals remain stable over this 8-12 week time period.
2. There would be a difference between the first two Tests and the second two Tests demonstrating an intervention effect.
3. There would be no difference between Tests 3 and 4 indicating any intervention effect has been maintained and is relatively permanent i.e. over a 4-6 week period.

The parents' mean scores (out of 10) for performance and satisfaction ranged from 3.15 to 3.82 between Test 1 and 2 indicating no change without intervention over 8-11 weeks. Following intervention at Tests 3 and 4 the mean scores ranged from 6.05 to 7.31 demonstrating clinically significant changes in parents' rating of performance and satisfaction. A change in score of two or more is considered clinically significant and Table 7: 8 shows mean changes of two or more between Test 2 and 3 that is maintained, or improved, at Test 4 demonstrating clinically significant changes following intervention. Generally satisfaction scores increase slightly more than performance scores showing that even small changes in performance can increase parent's satisfaction with the child's performance and many individual instances of this are presented in the next chapter. There were three children who could comprehend the COPM[217] scoring system and their mean scores for performance and satisfaction (out of 10) ranged from 2.07 to 3.75 at Tests 1 and 2 before intervention showing no change over the 8-11 week period. Following intervention mean scores ranged from 5.69 to 7.08 showing clinically significant improvements after intervention.

Means (and standard deviations) on the COPM				
Parents (n=8)	Test1	Test2	Test3	Test4
Performance	3.53 (1.39)	3.82 (2.13)	6.05 (2.08)	6.57 (2.47)
Satisfaction	3.15 (1.73)	3.66 (1.48)	6.98 (1.66)	7.31 (3.23)
Children (n=3)				
Performance	3.33 (1.46)	3.75 (2.17)	5.78 (2.60)	7.08 (2.27)
Satisfaction	2.70 (1.15)	3.03 (0.75)	5.69 (2.34)	7.00 (2.78)

Table 7: 8 COPM scores

When looking at the individual data seven out of the eight parents saw improvements using COPM following intervention. The one parent who did not see improvements is discussed in more detail in the next chapter (Mark, child 7). The three children who were able to do COPM all saw significant improvements in their performance and satisfaction that increased again at Test 4 suggesting that the children had taken responsibility for their goals and were continuing to work at them without needing ongoing intervention support. This suggests a more long-term intervention effect as improvements are continuing to be made even once intervention has stopped as the children must be continuing to work on the goals.

Self Perception Profile/Pictorial Scale of Perceived Competence & Social Acceptance

The data for the Self Perception Profile[320] and Pictorial Scale of Perceived Competence & Social Acceptance[321] are analysed using descriptive statistics. Six children completed the Self Perception Profile and two children completed the Pictorial Scale of Perceived Competence & Social Acceptance. For the purposes of analysis the domains from the two tests were put into similar categories for analysis. This gave six domains or categories scholastic/cognitive competence, social/peer acceptance, athletic/physical competence, physical appearance, behavioural conduct and global self-worth/maternal acceptance. Each category is considered individually as the constructs are considered to be separate. Overall children these children with DCD rate their scholastic/cognitive competence and athletic/physical competence as lower than the other areas.

Scholastic/cognitive competence

At initial assessment 5/8 children had serious doubts about their adequacy in the scholastic/cognitive domain and 3/8 felt good about their adequacy in the scholastic/cognitive domain. Following intervention one child moved from having serious doubts to moderate doubts and the rest remained in the same category.

Social/Peer acceptance

At initial assessment 3/8 children had serious to moderate doubts about their adequacy in the social/peer acceptance domain and 5/8 felt good about their adequacy in this domain. Following intervention all children felt moderately adequate, to good, in this domain but this effect appeared to take place between test 1 and 2 before intervention started.

Athletic/Physical competence

At initial assessment 4/8 children had serious doubts about their adequacy in the athletic/physical domain two had moderate doubts and two felt good about their adequacy in this domain.

Following intervention two children still had serious doubts, two had moderate doubts one felt moderately adequate and three felt good about their athletic/physical competence.

Physical appearance

At initial assessment 2/6 children had moderate doubts and the rest felt adequate to good. Following intervention all children except one felt the same or better.

Behavioural conduct

At initial assessment 2/6 had serious doubts two had moderate doubts and two felt good about their behaviour. Following intervention all scores were in the moderate to good range.

Global worth/maternal acceptance

At initial assessment one child had serious doubts and one had moderate doubts about maternal acceptance. The other six all felt good to very good about their global self worth. Following intervention this did not change.

Summary of intervention effect shown with Self Perception Profile / Pictorial Scale of Perceived Competence & Social Acceptance

Two children improved on athletic/physical: one child moved from serious to moderate doubts and on child moved from serious doubts to very good - supported by Movement ABC[41] score now 54th percentile. Two children thought their behavioural conduct had improved after intervention and one child improved their perception of their scholastic competence. Following intervention all children (except one whose score dropped but was still in moderate to good range) felt the same or better about their physical appearance. There were no changes in global worth/maternal acceptance after intervention. Intervention did not significantly change mean group scores suggesting these constructs are relatively stable, see Table 7: 9. These findings may be consistent with the constraints of a measure such as this, which measures insight as well as self-esteem. This test also asks the children to compare themselves with their peers rather than judge improvements in their own skills and therefore may not be able to capture these changes.

Means (and standard deviations) Harter's				
Domain/category	Test1	Test2	Test3	Test4
Scholastic/cognitive	2.26 (1.06)	2.03 (0.79)	2.40 (0.92)	2.42 (0.93)
Social/peer	2.64 (0.71)	3.44 (0.31)	3.35 (0.43)	3.15 (0.47)
Athletic	2.1 (0.86)	2.33 (0.93)	2.52 (1.10)	2.6 (1.10)
Appearance	3.11 (0.75)	3.34 (0.78)	3.33 (0.86)	3.42 (0.84)
Behaviour	2.63 (0.98)	3.14 (0.87)	3.46 (0.41)	3.44 (0.82)
Global worth/maternal acceptance	2.95 (0.81)	3.08 (0.70)	3.25 (0.73)	3.37 (0.60)

Table 7. 9 Harter's scores (scores >2.8 indicate child feels moderately competent)

Clinical judgement

Clinicians have a sense or feel for whether an intervention has been successful or not. The concept of clinical judgement for individual children is considered in more detail in the next chapter. Clinical judgement is based on the OT considering the whole range of outcome measures and listening to the child and parent/carer's view of the impact of intervention. She also observes the child performing the specific activity where possible and makes her own judgement about whether this is better, the same, or worse than at assessment. There were a total of 30 goals set with children and parents. Twenty-two goals were wholly met, 5 partially met and two not met at all. The goals vary from simple ones such as tying shoelaces to complex skills such as handwriting. Where possible an objective, observational measure was devised for each goal and some examples are given below.

All eight children had selected the goal of tying shoelaces. To measure the goal of tying shoelaces the child was presented with the "Early Learning®" shoe with a flat lace in it and asked to tie the laces. The OT observed, checklist style, if the child could

- Tie the knot
- Make the loop(s)
- Tie the bow

Following intervention 8/8 could do the knot, 8/8 could make the loops and 6/8 could do the knot and bow. Therefore all eight children showed some improvement and six met the goal of tying their shoelaces completely. Using COPM[217] seven out of eight parents/carers perceived clinically significant changes in performance, and/or satisfaction, with tying shoelaces at some stage in the intervention process. Two parents saw changes before intervention had started, as they had followed up advice given at the initial assessment. Both of these parents saw continued, increased improvement following the group. Five of the eight parents saw improvements in performance and 6/8 saw improvements in satisfaction immediately post group. All children perceived they had made clinically significant changes in terms of performance and satisfaction at some stage in the intervention process with tying shoelaces.

Five children had selected improving handwriting as a goal. They then identified specific goals using a handwriting checklist. The specific goals relating to handwriting were neater (5), faster (3), formation of specific upper and lower case letters (3), stabilise paper with other hand (3), reduce fatigue (2), sit correctly (2), spacing (2), stop hand hurting (1), letter size (1), sweaty fingers (1) and sitting letters on the line (1). All three children were faster on the timed writing task after intervention and this was maintained at Test 4 following no intervention for 2/3 children. Whilst improvements in neatness were observed for all five children this remained as issue when compared to their peers for 4/5 children. Letter formation had improved for all 3 children according to visual judgement but was still an ongoing issue for 2/3 children compared to their peers. All three children consistently used their hand to stabilise the paper immediately following intervention and at Test 4. Fatigue remained an issue for both children who identified it. Adopting the correct sitting position for writing and leaving the correct spaces, between letters and words, improved for both children who identified these goals. The children who identified their hand hurting and difficulty with letter sizing still had issues with both of these. The sweaty fingers issue was managed with the use of a foam pencil grip. The child now sat letters on the line that had identified this as a goal. The COPM[217] was used with all the parents and one of the children to evaluate the changes in handwriting as well as observations by the author of the child's writing described above. A change of two points improvement is considered clinically significant by the authors of COPM.

Three of the children in group 1 and two of the children in group 2 attended all eight sessions, one child in group 1 attended seven sessions and the other two children in group 2 attended six sessions.

Test 1 to Test 3 and 4: Handwriting

Test 1-3 Mean COPM score change for performance = 1.4, satisfaction = 3.9

Test 1-4 Mean COPM score change for performance = 1.4, satisfaction = 4

Test 2 to test 3 and 4: Handwriting

Test 2-3 Mean COPM score change for performance = 1.4, satisfaction = 3.9

Test 2-4 Mean COPM score change for performance = 2, satisfaction 3.2

Test 1 to Test 2: Handwriting

Mean COPM score change for performance = 0, satisfaction = 0.8

Test 3 to Test 4: Handwriting

Mean COPM score change for performance = 0.6, satisfaction = 0.1

Following intervention all parents saw clinically significant changes in handwriting performance and/or satisfaction between test 2 and 3 and 2 and 4. No changes were noted between 1 and 2 and 3 and 4 as was hypothesised. However the changes in performance between 1 and 3, 1 and 4 and 2 and 4 were all 1.4 below clinical significance although satisfaction did reach significance for these three test comparisons.

Three children had selected ball skills. The Movement ABC[41] has a ball skills section but this only covers throwing and catching and these children wanted improved football skills. This was judged by observation of the child stopping the ball with a foot on top of it, dribbling and shooting. All three children were observed to have improved their skills in all these areas although only one appeared to have made improvements to bring them in line with their peers, although this is clearly a judgement call. Two children had selected riding a bike without stabilisers. This was judged by asking the child and parents if the child could ride independently or not. Neither child learnt to ride independently. Two children had selected cutting with scissors. This was judged by visual comparison of the accuracy of cutting out a cone shape and both children were more accurate after intervention. One child had selected each of the following skipping, being more organised, having tidier maths, having a tidy desk, being faster at finishing schoolwork, drawing, swimming, running and using cutlery. Assessment of these tasks is described in the case studies.

Discussion

The discussion starts with a cautionary word about the results noting the qualifications that were mentioned at the beginning of the chapter. Nevertheless this new style group intervention appears to offer cautious optimism on several fronts. In the first instance children achieved 22/30 of their goals and even if there were no other outcomes, then this would be cause enough to claim this as a

successful outcome for these children. Should intervention only enable children to achieve the things they want to do then this is a valid intervention. However, in addition to achieving their goals the children's coordination also improved and this argues for some generalisation of the skills acquired for specific goals transferring to other areas. This combination of meeting goals and improving coordination may also have an additional effect on the children's self-belief as several parents also reported that the children demonstrated increased confidence. The children's coordination improved according to their Movement ABC scores which showed significant changes following intervention that were maintained at 4-6 weeks with no intervention. This would not necessarily have been expected using this approach, as there were no activities specifically targeted at improving coordination as an end in itself.

Overall the results provide support for a goal directed approach, as it appears to meet two objectives namely, meeting goals and improving coordination. For some of the children their coordination improved to such an extent that they no longer qualified for a diagnosis of DCD. At Test 3, immediately following intervention, five children no longer qualified for a DCD diagnosis due to their Movement ABC score being above the fifth percentile and at Test 4 this dropped to three children. Parents also reported changes in confidence and willingness to try new tasks even for the children whose coordination remained below the fifth percentile. There appear to be three types of children, those whose motor skills improve with intervention and this is maintained once intervention has stopped, those who improve with intervention but this is not maintained once intervention stops and those whose motor skills do not appear amenable to change. A recommendation would be that those implementing intervention could consider building the skills acquired in a group setting into everyday life to ensure permanency of skill acquisition. Sugden and Chambers also found similar categories with an intervention delivered by parents and teachers with specialist support.[325] It is possible that if the intervention had continued for longer there may have been more children in the group who moved out of the DCD category and stayed out. This also begs the question "Do the three children who remained above the fifth percentile qualify for a DCD diagnosis?" Should we answer "no" to this question then all children would have to receive intervention before being given a diagnosis. This would present huge practical problems and we do not have enough longitudinal studies to be clear about the stability, or otherwise, of motor skills over time to be sure about such predictions. Sugden and Chambers' work uses teacher and parents to deliver the intervention with positive effects.[262] It would seem reasonable to suggest that children should receive this type of intervention in the first place and only those who do not respond need to be referred on for occupational therapy or other specialist assessment. This is very much in line with the approach much in vogue with reading intervention in the USA called

the 'Three Tier Model' where increasingly more intensive layers of intervention are used according to how children respond.[326]

In addition a note of caution about the Movement ABC scores is raised due to the variability of the baseline scores. Can it be concluded that the Movement ABC is a suitable test for the measurement of change in motor skills, as it was not originally designed for this purpose? The improvements seen in the mean group scores could be simply fortuitous fluctuations in the desired direction.

There is also the question as to whether changes in motor skills equate to functional gains in a direct and linear fashion. The relationship between functional skills and motor skills is complex as discussed in Chapter 2. Even the child whose motor skills remained well below the first percentile throughout the study improved on his COPM performance and satisfaction scores and his mother reported positive changes in his social skills that she attributed to the group. These findings demonstrate that the relationship between motor and functional skills is not a simple, direct one. It may be that the experience of successfully learning to do task that the child has identified as important to them has effects beyond the task itself. It seems that the child's motor confidence increases when goals are met and this leads them to believe that they can do tasks that are difficult if they try. This links in with the discussion on attribution theory[262] below when the Harter's tests are discussed. The story of how successful intervention was might lie in the individual case histories that are presented in the next chapter.

The mean COPM scores for performance and satisfaction all showed clinically significant improvements immediately following intervention and this was maintained after 4-6 weeks without intervention. COPM captures the parent's (and in three cases the children's) view of how well the goals have been met and is clearly a subjective measure. In most cases satisfaction with performance improved more than performance itself and that may reflect their gratitude for providing intervention and therefore telling us what they think we want to hear rather than a real change. However, perceptions and beliefs are powerful agents in improving lives and if people believe they are better that may be more important than an objective measure of improvement and, conversely, if improvements are not perceived as such by the people involved then they may not be useful. For instance one of the children learned to tie his shoelaces during the group sessions and consistently performed this task but his mother only scored his performance as 6/10 at Test 4 when he could tie his laces compared to 6.5/10 at Test 1 when he was unable to do it. When asked about this she said that they still sometimes came undone so he had not perfected this goal yet. The COPM scoring process not only rates the goals out of 10 but also opens up a

discussion about each of the goals. Informal feedback from the blind assessor who saw the children at Test 4 was that scoring the COPM[217] and the subsequent discussions about the goals gave her a real insight into the achievements that the parents and children saw as resulting from the group even though she had no involvement with the children prior to this. Four of the parents specifically mentioned how much the child's confidence had improved during the COPM process. COPM was only used with three of the children who were able to understand the 1-10 scoring system, which the younger children find difficult. Further work is needed to establish if COPM can be used effectively with younger children using a different, simpler scoring system.

The Self Perception Profile / Pictorial Scale of Perceived Competence and Social Acceptance will be referred to as Harter's from now on as Susan Harter is author on both tests and this will enable ease of reading. The mean Harter's scores remained fairly stable for all constructs over the four Tests. They showed that the children had few or no doubts about their competence in the areas of social acceptance, appearance, behaviour and global worth/maternal acceptance but did have doubts about their athletic and scholastic/cognitive competence. This would seem to be a realistic evaluation for a child with DCD as it identifies poor physical skills with an impact on academic achievement. Since there were no significant changes following intervention Harter's did not capture the general increase in confidence to try more activities, which is reported by parents. Confidence may be a different construct than those measured by the Harter's tests. The Harter's asks the children to compare themselves with other children e.g. "Some children learn new games easily and some children find it hard to learn new games. Which one is like you?" Therefore although they may believe they have improved they still may not perceive themselves to have improved significantly, relative to their peers. The areas of athletic and scholastic/cognitive competence are the only areas where improvement could be expected given that the other areas were not perceived as an issue and whilst there was a slight trend upwards this could not be said to be significant. Harter's may have a cultural bias as it was devised in the USA. In particular maternal acceptance in the Pictorial Scale of Perceived Competence and Social Acceptance is partly evaluated by whether the children are allowed to go for sleep overs, to friends' for dinner or have their mother read to them. The two younger children who did the Pictorial Scale of Perceived Competence and Social Acceptance live on council estates where sleep overs, going to friends' for dinner and possibly mother reading to them is not necessarily part of the culture and may account for these relatively low scores. Given that Harter's did not detect differences another tool is required to capture the changes in confidence seen after this intervention and reported anecdotally by parents/carers. It is possible that therapy changes the child's attribution thereby increasing their willingness to try new tasks that parents commonly report as an outcome from

intervention. Weiner identified the main factors by which people attributed their achievements were ability, effort, task difficulty and luck.[327]

"According to attribution theory, high achievers will approach rather than avoid tasks related to succeeding because they believe success is due to high ability and effort which they are confident of. Failure is thought to be caused by bad luck or a poor exam, i.e. not their fault. Thus, failure doesn't affect their self-esteem but success builds pride and confidence. On the other hand, low achievers avoid success-related chores because they tend to (a) doubt their ability and/or (b) assume success is related to luck or to "who you know" or to other factors beyond their control. Thus, even when successful, it isn't as rewarding to the low achiever because he/she doesn't feel responsible, i.e., it doesn't increase his/her pride and confidence."

So perhaps therapy intervention changes children's attribution of their successes to ability and effort rather than luck or task difficulty. It gives them the experience of succeeding at a difficult task, often one which they have already failed to master. Giving them the experience of success through achieving goals they have selected as important to them may change their beliefs about using effort to achieve things that have been difficult. Their locus of control might change so that they believe they do have the power to change things themselves. This would explain why parents/carers so often report an increased willingness to "have a go" following intervention.

The final outcome measure is a qualitative summary of all the other outcomes plus some specific clinical observations made by the therapist. This process is referred to as clinical judgement in this study. It is an attempt to capture the part of the clinical process that relates to the therapist's beliefs about the intervention and what shapes these beliefs. Describing the processes involved in the clinical judgement section was complex due to the range of outcome measures being considered. They included task specific measures for assessing some goals such as laces and handwriting speed, as well as Movement ABC[41], COPM[217] and Harter's[321, 322] results, plus the qualitative feedback that arose during discussion with parents/carers and children. Each outcome measure, whether it is one of the formal tests, structured observation or informal discussion, all contribute to the overall picture. It could be argued that in a truly child and family centred approach the therapist does not have to have an objective measure for herself but can accept the parent/carer and child's evaluation of the outcome. I still feel the need to have an objective measure of outcome for myself. In addition I believe part of the therapist's role may be to take an overview of all the different outcomes and discuss this with parents/carers and children. The therapist can also provide support when parent/carer views are different from the child's and/or the therapist. This was the case in the incident when the parent still rated the child's performance

at tying shoelaces as the same even when they learnt to tie their laces. The therapist was in a position to say to the parent that the child had made progress with their skills. In order to do this the therapist does need to have a method of judging for herself whether goals have been met when parents and children views differ. There is evidence to support the view that an important part of intervention can be reframing the views of the adults in the child's life including parents/carers and teachers.[328] The process of clinical judgement and reasoning requires further investigation and development to establish the relevant elements in outcome measurement.

It has already been mentioned that ideally this study would have had more subjects but there were problems with recruiting sufficient numbers to enable a comparison of two intervention methods as originally intended. This is a reflection of the issues identified in the first study, described in Chapter 5, about appropriateness of referrals to occupational therapy. There were 38 children who were considered for inclusion but only nine met the criteria. First the children who were not included are discussed. From a clinical viewpoint it is important to look at the children who did not meet the criteria and therefore did not qualify for a diagnosis of DCD and consider the type of OT intervention, if any, they were offered. It could be assumed that the children who did not receive a DCD, or any other, diagnosis were unlikely to receive intervention. I had access to this data on the initial 24 children who were considered for inclusion. Fifteen of the 24 children were excluded. Eleven children were excluded because they scored above the 5th percentile and two of these children received some intervention from occupational therapy. One of them whose score placed them on the 11th percentile had input related to his handwriting. The other child whose score placed them on the 22nd percentile had a tremor and hypermobility in his hands, which were affecting his handwriting and there was some OT intervention related to this. The child with lipoma of the corpus callosum also received intervention in the form of a school visit and help with learning to tie his shoelaces. The remaining nine children were discharged following assessment, as they did not have functional deficits requiring occupational therapy. Therefore only three of the fifteen received some OT intervention and therefore the majority of children referred for coordination difficulties who do not meet criteria for a diagnosis of DCD do not require OT intervention. This means screening for DCD is a useful way of identifying those children most likely to require occupational therapy intervention. This is of importance clinically due to the long waiting lists around the UK for these children.[9]

Goal setting is a complex process and I have learnt lessons about the need for goals to be SMART, that is for them to be specific, measurable, achievable, realistic and time limited. For instance the goal of improving organisation proved to be very difficult to measure because it had no SMART attributes. Goal Attainment Scaling may be a useful tool to consider in future studies.

Goal achievement does not always take place at a single point in time but may be built up with several stages. The child who learns to tie the knot on shoelaces but still cannot tie the bow feels they have achieved part of the skill but knows they will not be able to do it on their own until they have learnt the whole task. Part of the skill of the therapist is drawing attention to new skills learnt at each stage and helping the child to understand they are working towards independence by achieving at each of these stages. There is still much to be learnt about how to deliver goal-orientated intervention.

Key points

- All of the following key points are presented cautiously as the study was more of a pilot in nature than a full experimental design. Nevertheless some reasonably strong conclusions are presented.

- Three hypotheses were made about the Movement ABC[41] scores and were all confirmed demonstrating an intervention effect, they were:
    - There would be no difference between Tests 1 and 2 as there has been no intervention and the traits are stable over this time period.
    - There would be a difference between the first two Tests and the second two tests.
    - There would be no difference between Tests 3 and 4 indicating any intervention effects have been maintained and are relatively permanent i.e. over a 4-6 week period.
- The combination of PEGS[289] and COPM[217] appears to be in this study an effective method of goal setting.
- Using COPM[217] the parent's/carers view of their child's performance and satisfaction did not change significantly after the period of no intervention but did show changes after intervention.
- The three children who were able to use COPM all perceived changes in their performance and satisfaction immediately after intervention and continued to improve after 4-6 weeks without intervention.
- COPM[217] in this study appeared to be an effective outcome measurement tool when using a goal-orientated approach.
- Self Perception Profile / Pictorial Scale of Perceived Competence & Social Acceptance (Harter's)[321, 322] showed these children with DCD had some doubts about their athletic and scholastic/cognitive competence but not about their social competence, appearance, behaviour or global worth/maternal acceptance
- Harter's in this study did not appear to capture the increase in confidence and willingness to try new activities that is reported by parents.

- It is suggested that therapy intervention changes children's attribution of their successes to ability and effort rather than luck or task difficulty.
- The process of evaluating the general effect of intervention, referred to as clinical judgement is complex and requires more investigation.
- The process of clinical judgement may be partly assisted by using Goal Attainment Scaling.
- No one outcome measure captured the effect of intervention and therefore a range of outcome measures are needed to capture potential changes and reflect the views of all concerned, child, parent/carer and therapist.
- Further research is required using a goal orientated approach and intensive scheduling following these promising early results.

Chapter 8, STUDY 3: A range of measures assessing intervention for DCD: Individual progressions through case study data.

The previous chapter presented the group data for the eight children in the intervention study. It was noted that with a small group with no control the study is probably best viewed as a pilot study. However, even with small numbers the group results were statistically significant providing cautious optimism. However group data can mask individual changes, and this is particularly true in populations such as DCD where heterogeneity is the rule rather than the exception. In addition, although it is beneficial to know global effects of any intervention through quantitative group results such that decisions can be made about funding, scheduling, numbers in groups and frequency of intervention, it is equally important to look at individual progressions using a wider range of measures to explore guidelines for specific intervention in the clinical setting. In Study 2 it has been shown that the meanings of the outcomes for individual children are more fully understood when combined with subjective views about the impact the intervention has had from the perspective of the child, parents/carers and therapist. Following a clinical intervention the therapist asks themselves "Was this intervention successful with this specific child, wholly, partially or not at all?" This question is best answered by considering all the quantitative and qualitative results and making a judgement using clinical reasoning.

This more individualised view is appropriate when using a child and family centred approach that considers the uniqueness of each person's experience within the specific framework of their family with its own set of values, experiences and expectations. The World Health Organisation's views on health and disability consider activity and participation as valid targets for health interventions within an ecological framework. From an ecological perspective intervention facilitates change through reducing constraints within the child, the task or the environment. Therefore I have considered the effect of intervention in terms of changes within the **child, task and environment.** Changes within the **child** may relate to sensorimotor skills, cognitive skills (e.g. problem solving), psychosocial abilities (e.g. self management) or spiritual attributes such as motivation and personal beliefs. Changes within the **task** may relate to breaking the task down, discovering alternative methods or using assistive equipment. Changes within the **environment** may relate to physical, social or cultural aspects such as changing attitudes of significant others in the child's life towards the child's difficulties. The interplay between the child, task and environment is considered.

Each child is considered individually with both quantitative and qualitative data presented and summarised. This includes the following:

- General Background
- Perceptions of
    - Teacher
    - Mother
    - Child
- Intervention Method
- Test Results
- Clinical judgement of outcome
- Summary of outcome and conclusions

In each of these case studies, sufficient information is presented in this chapter to enable the reader to have an overall picture of the child's progress from identification and assessment through to post intervention. In addition, more detailed information is presented in Appendix 2 through 9 in the form of tables and prose for each child that allows closer examination of the data.

The final part of the chapter identifies and discusses common themes and ideas across children drawn from the case studies.

Child 1: Charles

General Background

Charles, aged 11 years 1 month at assessment, lives at home with both parents and his sister who is three years older than him. At school his favourite subject is Information Technology and his least favourite subject is maths. He is a polite and somewhat boisterous young man. Charles was referred by his GP, because of concerns about dyspraxia. He had been seen in the past by two paediatricians, a child psychiatrist, an occupational therapist, a speech and language therapist and an educational psychologist who found his full scale Intelligence Quotient to be 96. He has a Statement of Special Educational Needs and has an hour a day extra support in school from a learning support assistant. Diagnoses of Asperger's syndrome and semantic pragmatic language disorder have been considered and rejected in the past. Attention deficit was also discussed with a paediatrician in the past with no definite conclusions made.

Perceptions

Mother

At the time of referral his mother's main concerns were

- That he is falling behind his peers at school.
- That he has poor concentration.

- His handwriting is slow and untidy which makes it more difficult for him to complete schoolwork.
- That he feels isolated and lonely and is sometimes ridiculed by his peers.

The things she found most difficult with Charles on a day-to-day basis were

- Making him remember things.
- Helping him with his homework, especially handwriting.
- Helping him put things in clear, concise words.

The things she is able to praise him for are

- Kindness.
- Behaviour.
- Trying very hard with his homework.

Teacher

At the time of referral Charles' teacher's main concerns were

- Listening skills.
- Social skills.
- Tidiness and legibility of work.

Charles

At the initial assessment he was co-operative and interacted well with the assessor. He scored below the first percentile on the Movement ABC[148].

Using the Perceived Efficacy and Goal Setting System (PEGS) Charles chose the following goals for therapy

- Climbing
- Handwriting – he finds writing neatly difficult. He has to use a pen at school but says he is better with a pencil. His hand tires after about five minutes of writing. His letter sizing is poor.
- Having a tidy tray at school
- Finishing school work on time
- Tying shoelaces

He said he was good at aiming things such as binoculars. He also identified difficulties with catching balls, cutting meat, making things with his hands, organising numbers on the page and skipping but did not choose these as things he wanted to work on.

The Self Perception Profile for Children by Susan Harter[258] scores suggest that Charles feels in a similar way to other children about his athletic competence, physical appearance and global self worth but is not so happy about his scholastic competence, behavioural conduct and to a lesser degree, his social acceptance (see Appendix 2, Table A).
Using the Canadian Occupational Performance Measure[217] with both parents and with reference to the PEGS goals that Charles had chosen the following goals were agreed

- Faster, neater handwriting
- Finishing schoolwork on time
- Organisation, including having a tidy school tray
- Tying shoelaces

Intervention method
Charles attended six group sessions over a two-week period. The group included Charles, two other boys and a girl all with similar difficulties. The groups took place at the children's centre at 4pm after school. The overall group activities and structure is shown below:

- Football skills were practised at every session and included dribbling, toe tapping, pass ball around body or feet, passing and shooting. Each group started with practicing football skills and Charles willingly joined in even though this did not represent one of his goals.
- An organisation task was included in every session. These included sorting out the pen and pencil tray, packing lap top case from list, packing school bag to timetable, sandwich making, puzzle, poster, RoboDoc game, form filling

Charles would be slow to start tasks and when he did would often pay attention to some small part of the task without appearing to have a clear idea of the end point to be reached.

- Tying shoelaces was practised at all eight sessions and he was successfully taught the two-loop method.
- Handwriting worksheets were used at every session with Charles to work on spacing and writing faster, which Charles had identified he needed to work on.

Charles was a lively member of the group, full of chatter. However during the sessions Charles was often off task and required many verbal prompts to bring him back on task. This often disrupted the other children.

Test results
Charles' coordination appeared to improve immediately post intervention on the Movement ABC from the 1st to the 29th percentile but this level was not maintained at Test 4 where he was at the 9th percentile and that means he no longer qualifies for a diagnosis of DCD but would be seen to be at risk. (Appendix 2 Table B).

Using the Self Perception Profile for Children by Susan Harter[258] Charles' perception of his behaviour and scholastic competence had improved immediately after the group intervention between tests 2 and 3, but again this was not maintained at Test 4. (Appendix 2, Table C)

Using the COPM[217] Charles' mother perceived some improvement in performance and satisfaction following intervention but this was not maintained at Test 4 (see Appendix 2 Table D). Charles' mother perceived his ability to finish schoolwork on time and his organisation had improved immediately following the group but this perception was not fully maintained at Test 4. Despite the fact that he had learnt to tie his laces his mother's view of his performance and her satisfaction with it did not improve. However this was not one of her goals for therapy. His handwriting speed had improved significantly and this was not reflected in the performance or satisfaction scores.

Charles copied the phrase "cat and dog" for two-minutes and the number of letters were counted and divided by two to give number of letters per minute. His writing speed improved significantly from 60 words a minute to 78 after intervention and this was maintained with a slight reduction in speed to 72 at Test 4.

Clinical judgement of outcome

Goals

- Faster, neater handwriting
- Finishing schoolwork on time
- Organisation, including having a tidy school tray
- Tying shoelaces

Charles's handwriting speed improved significantly and this was maintained at Test 4. His mother perceived clinically significant changes (measured via the COPM) immediately following the group, for finishing schoolwork and organisation, but this was not maintained at Test 4. Following the group sessions he can now tie his laces. However his mother still only scored his performance and her satisfaction as 6/10 as she said they still sometimes came undone. This may reflect the fact that this was one of her goals for therapy. He learnt some organisation strategies and demonstrated his ability to use them in the group. Whether this will transfer to other situations is not known. Charles' motor coordination had improved as measured by the Movement ABC. Charles main issue is staying on task, which was not obvious in the 1:1 assessment situation but was very obvious in the group. He was therefore referred to a paediatrician again for consideration of a diagnosis of attention deficit disorder but this was not felt to be an appropriate diagnosis. Charles improved his coordination, learnt to tie laces and could write faster following the group, the extent to which these changes have generalised to home and school is not known.

His mother scored performance and satisfaction (COPM) lower at Test 4 than at Test 3 and Charles' improved perception of his behaviour and scholastic competence was not maintained at Test 4. This could reflect a desire from both of them for ongoing input.

Summary of outcome and conclusions

Movement ABC[41] – moved from 1st to 29th percentile following group dropping to 9th at test 4.

Harter's Self Perception Profile for Children[320] – perception of behaviour and scholastic competence improved immediately after group intervention but not maintained at Test 4.

COPM - Using the COPM Charles' mother perceived some improvement in performance and satisfaction following intervention but this was not maintained at Test 4.

Handwriting speed – increased by 11.5 letters per minute at Test 4.

Psychosocial – Charles perception of his behaviour improved immediately after group but this was not maintained.

Charles's coordination improved with intervention although the dramatic level of improvement immediately post intervention, scoring on the 29th percentile Movement ABC[41], was not maintained without intervention dropping back to the 9th percentile at Test 4. However, this is still a significant improvement from the initial assessment when he scored below the first percentile. The concerns noted about the variability of baseline Movement ABC[41] scores means these changes may need to be viewed with caution. His perception of his behaviour and scholastic competence had improved immediately after the group but this was not maintained at Test 4. His mother perceived improvements in the specific goals set immediately after intervention but this was not maintained at Test 4. The blind assessor's clinical judgement at Test 4 was that goals had been reached but that the child's mother was still dissatisfied with the child's performance despite concrete evidence of new and improved skills. The therapist felt that the goals had been met and the ongoing difficulties related more to his poor attention than a motor deficit. It was agreed to refer him a paediatrician and review him in three months time. Judging whether intervention has been successful or not depends on whose view is considered paramount. Despite concrete evidence of him achieving the goal of tying his laces his mother was still not fully satisfied with his performance. This provides insights into the dynamics of the relationship between Charles and his mother and this may in fact be the crucial factor to change in order for things to be better for Charles.

Child 2 Patrick

General Background

Patrick, aged 10 years 4 months at assessment, is in long-term foster care. He lives with his foster parents, his brother and foster siblings. He has unsupervised access to his mother. He is a polite,

shy young man who is very willing to please. His foster mother says he is very willing to help at home but finds many things difficult to do. He likes football, tennis and riding his bike. Patrick was referred by the school health nurse due to concerns about gross and fine motor skills and difficulties with PE and handwriting. In line with local protocols the Movement ABC[41] checklist was completed as a screening tool prior to referral (Appendix 3, Table A).

The total score for sections 1-4 is 95 placing him well below the 5th percentile. Section 5 indicates there are not any behaviour issues. Patrick has been assessed using the Wechsler Intelligence Scale for Children and was found to have a verbal IQ of 91 and a performance IQ of 77. This is a significant discrepancy. He has significant difficulties acquiring basic literacy skills. He has been diagnosed with a specific learning difficulty.

Perceptions

Parent and Teacher

Due to the fact that Patrick is in foster care and has recently moved it was not possible to get information from parent and teacher questionnaires. There were general concerns noted about his motor skills at his current school.

Patrick

At the initial assessment he appeared a little anxious but was cheerful and co-operative. He scored below the first percentile on the Movement ABC[41] and exhibited some joint hypermobility but this was not excessive. Using the PEGS Patrick chose the following goals for therapy

- Running – to be better at rugby and PE
- Tying shoelaces
- Kicking balls – to be better at football

He also identified he had difficulties with skipping but did not want to work on this. He said writing was "a bit hard" and his hand "sometimes hurts" after writing. Using the Self Perception Profile for Children by Susan Harter[258] identified that he had serious doubts about his scholastic and athletic competence and behavioural conduct. He also had moderate doubts about his social acceptance. He was keen to attend group sessions.

Using the Canadian Occupational Performance Measure with his foster mother and with reference to the PEGS goals that Patrick had chosen the following goals were agreed

- Tying shoelaces
- Running
- Household chores e.g. sweeping up

- Kicking balls

Intervention method

Patrick attended six group sessions with two other boys and one girl, over a two-week period. The group took place at the children's centre at 4pm. The overall group activities and structure is shown below:

- Football skills - dribbling, toe tapping, pass ball around body or feet, passing, shooting. Patrick was very keen to improve his football skills and worked hard on his skills. Controlling the ball with his feet was difficult but he responded to prompts about where to look and which part of his foot to use for kicking and how to follow through to ensure accurate aiming when shooting.
- An organisation task was included in every session. These included packing lap top case, packing school bag to timetable, sandwich making, puzzle, poster, maths worksheets, RoboDoc game, form filling. Patrick often launched into these tasks without a plan but did listen to the other children when they made suggestions.
- Tying shoelaces was practised at all eight sessions and initially he could not tie the knot but by the sixth session he was tying laces independently.
- Writing – this was not one of his goals but he willingly joined in with the writing tasks.
- Sweeping up – Patrick willingly swept up at the end of the groups, initially needing some prompts about where to start sweeping and how to hold the broom.

During the group sessions Patrick was always well behaved and was prompt to start tasks when asked. This eagerness to start, motivated by being seen to be doing what was asked of him, meant he did not always plan what he needed to do effectively. He interacted with the other children but let them initiate conversations and would be guided by their suggestions during activities when they had to work together as a team.

Test results

Whilst Patrick's Movement ABC[41] scores are lower (i.e. better) after intervention moving from an overall score of 22 to 18, he still qualifies for a diagnosis of DCD (Appendix 3, Table B).

The initial Self Perception Profile[320] showed that Patrick had serious doubts about his scholastic and athletic competence and behavioural conduct (see Appendix 3 Table C). He had moderate doubts about his social acceptance. Patrick's foster mother felt he was being very "hard on himself" at the initial assessment, especially about his behaviour, which she felt was excellent. She was particularly pleased about this changing at test 2 and had obviously started working on it with him after the initial test as the score improved without any therapy intervention. Prior to

hearing him give his responses on this assessment she had no idea he felt like that about himself. All scores were better at Test 4 than at the initial test, apart from physical appearance, which stayed the same. Despite some improvement he continues to have concerns about his athletic competence, compared to other children, which is supported by his continuing difficulties with motor skills as evidenced by his continuing poor score on the Movement ABC. He also has moderate concerns about his scholastic competence, which is probably due to his specific learning difficulty. The scores for all the Test of the Self Perception Profile are shown in Appendix 3, Table C.

Patrick and his foster mother agreed to work on the goals he had chosen with the PEGS, running, tying laces and kicking balls. Patrick agreed to add household chores as a goal at his foster mother's suggestion and they both gave all goals 10/10 for importance. Patrick's approach to tying his shoelaces improved after having been shown the two-loop method at the assessment, hence the score change between Test 1 and 2. However he still struggled with organising the task without prompts. There was a clinically significant improvement in his performance of household chores and kicking balls as judged by his foster mother. His foster mother's satisfaction with his level of performance improved significantly with intervention, reaching the maximum level by Test 4 see Appendix 3, Table D.

Patrick's view of his performance started to improve without intervention. He explained that having identified goals for himself he started working on them immediately. The improvement continued after intervention. His satisfaction with his performance did not significantly change (except for household chores) until after intervention and this was maintained at test 4 (see Appendix 3, Table E).

Clinical judgement of outcome

Goals:

- Tying shoelaces
- Running
- Household chores e.g. sweeping up
- Kicking balls

Patrick's foster mum reports change in self-esteem and increased confidence. Listening to his responses for the Self Perception Profile[258] helped her to reassure and praise him about his behaviour as she had not realised he felt he behaved badly. He can do his laces now but still needs to work on getting it quicker and tighter. His running skills have not changed and these were not worked on specifically. He is now helping effectively with more household chores and not just

sweeping up. Football skills have improved and he is more accurate at shooting. Intervention has enabled him to improve his perception of his ability to perform most of his chosen goals and this has given rise to general increased confidence.

Summary of outcomes and conclusions

Movement ABC[41] – scores improved but still below 5th percentile

Self Perception Profile[320] – his perception of his behavioural conduct greatly improved and his perception of his scholastic competence and social acceptance also improved.

COPM[217] – Carer saw significant changes for all goals except performance of running (scores increased by 3-9 points). Patrick saw significant improvement for all goals (scores increased by 3-9 points.

Psychosocial – foster mother reports increased confidence.

Patrick's coordination has not improved significantly but he has met the goals of tying shoelaces, doing household chores and kicking balls. He said he still feels his running could be improved despite scoring it 10 for performance and satisfaction with the COPM[217]. His view of his behaviour has changed significantly which reflects a more realistic evaluation rather than a change in his behaviour, as neither his foster mother nor teacher, had concerns about his behaviour. His foster mother feels his increased confidence and self esteem can be attributed to the therapy sessions about which she was very positive. Patrick seemed to be helped by meeting other children with similar difficulties. Ongoing therapy would attempt to find a club that he could join, with a sympathetic coach, such as football, rugby or running. This was not possible as he was moving away from the area. It is likely that Patrick will continue to have difficulties with coordination but with suitable support this does not need to impact on his self-esteem although given his social background there are probably other factors contributing to his confidence and perceived competence.

Patrick's foster mum feels a bit more intervention would help. The family are moving out of area so he will need to be referred on to local services near his new home. Both Patrick and his foster mum still feel his running could be better and this was not a specific target for intervention in groups due to limited space. Patrick's foster mum commented on how much his confidence has improved since coming to the sessions and is keen for him to have more occupational therapy when they move.

Child 3: Liam

General Background

Liam, aged 9 years 4 months at assessment, lives at home with his parents and younger sister. He has four, much older half siblings. He likes playing with his toys, at school his favourite subject is Religious Education and his worst subject is maths. He is a quiet young man who responds slowly and with little animation, but appropriately, to questions and instructions. Liam was referred by his school health nurse, due to limited pencil control, stiff and uncoordinated gross motor skills and difficulty with self-help skills. She reported his parents are also concerned about him constantly running backwards and forwards whispering to himself, his photographic memory and that he dislikes sports except swimming and running. School report he finds it difficult to concentrate and stay on task, is reluctant to join in class discussion and he had made limited progress in maths and English. A paediatrician considered a diagnosis of Asperger's but decided this was not appropriate. He has been diagnosed with a specific learning difficulty.

Perceptions

Father

His father's main concerns about Liam at the time of referral were:

- Poor numeracy skills
- Poor literacy skills
- Inadequate coordination
- Poor self-esteem

His father says he can praise him for "succeeding at something; when he helps with household chores". His father has difficulty with his "lack of perseverance".

Teacher

Liam's teacher's main concerns were:

- Language and mathematics
- Coordination
- Slow at processing information

Liam

At the initial assessment Liam was seen jointly with a physiotherapist, he was co-operative but appeared to tire quickly and was easily distracted by incidental noises. His responses to questions did not come immediately and patience was required to allow him time to respond which he always did, eventually. He scored below the first percentile on the Movement ABC[41]. Using the PEGS Liam chose the following goals for therapy

- Tying shoelaces
- Playing ball games
- Drawing - four legged animals and computers, making them fill the page
- Using cutlery

He also identified himself as "not good a lot" at using scissors, trying new things on the playground, buttoning, skipping and running but did not select these as goals.

The Self Perception Profile[32] scores showed he had serious doubts about his athletic competence and moderate doubts about his scholastic competence. He was very clear about identifying the areas of schoolwork he was good at and those he struggled with. When asked general questions about for example "being slow at finishing schoolwork" he replied "depends what it is" showing an awareness of the specific nature of his learning difficulty.

Using the COPM[217] with his mother we agreed to go with the goals that he had set with the PEGS and negotiated with him to include some writing alongside the drawing goal. We also discussed the fact that there were issues around dressing apart from tying laces but agreed to focus on this first.

Intervention method

Liam attended eight group sessions with three other boys. The groups took place at the children's centre at 3pm.

Football skills were practised at all 8 sessions and skills included dribbling, toe tapping, passing the ball around body or feet, passing to another player and shooting. Liam willingly joined in and tried hard. He often leant against the wall or held on to furniture when trying to control the ball. He fatigued quickly and was often keen to sit down and rest. He had to be prompted not to touch the ball with his hands when trying to dribble it. Skipping was done at all 8 sessions – skills included jumping over rope, two others turning rope and running through and turning his own rope. Skipping was not one of his goals but he was happy to join in with skipping. He found timing when to jump extremely difficult but persevered with trying to do this. Drawing was practised at four sessions. Liam worked from "how to draw" sheets downloaded from the internet. He chose which animals he wanted to draw and the sheets broke the task down into stages and he was able to follow this once shown. He still found making his drawings fill the page difficult. Tying shoelaces was practised at five sessions. Liam tried hard to master tying laces but was not successful. Cutting with scissors was practised at two sessions. Although this was not a goal his

mother was impressed with the craft activity using scissors that Liam produced and he was proud of this. Liam was keen to improve his skills with cutlery and made sandwiches at two sessions. He needed help to be shown how to hold the knife for spreading margarine and cutting up items but was very motivated to persevere and followed instructions about how to hold the cutlery. Liam enjoyed the group sessions and his mother said he looked forward to coming.

Test results

There were some confounding variables that may also have had an effect. Liam was put in bilateral below knee softcast plasters by the physiotherapists for tight tendo-achilles between Test 3 and 4 and he was subsequently provided with insoles for his shoes. However there was no change in his Movement ABC[41] scores for balance, which is where it would be expected to change so it is assumed that changes noted are related to the group intervention. His best score was at initial assessment but all scores remained below the first percentile throughout indicating no improvement in motor coordination, rather it appeared to get worse after the initial assessment (see Appendix 4 Table A).

The Self Perception Profile for Children showed that Liam had moderate to good scores in all areas, except athletic competence, with scores remaining fairly stable throughout see Appendix 4 Table B.

His mother perceived that his performance had improved on all of the goals using the Canadian Occupational Performance Measure following intervention and continued to improve once intervention had stopped (see Appendix 4 Table C). Drawing was only rated at Tests 3 and 4 due to an omission. His mother's satisfaction with his performance improved for all goals following intervention and continued to improve once intervention had stopped see Appendix 4 Table C.

Clinical judgement of outcome

Goals:

- Tying shoelaces
- Playing ball games
- Drawing and writing
- Using cutlery

He can now tie knot on laces, which he was unable to do initially. His ball skills have improved and he hardly ever uses hands now when dribbling. Both he and I feel his shooting is more

accurate. He was pleased with his drawings but would still like to be able to make them bigger to fill the page. Spreading with a knife has improved and cutting with knife and fork improved considerably with use of Boots first cutlery. Mum says he really enjoyed the group and this is unusual as he does not usually like "social" things. She feels the group helped to give him confidence.

Summary of outcomes and conclusions

Movement ABC[41] – remained below first percentile and best score was at initial assessment
Harter's Self Perception Profile for Children[320] – Liam had moderate to good scores in all areas, except athletic competence, with scores remaining fairly stable throughout.
COPM[217] His mother saw improvements in performance and satisfaction for all goals.
Psychosocial – His mother reported positive changes in social skills.

Liam's motor skills remained well below the first percentile throughout the study. However, he did improve on performance and satisfaction, according to his mother, for all his goals. Furthermore, his mother feels that there were very positive changes in his social skills and confidence that she attributes to the group. There are ongoing issues with writing and drawing. His mother does a lot of work with him at home to help him with his coordination difficulties. He goes swimming and plays rugby at lunch-time at school. It appears that Liam will continue to have difficulties with coordination but with suitable support and understanding has the potential to achieve many of the things that he wants to do.

Child 4: Peter

General Background

Peter, aged 11 years 11 months at assessment, lives at home with both parents and his older brother. His teacher reports he is keen to do well and responds positively to praise. He is very respectful towards adults but is capable of speaking up for himself. Peter was referred by his consultant paediatrician for assessment of his motor skills. There are concerns about education, particularly English, maths, attention and concentration. Peter has seen a dietician because of concerns about his diet. He receives extra help in school from the specific learning difficulty service. He has joint hypermobility and a specific learning difficulty.

Perceptions

Father

At the time of referral his father's main concerns were

- Fine motor skills
- Falling behind in school work
- Concentration
- Improve his self esteem

The things his father found most difficult with him on a day-to-day basis were tying shoelaces but he was able to praise him for doing his homework. He said he would like help for Peter with his fine motor skills – strength and coordination and his handwriting.

Teacher

At the time of referral Peter's teacher's main concerns were

- Lack of concentration
- Works slowly/often unfinished (due to the above)
- Spelling/writing

She reported his SATS results at Key Stage 2 to be

Maths Level 2/3

English Level 4 (teacher says not working at this level)

Science Level 4

} Expected Level = 4

Peter

At the initial assessment Peter was seen with a physiotherapist and he was cooperative and interacted well with the assessors. Using the Perceived Efficacy and Goal Setting System he chose the following goals for therapy:

- Tying shoelaces
- Riding bike without stabilisers
- Being tidier in maths
- Having neat handwriting all the time. Peter says writing fast is hard and his hand hurts and gets sweaty.

The Self Perception Profile for Children[320] scores suggests Peter has serious doubts about his scholastic and athletic competence. He has moderate doubts about his physical appearance, this is because he would like to be taller. Using the Canadian Occupational Performance Measure[217]

with his father and with reference to the PEGS goals that Peter had chosen it was agreed that the goals Peter had chosen above would be the goals for therapy.

Intervention method

Peter attended six group sessions with two other boys and one girl, over a two-week period. The group took place at the children's centre at 4pm. The overall group activities and structure is shown below:

- Football skills these included dribbling, toe tapping, pass ball around body or feet, passing and shooting. Peter had not chosen this as one of his goals and said he did not like football but joined in with the others and it was explained to him that this reflected their goals and he said he was happy to take part.
- Organisation task/page layout activities included packing a lap top case, packing a school bag to a timetable, sandwich making, puzzles, making a poster, maths worksheets, RoboDoc game and form filling. Peter was very good at planning and organising the other children for the group tasks. He would usually suggest working all together and guide the other children about what to do. He was willing to give help when he could. It became clear that his goal of "being tidier at maths" was not due to poor organisation skills but rather due to difficulties with motor control and placing numbers in the squares accurately.
- Shoelaces were practised at all eight sessions and he was able to do the knot and was shown the two loop method. He tied the knot and bow independently but slowly at the second group session. By the fifth session he was tying his laces with ease and was pleased with his success.
- Using the handwriting self evaluation checklist Peter identified that he needed to sit properly, hold the paper with his left hand, form letters e, y, H, M and U correctly, make e and b the correct size and to write faster. Worksheets were selected that addressed these aims and used in each session.
- Bike riding (5 sessions) – this proved challenging to do in the group situation due to lack of space and the fact that other children did not have this goal. In a clinical situation (rather than research) bike skills are addressed in a group with only this aim, run on four consecutive days during the school holidays. However, we were able to address some skills during this group. Peter learnt to put his helmet on independently on the fourth session. He also learnt to mount the bike, use the brakes safely, prepare the pedal for push off and push off with minimal assistance to balance. He was able to pedal the bike with intermittent support to balance by session four.

At group session 3 Peter asked to talk to me about DCD. He chose to have his parents and older brother present to listen but he asked the questions. He wanted to know why he had it, how did he "get it" and would it go away. I explained it was just one of those things that some people had like having a big nose but we did not know what caused it. I also explained that he was likely to always have difficulties with coordination but would learn ways around things and that for many people with DCD life gets easier once school is over and you can make more choices about the things you do. He agreed to me talking to the SENCO at his school to ensure his teachers understood his difficulties because he says he sometimes gets comments about his untidy work or not trying in PE.

Test results

Peter's MABC total impairment score has reduced since the initial assessment but he still qualifies for a diagnosis of DCD see Appendix 5, Table A.

The Self Perception Profile for Children[320] suggests Peter has serious doubts about his scholastic and athletic competence and moderate doubts about his physical appearance with all other scores being adequate. This remained the same during the period of the study see Appendix 5 Table B.

Using the Canadian Occupational Performance Measure[217], there were significant improvements in his father's perception of his performance and satisfaction for all goals at Test 4 compared to Test 1 and 2 see Appendix 5 Tables C. There were also significant improvements in Peter's perception of his performance and satisfaction with all goals at Test 4 compared to Test 1 and 2 see Appendix 5 Tables D.

Peter wanted to improve his handwriting by sitting properly, holding the paper with his left hand, forming the letters e, y, H, M and U correctly, making e and b the correct size and to write faster. He tried a thin foam pencil grip to help absorb the sweat that he said was a problem for him. He reported that he had taken this to school and it had helped. His handwriting speed improved after intervention, moving into the expected range for boys his age, which is 76-103 letters per minute.[329] However his speed dropped at Test 4 which was just after he came back from holiday and had not been writing at all. His scores for number of letters per minute are shown in Appendix 5 Table E.

Clinical judgement of outcome

Goals:

- Tying shoelaces
- Riding bike without stabilisers
- Being tidier in maths
- Having neat handwriting all the time

Peter has learnt to tie his laces. He has learnt some basic bike skills and I am sure will learn to ride a bike. His writing speed improved immediately post intervention but this was not maintained. Test 4 was done during the school holidays when he was not writing on a daily basis. His difficulties with being tidy in maths are clearly due to motor control, not poor organisation. This became obvious during observation in the group sessions. His SENCO will see if he can use larger squared paper in maths. His parents report he has increased confidence to try and learn new skills and is more willing to "have a go". He appeared to benefit from meeting other children with similar difficulties and from making time to ask me questions about DCD.

Summary of outcomes and conclusions

Movement ABC[41] – scores improved but still below 5th percentile.
Self Perception Profile[320] – serious doubts about his scholastic and athletic competence and moderate doubts about his physical appearance and these did not change with intervention.
COPM[217] - Both Peter and his father saw improvements in performance and satisfaction for all goals except Peter did not feel hi performance of tidier maths had improved.
Psychosocial – His father says he is more willing to "have a go".

Peter continues to have difficulties with coordination. However the group sessions enabled him to achieve his goals and he was very positive about this. This also led to increased confidence and willingness to try activities his father felt he would have avoided before, such as skate boarding and playing ball in the pool whilst on holiday. Peter was very clear about the sort of help he wanted from me following the group, selecting basketball skills to work on as well as wanting me to help his teachers understand his difficulties. Helping with his understanding of the condition was an important part of intervention for him, his family and his teachers. I spent time talking to him, his brother and parents about DCD. I also discussed his difficulties by phone with the SENCO in his school who said he would make sure his teacher's were aware of his DCD. In particular the SENCO was going to speak to the PE teacher who had unwittingly made a couple of comments to Peter about trying harder. He was also going to speak to his maths teacher to see if

he could use larger squared paper as his difficulties with having tidy maths are not due to poor organisational skills but difficulties with pen control and accuracy required for placing numbers in small boxes. Intervention has not changed the impairment of DCD but does appear to have reduced the impact of the impairment on Peter's everyday life by helping him and others understand his condition and giving him the belief that some of his difficulties can be changed.

Child 5: Sally

General Background

Sally, aged 10 years 9 months at assessment, lives at home with her parents, grandparents and brother. She enjoys swimming and dancing and is generally outgoing and confident except about her schoolwork as she has insight into her specific learning difficulties. During school term she wets the bed most nights but has "periods when she is dry like in school holidays". Sally was referred by her GP following her assessment at the Dyslexia Institute who suggested she be referred for an occupational therapy assessment. Sally is known to a consultant paediatrician, educational psychologist, the Specific Learning Difficulties Service and an optician. The Dyslexia Institute has diagnosed her with specific dyslexic learning difficulties. She gets hay fever and had febrile convulsions from 15 months to 5 years but has had no fits since then.

Her mother finds the most difficult thing to deal with on a day-to-day basis is Sally's frustration when she finds things difficult and not knowing how to react to it. She can praise her for being very loving and trying very hard to please and the fact that despite her various difficulties she keeps on going.

Perceptions

Parent

"We are concerned with the lack of progress Sally was making in school. We had Sally assessed at the Cardiff Dyslexic Unit. The psychologist confirmed she has severe dyslexia but was also concerned she may have dyspraxia and told us to get her referred to occupational therapy to diagnose."

Teacher

We are happy with the progress Sally is making. She is achieving her potential at the moment, in our opinion. All the extra help Sally is receiving and always has received are helping her to learn at her pace. From September (2004) Sally will receive additional support from Specific Learning Difficulties service.

Sally

The initial assessment was conducted with a physiotherapist and Sally's mother was present. Sally was very nervous but completed all the assessment tasks. She scored below the first percentile on the Movement ABC[41]. She adopted a good sitting position for writing and held the pen in her left hand too close to the tip. She says her hand hurts when writing. She had hypermobility in her metacarpal-phalangeal joints in both hands and distal phalangeal joint of her left index finger. The Developmental Test of Visual Motor Integration[187] showed within average range scores for visual motor integration and visual perception but below average score for motor control.

Using the Perceived Efficacy and Goal Setting System (PEGS) Sally set the following goals

- To be better at dressing - doing up zips, tying shoelaces, being quicker
- Having a tidy desk
- Scissors - to "cut out letters and help teacher". To "not cut through the middle and not have raggedy edges".

She also identified herself as being "not good, a lot" at finishing schoolwork on time and playing ball games but did not select these as goals. She said she sometimes sits out when her friends are playing games and sports. She will try new things on the playground as long as they are not high. Both Sally and her mother feel she is well supported in school with the right help and allowances are made for her difficulties therefore this did not need to be a goal for therapy. Sally said she rode her bike for short periods and likes her scooter and making up games.

Using the Canadian Occupational Performance Measure[217] with Sally and her mother, it was agreed that the goals Sally had chosen using the PEGS would be the goals for therapy.

Intervention method

Sally attended eight group sessions, with three boys, over a two-week period. The group took place at the children's centre at 4pm. The overall group activities and structure is shown below:

- Football skills these included dribbling, toe tapping, pass ball around body or feet, passing and shooting. Sally willingly joined in the football practice and commented, "I need to work on catching." At the second session she said the ball was "all over the place" when she was trying to dribble.
- Organisation task/page layout activities included packing a lap top case, packing a school bag to a timetable, sandwich making, puzzles, making a poster, maths worksheets, RoboDoc game and form filling. Sally tidied my pen and pencil drawer very efficiently

and when I commented on this said she could do it well because she "had about an hour" to do it and at school things need to be done more quickly. With the group floor puzzle she launched into the task with a random trial and error approach and ignored Peter's suggested plan to find all the outside pieces first. However Peter kept insisting on his plan and Sally started to work co-operatively with the others to complete the puzzle. She tricked me into eating a tomato, cheese and JAM sandwich, which she had made, and was very amused at my horrified reaction when I tasted the sandwich. Sally showed poor ability to plan the layout for the poster and failed to fit the word "DANCE" across an A3 sheet of paper. She demonstrated good drawing skills and had creative ideas about what should be on the poster.

- Scissors – Sally was shown how to elbow prop when cutting to give her more control and therefore accuracy.
- Laces – Sally learnt to do the two-loop method at the first session and continued to improve this skill so her hand movements became quick and efficient.
- Writing – Sally had not chosen this as a goal with the PEGS but set some goals for herself in the group. These were making the letters a, b, c, d, f, h, r, s, A, B, C, E, M, W, Z and the numbers 2, 4 and 7.
- Bike riding – (2 sessions) Sally can ride a bike but was keen to bring her bike in and help Peter learn to ride his bike.

Test results

Immediately following intervention Sally's Movement ABC[41] score had moved from the significant impairment to borderline range, but dropped back to the significant impairment range following four weeks without intervention see Appendix 6, Table A. Sally had her 11th birthday between test 3 and 4 so it was decided to repeat the Movement ABC for age 10 as well as it was one manual dexterity score (cutting out the elephant) which was significantly lower and reduced her percentile ranking. However when re-tested on the 10-year-old assessment her score still placed her on the 2nd percentile.

Using the COPM[217] Sally's mother's view of her performance had improved significantly for all goals at Test 4 compared to Test 1 see Appendix 6, Table B.

Sally's mother's satisfaction with dressing had improved without intervention as there was improvement between Tests 1 and 2 see Table B. Sally's father described her improvement with

dressing as happening "spontaneously". Mother felt having a tidy desk (and general organisation) had improved steadily from Test 1 to 4. Using scissors did not improve until Test 4.

Sally's thought her performance of dressing improved after the initial test without intervention. She did not think having a tidy desk and scissor skills had improved until Test 4 see Appendix 6, Table C.

Sally did not see any changes in her satisfaction immediately following intervention see Appendix 6, Table C. Sally felt her performance at dressing had improved immediately post intervention but this was not maintained at Test 4. She felt having a tidy desk had improved at Test 4. She felt using scissors improved after initial assessment and this was maintained at Test 4.

Sally's Harter's[320] scores remain fairly stable over the four tests see Appendix 6,Table D. Sally has serious doubts about her adequacy in the domain of scholastic competence and this reflects her specific learning difficulty. She has moderate doubts about her athletic competence. She had some doubts about her behavioural conduct and physical appearance at the initial assessment but this had improved at Test 2. She feels good about her social acceptance and global self worth.

Clinical judgement of outcome

Mother says she has seen improvement in Sally. She can now tie her laces. Sally feels her performance and satisfaction with scissors has improved but she still only scores herself 5/10 for performance and 4/10 for satisfaction. The main issue is now disorganisation and untidiness and her mum feels that she forgets. Sally says she does not have enough time in school to organise herself.

Summary of outcomes and conclusions

Movement ABC[41] – Sally's scores went from significant impairment to borderline post group dropping back to significant impairment at Test 4.

Self Perception Profile[320] – Sally has serious doubts about her adequacy in the domain of scholastic competence. She has moderate doubts about her athletic competence. She had a few doubts about her behavioural conduct and physical appearance at the initial assessment but this had improved at Test 2. Otherwise all scores remained stable throughout and intervention does not appear to have changed anything.

COPM – Both Sally and her mother have seen improvements for performance and satisfaction for all goals.

Psychosocial – both Sally and mother reported they are pleased with the outcomes from the group.

Both mother and Sally are pleased with the outcomes from intervention and do not feel Sally requires further input from occupational therapy. Sally's coordination, as measured by the Movement ABC, improved immediately following intervention but this was not maintained four weeks later although her score was still better than prior to intervention. Both Sally and her mother felt her ability to tidy her desk had improved following intervention. Her disorganisation and untidiness are due to poor planning and difficulty with doing things at speed. We discussed stopping to think and talk tasks through before starting and her mother is going to try and help her with this at home. We also discussed the speed/accuracy trade off and that attempting to rush tasks actually does not help her. The button-hook is enabling her to do up her jeans and she is now hooking the zip on her coat quickly, so her dressing skills have improved.

Sally's coordination, as measured by the Movement ABC[41] improved immediately after the group but this was not maintained at Test 4 although her final score was better at test 4 than at initial assessment. She had significantly improved performance and satisfaction COPM[217] scores for all goals according to her and her mother except for her satisfaction with dressing. Both Sally and her mother spoke enthusiastically about the benefits of the group. She continues to have ongoing difficulties with coordination, organisation and tidiness and this is further compounded by her specific learning difficulty although this is being well managed in school. Sally presents as a confident, outgoing young person with insight into her difficulties who will work around these issues.

Child 6: Paul

General Background

Paul, aged 8 years 3 months at assessment, lives at home with both parents. The family have an active lifestyle and enjoy the outdoors. Paul enjoys ball games such as rugby, football and cricket. He would like to be more coordinated with his swimming. Paul's favourite subjects at school are maths and science and his least favourite is writing. Paul was referred by the SENCO who described him as a "very bright, intelligent child, that could easily be viewed as "lazy", but this is not the case." His class teacher reported specific difficulties in handwriting skills, using tools e.g., rulers/scissors and possible spatial awareness difficulties. He is at the "School Action Plus" stage

on the Code of Practice and receives additional support in class from a learning support assistant and his teacher. He wears glasses as he is very long sighted and colour blind (red/green). He was attending a specialist optician but has since been discharged. He has joint hypermobility.

Perceptions

Parents

Paul's parent's main concerns at the time of referral were:

1 That his difficulties with writing, drawing, symmetry, graphs etc. will hinder his education.

2 Paul seems to lack strength in his fingers, for example opening and closing a bulldog clip would be difficult for him.

His parents said they found his writing and problems following instructions difficult to deal with on a day-to-day basis. They are able to praise him for reading, spelling, maths and many more things as he is "a bright, happy, caring child and therefore easy to praise". They would like help with his writing, fine motor skills, scissor work, ruler work and drawing.

Teacher

Paul's teacher's main concerns at the time of referral were:

1 Handwriting

2 Spatial awareness

3 Fine motor skills

His individual education plan (IEP) targets areas are handwriting and spatial awareness. His SATs results at the end of Key Stage 1 are given below (expected level = 2)

English	Level 2
Reading	Level 3
Maths	Level 3
Science	Level 3

Paul

At the initial assessment Paul was co-operative and inquisitive. He scored on the 4th percentile of the Movement ABC[41]. He set the following goals for therapy using the PEGS:

- He would like his writing to look tidier
- Skipping – to be better on sports day
- Tying shoelaces

He also identified himself as "not good, a lot" at playing video games, making things and painting but did not chose any of these as goals for therapy. Harter's Self Perception Profile for Children[259] showed he had good perceived competence in all areas.

Using the Canadian Occupational Performance Measure[217] with his mother and with reference to the PEGS goals that Paul had chosen the following goals were agreed

- Writing
- Skipping
- Tying shoelaces
- Cutting with scissors – mother suggested this and then he agreed to it as a goal

Intervention method

Paul attended eight group sessions over a two-week period. The group included Paul and three other boys with similar difficulties. The groups took place at the children's centre at 3pm.

- Football skills were practised at all 8 sessions and included dribbling, toe tapping, pass ball around body or feet, passing and shooting. This did not represent one of Paul's goals but he willingly joined in and wrote that he liked the football because the boys beat the therapists 3-0.
- Skipping was practised at all eight sessions and included jumping over a rope, two others turning rope and turning his own rope. At the initial group session Paul was able to turn a rope over his head and step over the rope as two separate actions. With practice during the groups he started to combine these two skills into a more flowing action. He could not jump over a rope turned by two people initially but managed two jumps over the rope at the third session and the number of consecutive jumps gradually increased with his best score being 17 consecutive jumps. He achieved this by working out the timing of when to jump.
- Writing was practised at four sessions. Paul said he sometimes forgot to hold the paper still when writing and sometimes his spacing between letters and words was poor. He also wanted to work on making the letters b, p and P and sitting the letters on the line. He was given a laminated card with his handwriting targets on to take into school to act as a reminder.
- Tying shoelaces was practised at five sessions. Paul tied the knot and bow independently for the first time at the second group session and maintained this skill over time.

- Cutting with scissors was practised at two sessions. During the group we discovered that Paul's scissor control was better if he propped his elbows on the desk when cutting. He found the long loop scissors easier to use. He needed verbal prompts to be reminded of this as well as to hold the paper with his left hand with his thumb on top.
- The children made sandwiches at two of the sessions. Paul had difficulty using a knife to spread margarine but got the idea of how to hold and move the knife following the therapist using a hand over hand approach.

Test Results

Paul's coordination, as measured by the Movement ABC[41], improved significantly without intervention see Table 8: 40. This may be attributable to the fact that his father is a PE teacher and started working with him immediately after the initial assessment. He no longer qualifies for a diagnosis of DCD but his joint hypermobility continues to make some functional tasks difficult.

MABC	Test 1	Test 2	Test 3	Test 4
Manual dexterity	9	3	3.5	4
Ball skills	2	2	0.5	2.5
Balance	3.5	2.5	2.5	2
Total impairment score	14.5	7.5	6.5	8.5
Percentile rank	4th	26th	32nd	20th

Table 8:40

The Harter's Self Perception for Children showed that Paul has good perceived competence in all areas and this did not change over time see Table 8: 41.

Harter's Self Perception Profile for Children

Domain	Test 1	Test 2	Test 3	Test 4
Scholastic competence	3.67	3.5	3.83	3.17
Social acceptance	3.5	4	3.4	3.5
Athletic competence	3	3.33	2.83	3.83
Physical appearance	3.83	4	4	4
Behavioural conduct	4	4	4	4
Global self worth	3.83	4	4	4

Table 8:41

Using the COPM[217] there was no change in Paul's mother's view of his performance of any of his goals between Test 1 and 2. All goals had clinically significant changes following intervention which were maintained at Test 4 see Table 8:42.

Performance - mother's view 1= not able - 10 = able to do well

Goal	Importance	Test 1	Test 2	Test 3	Test 4
Laces	4.00	6.50	6.50	9.00	8.00
Writing	10.00	4.00	4.00	7.00	8.00
Scissors	9.00	2.50	2.50	6.00	8.00
Skipping	5.00	3.00	3.00	7.00	7.00
Mean score		**4.00**	**4.00**	**7.25**	**7.75**

Table 8:42

The COPM[217] showed there was no change in his mother's satisfaction with his performance of any of his goals between Test 1 and 2 see Table 8: 43. Following intervention her satisfaction had significantly increased for laces, writing, and scissors but not skipping.

Satisfaction - mother's view 1 = not satisfied at all - 10 = extremely satisfied

Goal	Importance	Test 1	Test 2	Test 3	Test 4
Laces	4.00	7.50	7.50	10.00	9
Writing	10.00	2.00	2.00	8.00	8
Scissors	9.00	2.50	2.50	6.00	9
Skipping	5.00	8.00	8.00	7.00	8
Mean score		**5.00**	**5.00**	**7.75**	**8.50**

Table 8: 43

Paul's writing speed was assessed with the two-minute test devised by Watson and Ziviani[141] see Table 8:44. The average range for boys his age is 27-65 letters per minute so his speed in within range but he would still like it to be faster.[141] Following intervention his writing speed had improved by 14.5 letters per minute.

Writing	Test 1	Test 2	Test 3	Test 4
Letters/minute	41	43	57.5	58.5

Table 8: 44

Clinical judgement of outcome

His coordination improved as measured by the Movement ABC[41] post assessment before any intervention. The improvement was in his manual dexterity score. His functional difficulties appear to be attributable to his hypermobility. Paul learnt to tie his laces in the group and has maintained this skill. Paul's writing speed improved post group and was maintained at Test 4. However he still experiences fatigue when writing longer pieces and typing should be considered as an alternative for him. A visual comparison of his scissor accuracy for cutting out an ice cream cone shape before and after intervention revealed less jagged edges and shorter diversions from the line at Test 4. He needs to be reminded to elbow prop and hold the paper with his thumb on top. The long loop scissors are easier for him to use. The number of consecutive jumps he could do when skipping on his own improved from 2-17 and his mother's view of his performance increased but not her satisfaction for this goal. His parents would like a review in 3 months time.

Summary of outcomes and conclusions

MABC – increased to above 15th percentile at Test 2 and this was maintained
Self Perception Profile – good scores in all domains remained throughout.
COPM – Mother saw improvements in performance and satisfaction for all goals.
Psychosocial – no changes noted, he already had good perceived competence at the initial assessment and not surprisingly, no comments were made about changes his confidence or social skills.

Paul only qualified for a diagnosis of DCD at his initial assessment and this is no longer an appropriate diagnosis that suggests making a diagnosis on a single assessment may be unsafe. The concerns noted about the reliability of the Movement ABC[41] score over time, which are discussed earlier may also be relevant. Paul made progress with all his goals following intervention. Some were met by within child changes, that is, improving his skills for tying laces, writing more quickly and achieving a more flowing action and improved timing with skipping. The task constraints were changed for using scissors by getting him to elbow prop to stabilise his shoulders and using long loop scissors. My clinical judgement is that his functional difficulties relate to his hypermobility rather than a coordination difficulty.

Child 7: Mark

General Background
Mark, aged 8 years 3 months at assessment, lives with his mother, grandparents and four brothers. He likes going to the park and playing with his brothers. His favourite subject at school is maths and his worst subject is English. His mother says she does not get angry with him and praises him about everything he does "because he puts so much effort into everything". Mark is quiet and

appears unsure of himself and does not seek adult attention but responds positively when he gets it. Mark was referred by the school health nurse because of concerns about his gross and fine motor abilities. He was assessed by the educational psychology service in 2004 using the Wechsler Intelligence Scales for Children III which found that his Verbal IQ = 100 and Performance IQ = 68. School had identified problems with literacy, numeracy, short-term memory and processing visual and spatial information. His receptive language skills were within the average range.

Perceptions

Mother

His mother's main concerns at the time of referral were

- Poor concentration
- Poor pencil control
- Unable to work independently, has trouble putting things on paper.
- Sequencing.
- Short memory

She would like him to have help with coordination, confidence and writing skills.

Teacher

His teacher's main concerns at the time of referral were

- Poor concentration
- Poor pencil control
- Unable to work independently, has trouble putting things on paper.
- Sequencing.
- Short memory

Mark

At the initial assessment Mark was seen with a physiotherapist and he was cooperative but rather quiet and timid. Using the Perceived Efficacy and Goal Setting System Mark chose the following goals

- Tying shoelaces
- Riding a bike
- Work faster at school

He did not identify any other areas of difficulty using the PEGS. Using the Pictorial Scale of Perceived Competence and Social Acceptance for Young Children[259] Mark did not identify any areas of doubt about his competence.

Using the COPM[217] with his mother and with reference to the PEGS the following goals were agreed for therapy

- Laces
- Riding a Bike
- Writing
- Swimming

Intervention method

Mark attended eight group sessions over a two-week period. The group included Mark and three other boys with similar difficulties. The groups took place at the children's centre at 3pm.

- Football skills were practised at all 8 sessions and included dribbling, toe tapping, pass ball around body or feet, passing and shooting. Mark joined in willingly even though this was not one of his goals.
- Skipping was practised at all eight sessions and included jumping over a rope, two others turning rope and turning his own rope. This was not one of Mark's original goals but following some initial success with skipping he became very keen on this. His mother bought him a skipping rope and he tried to teach his grandmother how to skip.
- Writing was practised at four of the sessions. Mark identified sitting properly, holding the paper, letter sizing, spacing, sitting letters on the line, forming letters a, b, c, d, f, p, v, y, A, K, Q, R, V, W and Y and writing faster as things he wanted to improve. This all relates to his goal of working faster at school. He was given a laminated card with his goals on to take to school and found the bulbous pencil grip helpful.
- Tying shoelaces was practised at five sessions. He learnt to do the knot on the third group session and was practicing the two loop bow at home with grampy. He makes the loops too far from the knot.
- Cutting with scissors was practised at two sessions. He performed cutting better when he propped his elbows on the desk.
- Sandwich making was done at two sessions. Mark enjoyed this even though it did not relate to any of his goals. He struggled to cut cheese with a knife.

Mark really enjoyed coming to the groups and chose to miss a school trip so he could come to the group on one occasion. He was generally quiet but always did as he was asked and clearly liked any attention from the other children or therapists although he never sought this out for himself.

Test results

Using the Movement ABC[41] Mark's coordination showed significant improvement immediately after intervention but this was not maintained at Test 4 see Appendix 8, Table A.

Mark's scores on the Pictorial Scale of Perceived Competence & Social Acceptance are all within the moderate to good range although there was a drop in his view of his peer acceptance at Test 4 see Appendix 8, Table B.

Using the COPM[217] there was a small but clinically significant change in his mother's view of Mark's writing performance from Test 2 to 3 but she did not change her view of his performance for all the other goals see Appendix 8, Table C. His mother's satisfaction did not change for any of the goals over time see Appendix 8, Table C.

Handwriting goals he set

- Needs to sit properly (sometimes)
- Needs to hold paper (sometimes)
- Lower case letters a b c d f p v y
- Upper case KQRVWY

Additional handwriting goal from therapist's perspective

- Spaces between words

Clinical judgement of outcome

Mark became more confident at attempting tasks he found difficult in the group. Mark learnt to tie the knot of his laces but makes the loops too far away from the knot. HI handwriting showed improvement with spacing words, adopting a good sitting posture and holding the paper steady with his right hand.

Summary of outcomes and conclusions

Movement ABC – improved immediately after group but not maintained.
Pictorial Scale of Perceived Competence & Social Acceptance – good scores in all domains remained throughout apart from a slight drop in peer acceptance.
COPM[217] – Mother did not see any significant changes in performance or satisfaction.
Psychosocial – mother says his confidence is improving but she still has many concerns for him.

Mark has made improvements with intervention but there are still a number of outstanding issues to be addressed. Although his mother says she has seen improvements she still has many concerns

for him. Mark has made progress with learning to tie his laces but still cannot tie the bow independently. It was not possible to work on bike skills in the group but he subsequently attended our bike skills group and learnt to ride independently. He had made some improvements in his writing with spacing words, adopting a good sitting posture and holding the paper steady with his right hand. His teacher has noticed improvements in school. However his writing is still not comparable to that of his peers nor does it reflect his verbal IQ. Swimming is a goal that will be addressed by the physiotherapist. Skipping was not a goal for him initially but it became one when he saw the other children in the group doing it. He made a lot of progress and went and bought a skipping rope and tried to teach his grandmother to skip! This intervention did enable him to achieve some goals but he required further intervention to ensure he made all the progress that was possible for him.

Child 8: Gary

General Background

Gary, aged 7 years 8 months at assessment, lives at home with both parents and his brother and sister. He likes skipping and music. His least favourite subject at school is English. Gary is a confident young man who seeks adult attention. Gary was referred by his health visitor. There have been concerns in school since reception, "constantly fidgeting, unable to keep still, poor concentration, shouts out inappropriately, very clumsy". Gary has extra help in school. He has good memory and conversation skills and uses the computer well. Gary has real problems with holding a pencil and his handwriting is described as "appalling". He has also been referred to the Specific Learning Difficulties service by the school. He is thought to have a possible specific learning difficulty. Gary's parents report he has slight colour blindness, gets migraines and had convulsions, the last one being over two years ago. He was born six weeks prematurely, his infancy was uneventful but he has always had behavioural problems. He has an individual education plan to improve fine and gross motor skills and to write one sentence with correct word spacing and spelling. The results from the end of Key Stage 1 teacher assessment are shown below (expected Level = 2).

Maths Level 2

Science Level 2

Speaking and listening Level 2

Reading Level 1/2

Writing Level 1

Perceptions

Mother

His mother's main concerns at the time of referral were:

- Very poor pencil grip (left-handed as well).
- Very poor handwriting.
- Poor co-ordination and balance (clumsy at home).

His mother finds his temper, the fact he does not listen and has difficulty mixing with his brother difficult to deal with on a day-to-day basis. She can praise him because he helps a lot, is "very loving and complimentary, advanced for his years in conversation and his memory is very good". His mother would like help with his handwriting, pencil control, fine and gross motor control and balance.

Teacher

His teacher's main concerns at the time of referral were:

- Very poor pencil grip.
- Very poor handwriting.
- Poor co-ordination and balance.

His class teacher stated "Gary is being held back academically by his difficulties with motor control. Gary is a bright boy with the potential to achieve higher than he has. He is deeply frustrated by his inability to write neatly and knows how much it is affecting his work in all areas of the curriculum".

Gary

Gary was assessed with a physiotherapist and both his parents. He was confident and interacted well with the assessors but said that his hand was getting tired towards the end of the assessment. Using the Pictorial Scale of Perceived Competence and Social Acceptance for Young Children[321] Gary felt his cognitive abilities were good but had serious doubts about hi physical competence and peer and maternal acceptance.

Using the Perceived Efficacy and Goal Setting System[238] Gary chose the following goals for therapy:

- To be better at ball games for playing baseball with friends and his brother and sister
- To be faster at running so that "in races he could mostly win"
- To be brave enough to try new things in the playground because he is a "bit scared"
- To tie his shoelaces

Using the COPM[217] with his mother and with reference to the PEGS[289] the following goals were chosen for therapy

- Laces
- Writing – Gary's mother chose this as a goal which he then agreed
- Ball games

Intervention method

Gary attended 7 group sessions at the children's centre with three other boys. The sessions were from 3-4pm over a period of two weeks. Gary was confident in the group and took the role of group leader and constantly called the therapist's names to get their attention. The group comprised of the following activities:

- Football skills were practised at all eight sessions and included dribbling, toe tapping, passing ball around body or feet, passing and shooting. At first I thought Gary was "messing about" when he tried to dribble the football. He got the ball between his feet and walked forward holding the ball between his feet. On the fourth session he started to dribble the ball properly and when I asked him why he had not done that before he said he could not do it before. This made me realise my mistake and understand how well he could mask difficulties.
- He practised skipping at seven sessions including jumping over a rope, two others turning rope and turning his own rope. Gary had identified skipping as one of his favourite activities and not as a goal for therapy but he could only skip with a rope when moving forward so we decided for him to work on staying on the spot when skipping.
- Writing was practised at four sessions. He identified he need to work on sitting properly and making g, l, p, q, z, R, S, V, Z, 5 and 8.
- Tying shoelaces was practised at five sessions. He learnt to do them at the first group and did them up the next morning and they stayed done up all day. By the 7th session he could tie a bow with short round laces.
- Sandwich making was done at two sessions. This was not a goal for him but he joined in and had difficulty spreading margarine with a knife. He had good planning for assembling the sandwich.

Test results

Gary's Movement ABC[41] score improved dramatically following intervention and this was maintained at Test 4 see Appendix 9, Table A. He no longer qualifies for a diagnosis of DCD.

Using the Pictorial Scale of Perceived Competence & Social Acceptance[259] Gary has no doubts about his cognitive competence. At the initial assessment he had serious doubts about his peer acceptance, physical competence and maternal acceptance. His doubts about peer acceptance and physical competence had improved at Test 2 and this was maintained at Test 3 and 4. By Test 4 his view of his maternal acceptance was in the "good" range. See Appendix 9, Table B for a summary of his scores.

Using the Canadian Occupational Performance Measure[217] Gary's father saw improvement in his performance see Appendix 9, Table C. Gary's father's view of his writing performance gradually improved over the four tests. His father felt his performance at tying laces and playing ball games improved following the group and this was maintained at test 4. His father used to play football himself and he was keen for Gary to improve his skills so they could knock a ball about together.

His father's satisfaction with all goals improved following the group and this was maintained, or improved at Test 4 see Appendix 9, Table C.

Clinical judgement of outcomes

Gary's coordination improved dramatically as measured by the Movement ABC following the group. There were clinically significant changes with COPM[217] for all goals. His writing has improved his sitting position, hand on paper and mum says she can now understand his writing in his homework book. He can now do own laces although they occasionally come undone. There was no change in ball skills score on Movement ABC but improvement in football skills noted by parents, child and OT.

Summary of outcomes and conclusions

Gary's coordination improved dramatically as measured by the Movement ABC[41] following the group. There were clinically significant changes with COPM[217] for all goals. The therapist also observed significant changes. His writing has improved his sitting position, hand on paper and mum says she can now understand his writing in his homework book. He can now do own laces although they occasionally come undone. There was no change in ball skills score on Movement ABC[41] but improvement in football skills noted by parents, child and OT. Gary no longer has

coordination or functional difficulties following intervention. This was confirmed during the two day camp when he demonstrated competent coordination skills in an ecologically valid setting. He could run on uneven ground and stop quickly when running down hill. He climbed and balanced on the adventure playground equipment with ease and confidence. He rode a bike without difficulty. Gary was also independent in self-care activities.

Movement ABC – improved dramatically after group and maintained.
Self Perception Profile – his view of his physical competence and peer and maternal acceptance had all improved from his initial assessment.
COPM[217] – Father saw improvement in performance and satisfaction for all goals
Psychosocial – Gary was proud of his newfound skills and keen to demonstrate them.

Themes emerging from the case studies

So far the analysis of the data has been done in two parts. First, in Chapter 7, group analysis has allowed an overview of the results of the programme much of it using quantitative methodology. The data in this Chapter show that there is some cause for optimism with the results of the programme. Secondly, in this current chapter, individual progressions have been explored and the results have shown how different children have responded in different ways to the intervention programme. A final analysis is to take the individual results and examine them by themes that have been proposed by a range of researchers. These themes help us by extending the manner in which we examine our whole approach to intervention, and the current data may be able to add to the themes already established in the literature.

There are a number of ways in which themes can be analysed and the choice made here is based on the wider concept of how we view the whole process of identification through intervention. For this, the approach here is on a framework influenced by Bronfenbrenner's ecological approach and the adapted PEO[66] model described in Chapter 3. Complementary to this is the model proposed by both Sugden and Keogh (1985)[15] and Newell (1986)[54] both of which have now become standard ways of examining outcomes of motor behaviour.[70] These models both show how the interaction of the child resources, the environment in which the activity takes place and the task itself, are all required to fully understand the final movement product.
In this study, the final outcomes and the process by which they were attained included the following measures and their relationship to each other:

The Movement ABC[41]

Harter's Scales of Perceived Competence[320, 321]

COPM[217]

Clinical judgement

These outcome measures can be divided into within child changes and within task changes with the former measured by the Movement ABC and Harter's Scales of Perceived Competence and the latter measured using the COPM and clinical judgement relating to the specific tasks. In addition, a reflective diary was kept during the group intervention period, which contained impressions relating to outcomes that are incorporated into the themes.

Environmental influences were analysed using Bronfenbrenner's view of the environment to consider the specific micro-system created by the group intervention whilst considering the potential impacts on the meso-system. Using a dynamic systems approach means studying any one aspect in isolation goes against the theoretical concept but this must be done in order to consider how the variables interact. Tasks cannot be analysed without considering the child and environment any more than the environment can be considered without reference to the child and the task. At times the lines between, for example, the task and the environment are not clear. When a task is modified the environment is also changed so, for example changing the type of laces a child uses to learn to tie the bow changes the environmental and task demands for the child.

This analysis considers the specific micro-system created by the group intervention whilst considering the potential impacts on the wider, meso-system. The group had its own culture, which evolved partly by the deliberate creation of the therapists and partly by the children themselves. It was explained to the children that they were all there to work on things which they found difficult as well as tasks that others found difficult which they would be able to help with. The principles of the group culture were to create an enabling environment where children and therapists helped each other. Personal improvement and mastery were ascribed valued in a climate that supported practising tasks that were difficult.

The PEO model considers the interactions between the person, environment and occupation, which enable occupational performance, a model very similar to, and influenced by, the task-environment-child one proposed by Keogh and Sugden[51] and Newell[52]. The micro-system of the group is analysed using this model. The analysis will consider the constraints and enablers provided by the group intervention by considering the task/activity/occupation, the person/participant and the group environment with consideration of how skills and behaviours transfer into other environmental contexts. Since the approach to intervention taken was task specific each of the tasks will be considered first.

Within task factors

The eight children and their parents identified a total of 30 goals to be achieved. Deciding whether goals were achieved is not straight forward as the views of the children, their parents and the therapist were not always the same. Therefore I have made a judgement call for each goal as to whether it was wholly or partially achieved or not achieved at all. Many of the goals were not specific enough to be clear about whether they had been met or not. This reflects the desire to be led by the children and parents in goal setting and accepting their definition of the goals, but in future the therapist's role should be aimed at describing the goal in measurable terms and this is a lesson learnt for the future. In future when a parent says "I want him/her to be more organised" then the therapist should identify the specific tasks that the parent has in mind such as packing their school bag or putting dirty laundry in the basket.

Twenty-two of the 30 goals were wholly achieved, five were partially achieved and two were not achieved at all. Partial achievement meant progress was made from the child's starting point but further skills were needed for total achievement of task e.g. child learnt to tie knot but not bow on laces or writing improved but was still not comparable with peers, were both considered to be partial achievement. The goals that were not achieved were swimming and riding a bike, neither of which were directly addressed in the group sessions for these children.

A range of methods was used to help the children achieve the tasks; appropriate practice, task analysis, task modification, guided discovery, scaffolding, backward chaining and peer teaching. Each task is considered and the methods used and those found to be effective are described.

Self care tasks

All 8 children selected tying laces as a goal and six of them achieved this and two children partially achieved it in that they learnt to tie the knot but not the bow. All children understood the requirements of the task and some knew the sequence of movements required but initially none of the children were able to execute the sequence of movements to complete the task. The task was modified in several ways to enhance learning. The children were provided with a selection of shoes and the Early Learning "shoe" to practice with. There was a selection of round and flat laces and some had the two laces in different colours. The children were shown the adapted two-loop or "bunnies ears" method as previous clinical experience and reference to the literature had suggested that this was easier to teach than the traditional method. The children were encouraged to try different lace and shoe combinations and see which they found easiest. As children gained skills the task was graded to be more difficult with using short, round laces considered the most

difficult. Once they had learnt the task they were encouraged to bring in their own lace up shoes to practice with to ensure transfer of the skill. Even once they had achieved the skill they were still encouraged to practice so that movements became smooth and flowing and more automatic. The first children in the group who learnt how to tie laces helped the other children using demonstration and verbal prompts as teaching techniques. The relationship between Movement ABC[41] improved manual dexterity scores and learning to tie laces was explored and there does not appear to be a relationship between learning to tie laces and manual dexterity, as some of the children who learnt to tie laces did not show improvements in their manual dexterity. Or it may be that the specific manual dexterity skills required for tying laces are not the same as the ones tested by the Movement ABC[41].

One child selected using cutlery as a goal although they all willingly joined in this part of the group. The children who had not chosen cutlery as a goal still demonstrated immature skills using cutlery during the group. Therefore they had the potential to benefit from this activity. The children made sandwiches in order to practice cutlery skills. This allowed them to practice spreading and cutting with a knife that are developmentally earlier skills than using a knife and fork together. The children needed to learn handling a knife successfully first. The child, Liam, who chose cutlery as a goal made significant improvements. Task modification enabled Liam to achieve this goal. Using the First Cutlery from a major chemist's store with moulded handles, which have an indentation for the index fingers, enabled him to become successful with using cutlery independently. All the other children had difficulty using cutlery and benefited from, and enjoyed this task, even though they had not chosen it as a goal. However this task was also used to help the children develop organisation and planning strategies.

Productivity tasks

Five children had selected improving handwriting as a goal. The specific components of handwriting that were difficult for the child were identified with the child. Children identified fatigue, their hand hurting, sweaty fingers, sitting correctly, stabilising the paper with the non-writing hand, writing faster, sitting letters on the line, being neater/tidier, letter size, formation and spacing as specific factors. The children were given worksheets tailored to their specific goals.

Assessing handwriting is notoriously difficult. Task analysis of handwriting is complex as it requires sensorimotor, cognitive and language skills. The focus of intervention was on task analysis of the required sensorimotor skills. Examining consistent sizing, correct formation and spacing could assess being neater/tidier. Handwriting speed was measured using a two-minute timed copy task.[328] It can be argued that this is not an ecologically valid task but improvements in speed on this task are assumed to be partially reflective of changes, which would also be seen in

the classroom. Children were instructed to write slowly then quickly and compare the results and problem solve possible solutions. The trade off between speed and legibility was discussed. Fatigue, pain and sweaty fingers were assessed by asking the child whether this had improved. Stabilising the paper, sitting letters on the line, being neater/tidier, letter size, formation and spacing were assessed by therapist observation and feedback from the child and parent and sometimes teacher via the parent/carer. For two children using a pencil grip modified the task. A foam grip was provided for Peter who complained of sweaty hands, which meant his hand slipped down the barrel of the pen. The foam grip stopped this. Paul used a soft bulbous grip, which he felt helped his grasp. He has hypermobility in his distal finger joints and this soft bulbous grip helps to support these joints.

The methods used to assist children met their handwriting goals were task analysis, task modification and the use of verbal and visual prompts. The task analysis of their handwriting was done by the child responding to questions on the checklist and the therapist provided worksheets to allow them to practice. Using pencil grips with two children modified the task of handwriting. During the group sessions the therapists gave verbal prompts to remind the children about the goals and they were given the key prompts a laminated card to take to school. Examples of prompts for body position were stabilising paper when writing and tucking chair in.

One child selected drawing as something he wanted to improve. He wanted to draw four legged animals and make them fill the page. He was given worksheets, downloaded from the internet, which broke drawing animals into stages which he was able to follow. Subjective judgement made by him and myself was that his drawings had improved but he would still like them to be bigger to fill the page. Improvements in this task were achieved by breaking the task down into stages for the child.

Finishing schoolwork on time was chosen as a goal by one child and as the intervention did not take place in school this could not be measured by direct observation. The mother's view, using COPM[217], was that this had improved immediately following the group but this was not maintained. This goal needed more analysis as to why he struggled to finish schoolwork on time by the OT and needed to be written in more specific terms. Observing the child in the group suggested he had difficulties staying on task without prompts, had difficulty organising himself and his handwriting was slow; all of these factors may have made finishing schoolwork difficult for him. In future research this goal would need to be clarified in order for it to be measured as it is not a specific task but a group of tasks.

Two children selected having a tidy desk as a goal and one child chose tidier maths as a goal. Both parents stated that general organisation, not just the desk was an issue for the children. When planning the group format I considered these tasks to have an important planning and organisation element and thought about everyday tasks that the children did that would require planning and organisation that I could use within the group to teach them some strategies which they could apply to a range of tasks. Difficulties with finishing schoolwork on time may relate to organisation difficulties. I used the tasks of packing a briefcase/schoolbag, making sandwiches, designing a poster doing a floor puzzle together as a group. This allowed me to see which children could plan and those that needed help. It became obvious that Peter had good planning and organisation skills, he made sure he understood the whole task then broke it task down and decided where to start. He would organise the others as well and give them advice e.g. "you need to lay everything out first". His difficulties with having tidy maths related to his poor motor control when trying to write numbers in small squares. I spoke to the SENCO who said he would ensure Peter had larger squared paper. This task modification has worked for Peter and his maths is now tidy. Sally demonstrated her ability to tidy desks or trays very well as long as she had enough time but when rushed everything fell to pieces.

Patrick selected performing household chores as a goal. He lives with his foster parents, brother and foster siblings in a busy household where all the children have set jobs to do and he wants to contribute to the family chores like the others but struggles with tasks such as sweeping up and folding clothes. At the end of each group session he swept the floor. He needed to be shown where and how to place his hands on the broom handle and how to sweep all the bits into a pile. By the third session he was able to hold and wield the broom correctly without having to be shown and by the end of the group his movements where more rhythmical and smooth. Sally and Paul both chose using scissors as goals. Both Sally and Paul were shown how to prop their elbows on the table when cutting with scissors to give them better control and accuracy.

Play and leisure

Liam and Gary selected being better at ball games and Patrick chose being better at football as a goal. The group included ball skills sessions practising dribbling, toe tapping, pass ball around body or feet, passing, shooting. The children were shown which part of their foot to kick the ball with and where to look e.g. look at the goal before shooting football, point your foot to where you want the ball to go at the end of the kick.

Peter and Mark chose riding a bike without stabilisers as a goal. They were in different groups and it was only possible to try and address this in Peter's group. Sally offered to help him as she

could already ride so she brought her bike in for two of Peter's five sessions including bike riding. Our service runs separate bike skills groups in a nearby velodrome and it proved difficult to use the same techniques at the children's centre due to lack of space. However Peter did gain some skills. He learnt to put his helmet on independently on the fourth session. He also learnt to mount the bike, use the brakes safely, prepare the pedal for push off and push off with minimal assistance to balance. He was able to pedal the bike with intermittent support to balance by session four. A straightforward task analysis approach was used established from previous experience and working in collaboration with several cycling coaches.

Paul chose skipping as a goal as he was going to have to do this soon at sports day and was nervous about performing poorly in front of his peers. When the other children saw him skipping they wanted to join in so this became a regular group activity demonstrating the influence of peers and how goals may change. The children were guided to attend to visual and auditory stimuli to help with timing and the use of verbal rote scripts such as "bend and jump" watch the rope when skipping, listen to the sound of rope hitting floor. Verbal guidance was given where deemed appropriate.

Running and swimming were additional leisure goals selected by children that could not be addressed in these group sessions. The child's physiotherapist will address swimming but we have yet to devise a care package to help children with running but this is under discussion with the physiotherapists.

Within child factors

For three children (Charles, Paul, and Gary) their general coordination (as measured by the MABC) improved so that they no longer qualified for a diagnosis of DCD, and this was maintained at test 4. Two children (Sally and Mark) no longer qualified for a DCD diagnosis immediately after the group but this was not maintained at test 4. The remaining three children stayed below the 5th percentile throughout the study period. All children acquired some skills for specific tasks evidenced by their ability to perform new tasks but these skills were not necessarily reflected by changes in their Movement ABC[41] scores. These changes are detailed in within task changes. It is assumed that object control must have improved for the children to achieve the goals of laces, handwriting, scissors and ball skills. Motor abilities were not addressed as a general skill but as required for each specific task.

There was no assessment of sensory abilities and therefore it is not possible to judge whether the newly acquired skills were due to changes in sensory processing, but some children achieved some additional cognitive skills. Charles, for example, learnt some new organisation strategies.

His difficulties with maintaining attention became obvious during the groups, as he often required verbal prompts to stay on task. During the organisation tasks children were guided in planning and strategy use by the therapists or other children. Prompts for where to look during tasks were often used for specific tasks.

One of the benefits of group intervention is that it gives opportunities to develop social skills in a safe environment. Liam's mother said she was surprised at how much he enjoyed coming to the groups, as he did not usually like "social things". Children were guided to think about their approach to the task in an atmosphere that rewarded effort above skill. All of the children exhibited or expressed frustration with their inability to do tasks at some time during the group. Both therapists and the other children supported children when they expressed frustration. The therapists tended to break the task down further or modify it whilst the children tended to demonstrate how they did the task e.g. "look I do it like this". In this way the children learned to work with others to achieve goals and to ask for help when necessary. The children were noted to watch each other a lot and seemed reassured by seeing other children struggling with the same tasks they did. I would suggest that knowing they are not the only one with problems brings a sense of relief. As the group progressed interaction between all group members (children and therapists) became more relaxed.

It is difficult to judge objectively if changes in temperament took place as a direct effect of the group but from observation of the group some aspects of temperament can be picked up. Temperament includes such qualities as sense of purpose, internal motivation and confidence. The children had demonstrated their motivation to achieve their goals as they selected them themselves. They also demonstrated willingness to work on tasks they had not selected which had been chosen by other children in the group. Patrick, Liam and Mark's parent/foster parent all commented spontaneously on the fact that they felt the child's confidence had improved. Peter's father said he was more willing "to have a go" and Gary was proud of his new skills and keen to show them. In my clinical experience it is often improved confidence and willingness to try new tasks that parents and carers report as perceived outcomes following therapy. It was hoped that the Harter's Scales may have captured this but it does not appear that this tool captures this, probably as it asks the children to compare themselves with their peers rather than with themselves and their personal gains.

Judging changes in personal beliefs is also a subjective exercise. It is possible that children believed they had gained skills due to effort and this may have changes their beliefs about attribution. It has been shown that children attribute success to effort, skill, task difficulty or luck.

Attributing success or failure, to effort and skill shows an internal locus of control, which means that the children think they have the power within themselves to effect changes. Attributing success or failure to task difficulty or luck demonstrates an external locus of control, which is not within the power of the child to change. I would tentatively suggest that by achieving goals, which were initially difficult for them the children may shift their attribution from external to internal and therefore have an impact on the next difficult task they encounter. This may be an avenue to consider as an outcome measure as if it can be shown that children's attribution has changed then this has the potential to generalise the effects of therapy to tasks other than the ones worked on in therapy. The three children who were able to use the COPM[217] showed they perceived their competence had improved as they rated their performance higher after the group and this continued to improve after the group had finished. Charles' perception of his behaviour and scholastic competence improved immediately after the group but this was not maintained at test 4 suggesting the group had a short-term impact for him.

Environmental Factors

The impact of environmental factors is first considered from the viewpoint of the environment within the group i.e. the group micro-system. Test 4 is measuring whether permanent learning has taken place and to see if the changes in skills have generalised to outside the group environment – the meso-system. The physical environment of the children's centre is child friendly with adjustable height tables and suitably sized chairs. It was unsuitable for bike riding and somewhat cramped for football skills and skipping although the room was cleared before each group to give the maximum space available. The social/cultural environment was supportive and accepting with both therapists and children contributing to this although the therapists set the tone. The motivational climate was deliberately task involved (as opposed to ego involved) and focussed on goals, mastery and personal improvement. The group provides an appropriate peer group of children with similar difficulties. It also provides an attitudinal atmosphere of acceptance, support and giving help when needed from the other children and therapists. Attitudes to the child may change with understanding of condition e.g. school staff, sibling and parents for Peter. Parental perceptions of competence and confidence may affect their attitude towards the child.

The gains demonstrated between test 3 and 4 are evidence that the skills had transferred to be used in other environments. There is evidence of consolidation and improvement post group although not all gains were maintained at test 4 suggesting the ongoing support of the group may be required for some children or that they needed a longer period of intervention.

In conclusion, an examination of these themes confirms that a full picture of a wide range of factors is required to fully evaluate a programme and that in the words of Sugden and Henderson:

"the success (or failure) of an intervention programme is a function of the dynamic interaction between the child, the environment and the task"[295] (page 3).

CHAPTER 9: Summary, discussion, limitations and implications

Summary and discussion

The overall aim of this thesis is to explore outcomes and effectiveness of occupational therapy interventions to children with DCD and their families. As the core feature of DCD is a motor impairment it was necessary to understand how children develop their motor skills and thus the literature relating to motor development in children was first reviewed. This review revealed the complexities of motor development with a dynamical systems explanation preferable and leading to many implications for intervention in children. The literature on DCD as a condition was reviewed showing it to be a heterogeneous condition, with children portraying multiple profiles. The work of occupational therapy is described illustrating differences between traditional and more recent innovative approaches. Finally in the literature review, intervention for children with DCD was summarised.

In the analysis of literature there were several key points that influenced the three subsequent studies, which form the body of the thesis. First a dynamic view of development and learning is adopted that views the dynamic interaction between the child, task and environment as fundamental to learning and development and this has implications for diagnosis, assessment and treatment. Secondly from the literature it is clear that the condition of DCD is still undergoing a process of definition and description even though the DSM-IV[8] diagnostic criteria have been accepted as the best definition currently available. The DSM-IV[8] criteria still require interpretation in order to be applied in a clinical setting. Thirdly the literature on occupational therapy intervention in DCD does not tend to endorse traditional methods but rather suggests there should be further exploration of more task orientated approaches that place a greater emphasis on changing the task and environment rather than the child's skills.

This thesis considers the impact of DCD on activities of daily living as a key focus for occupational therapy assessment and intervention. This in turn leads to exploring the different perspectives of children, parents and teachers in terms of the activities of daily living that are of importance. Listening to children and parents talk about the impact of DCD on daily living leads to thinking about how to address those everyday tasks in intervention, not just as part of the assessment process. This led in turn to designing a task-orientated intervention guided by knowledge from the motor learning literature about how children learn new motor tasks. This more individualised approach where intervention is tailored to each child also leads to considering outcomes from an individual as well as group perspective.

The initial impetus for studying these children was the large numbers of children referred to occupational therapists in Gwent and throughout the UK, because of concerns about their coordination, which creates long waiting lists. In order to reduce waiting lists it is necessary to improve effectiveness and efficiency by ensuring the correct children are referred and offered intervention and that the intervention methods used are effective. To establish whether intervention had been successful or not then outcome measures suitable for evaluating a task orientated approach need to be identified. If a service is to invest in intervention for children with DCD it is essential that the best available evidence support this intervention. Children with DCD are at risk of long-term negative consequences and intervention should aim to reduce this risk thus providing both a personal health and well-being rationale and efficiency of service rationale for the whole intervention process.[155]

The first objective is to identify and describe a method of applying the DSM-IV[8] diagnostic criteria for DCD in a clinical setting

The DSM-IV[8] diagnostic criteria require interpretation and there is no gold standard method for assessing children and applying the criteria in clinical settings.[22, 266] An approach to identification was taken which examined each criterion in turn. Anecdotal evidence suggests that not all the children are appropriately referred to occupational therapy and the first study supported this view as it found that only 31% of children referred for coordination difficulties met the criteria for a diagnosis of DCD. Inappropriate referrals included children whose difficulties could not be attributed to coordination as they scored above the fifteenth percentile on the Movement ABC[41] (28%), children with general learning difficulties (21%) and other medical conditions (10%).

The Movement ABC[41] appeared to be a suitable test for the application of criterion A whilst acknowledging that no test measures the whole range of motor skills and the Movement ABC is not without flaws as detailed in Chapter 5. Others also support the use of the Movement ABC such as Geuze and colleagues[30] in their review and discussion article where they identify the Movement ABC as one of the three most commonly used quantitative assessments for criterion A. They go on to state that the Movement ABC is the preferable test. The Leeds Consensus Statement guidelines[10] state that criterion A should be applied using an "individually administered and culturally appropriate, norm referenced test of general motor competence" (page7) and the Movement ABC fits this description. The Leeds Consensus[10] recommends the fifth percentile as the cut off point for criterion A, whilst the first and second studies included children below the fifteenth percentile the third study only included those below the fifth percentile. The initial

studies included children in the fifth to fifteenth borderline range as at that stage there was still ongoing debate about where the cut off should be. Most recently Missiuna and colleagues endorsed the use of the Movement ABC[41] as having several advantages over other assessment tools, which outweigh its limitations.[330]

Criterion B requires the clinician to establish whether the child's motor difficulties are "impacting on academic achievement or activities of daily living". Criterion B was applied by identifying the concerns of parents and teachers via a questionnaire and children's concerns via the PEGS. The combination of the PEGS plus parent and teacher questionnaires again appeared to a suitable method of applying criterion B and ensured the voices of the children as well as those of the adults who spend time with them was heard. It was felt to be of prime importance that the views of children, as well as parents and teachers, were sought to ensure the full range of activities of daily were considered. Applying the diagnostic criteria in this more systematic way resulted in taking a more in-depth view of criterion B than had been reported in some previous work. Different professionals have interpreted criterion B in a multitude of ways and little attention has been paid to it in many studies.[22] This study confirmed it as of unique interest to occupational therapists as assessing the impact of motor impairments on everyday tasks is a core occupational therapy skill. Consulting with parents about their concerns is a central tenet of family centred practice. Applying criterion B therefore not only contributed to the diagnosis but also to child and family centred practice.

A paediatrician examined all children and this should have ensured that criterion C was covered. Only a paediatrician can confirm the presence or absence of other medical conditions and they are therefore key professionals in the diagnostic process. However this study had no control over the actual medical examination that took place or the other diagnoses, such as ADHD, that were considered. As long as the child had seen a paediatrician who did not identify any other medical conditions then criterion C is considered to have been met. Future studies may wish to be more prescriptive in terms of the content of the medical examination.

Criterion D requires some clinical judgement but the guidance from the Leeds Consensus Statement[10] (published after this study) that a presumed or measured IQ cut off of 70 will remove the need for this subjective application to be made. Operationalising this criterion relied heavily on judgements made by teachers and therapists. The teacher's opinion of the child's cognitive level was used where IQ scores were not available. The therapist judged whether children with lower IQs had motor skills in line with their general developmental level. This study excluded 14 children because their motor skills were considered to be in line with their general developmental

level. Only one quarter of the children had an IQ score and it was not possible to either test or obtain these scores on the rest. Where IQs were available, a conservative cut off score of 85 was taken and it may be that some additional children may have been included if the IQ cut off of 70 rather than 85 had been used. In addition, both teachers' reports and clinical judgements were used to eliminate any child who was suspected of having a learning difficulty. Despite these careful attempts to ensure that no child below an IQ score 70 was included in the study, and a firm belief that these attempts were successful, Criterion D in the strictest formal sense was not comprehensively addressed and covered.

The first objective has been met by establishing a suitable method of applying the DSM-IV[8] diagnostic criteria in a clinical setting. The finding that many children are inappropriately referred to occupational therapy could be the first step in reducing waiting times as inappropriate referrals often use up valuable therapy resources. Each child must be assessed and have a report written of the findings which may take between two to four hours of therapy time according to informal discussions with occupational therapy colleagues. The process of applying the diagnostic criteria not only informs the diagnostic process but also helps to identify those children who need occupational therapy intervention. There is a high correlation between meeting the diagnostic criteria and needing occupational therapy, as most of the children who did not meet the criteria did not require further intervention. However we do not currently have the ability to identify which children will meet the criteria and need intervention without actually assessing them. The information provided at the time of referral proved insufficient to make this judgement. When the referrers', parent's and teacher's concerns of the DCD and non-DCD children were compared it was not possible to find any significant differences. On paper both groups of children appeared to have similar difficulties. Many referrers made reference to poor coordination for children who subsequently scored well above the fifteenth percentile on the Movement ABC. Other tools are therefore required to identify appropriate children at the point of referral. Implementation of a screening system to ensure the children without coordination difficulties are directed towards appropriate services requires investigation as this could significantly reduce waiting lists. The Developmental Coordination Disorder Questionnaire (DCD-Q) is a screening tool for children with DCD that could be considered.[294] When the DCD-Q[294] was compared with the Movement ABC[41] it met standards for sensitivity in a referred sample, but not the case in a random sample. Specificity did not reach the desired level of 90% in either sample, so the criteria for a screening tool are not quite met.[331] Specificity was particularly low in the population-based sample at 29%. However sensitivity was 82% and specificity 84% in the referred population so it may be acceptable for screening a referred population. The Movement ABC-2 is published this month

with a revised and shorter checklist, which has potential to be an initial screening tool but the psychometric properties will need to be examined when it is published.

The results from the first study were used to rewrite the referral guidelines for the department. The guidelines encouraged referrers to consider the DSM-IV criteria before making a referral. Following the publication of the article in *Archives of Disease in Childhood*[296] some key referrers contacted the department for further training. Presentations were made at team referral meetings. Children with known learning difficulties were not accepted for assessment unless a special case was made. To ensure children with learning difficulties needs were addressed training was offered free of charge to the entire special needs units in Gwent. This training provided general advice on enhancing gross and fine motor and self-care skills. Discussions also took place with local paediatricians about the differential diagnostic process to be used when considering criterion C. An audit of referral two years later demonstrated a significant drop in inappropriate referrals. There were still almost a third of the children who were assessed and discharged but this level was much more acceptable than the two thirds found in the first study. During discussions and training many colleagues stated the value of the assessment in understanding the child's needs and therefore this level of children seen for assessment, advice and discharge was considered acceptable by the service. It also ensured that children who needed the service were not denied it due to over zealous initial screening procedures.

The subsequent publication of the Leeds Consensus Statement supports the method of applying the DSM-IV[6] described in the first study and provides additional guidance, which will make subsequent studies even clearer in terms of inclusion and exclusion criteria for diagnosing DCD. The article based on this study and published in *Archives of Disease in Childhood* created much interest via email enquiries and has been referenced in a subsequent book and several articles. Applying the DSM-IV criteria in this way led me on to further consider diagnostic criterion B in detail, the impact of the motor impairment on activities of daily living which is covered by addressing the second objective.

In summary the method of applying DSM-IV criteria in a clinical setting involved the following:

Criterion A. Use of the Movement Assessment Battery for Children[41] and this appears to be an appropriate method.

Criterion B. Use of the Perceived Efficacy of Goal Setting together with Parent and Teacher Questionnaire. While this appeared to be satisfactory, this would have been enhanced through the use of the DCDQ.

Criterion C. This was addressed by all children having a paediatric

examination but this would be more consistently applied if information about the assessments used were made available.

Criterion D. This was addressed by some children having IQ scores (1/4) and a conservative cut off point (IQ<85) plus teacher questionnaire and clinical judgements by the occupational therapist. This would have been strengthened by all children having their IQs tested.

The second objective is to assess the similarities and differences between parent, teacher and child views of the impact of DCD on activities of daily living.

The second objective is examined in study 2 using the sample collected for study 1. The analysis for this objective was mainly qualitative in nature with no inferential statistics mainly because the data was mainly categorical and most of the cell sizes were too small for non-parametric statistics. In a bigger sample the addition of inferential statistics to look more objectively at the differences between the views of parents, teachers and children may be useful.

The literature review showed that activities of daily living are variably defined, particularly for children, so the taxonomy compiled from reviewing the literature in Chapter 4 was used to categorise activities. Activities were considered under the three generally accepted categories of self-care, productivity (work), play and leisure. Self-care tasks include personal hygiene, toileting, eating, drinking and dressing. Productivity tasks are the things that a child is expected to do like going to school, doing chores around the house and caring for others Productivity tasks include school based activities such as writing, using scissors, rulers and rubbers, home chores such as washing up, setting the table, sweeping up and looking after younger siblings. Play and leisure activities are the things that the child chooses to do with their free time for fun, pleasure and relaxation. Play activities for 5-11 year olds include construction, crafts, hobbies, games with rules, media and technology use (e.g. CDs, DVDs, computers), organised sport, social and dramatic play. Children with DCD were found to have difficulties with a wide range of activities of daily living across the three categories. The common self-care activities identified by these children with DCD were tying shoelaces, dressing quickly, cutting up food, doing zips and buttons whereas parents and teachers seldom identified self-care activities as an area of concern. It was not that the adults were not aware of the children having difficulties with self-care tasks rather that they did not see this as a major concern or priority for intervention. Often parents continue helping their children with self–care tasks without paying too much attention to the fact that the child may be better off with independence training. They are often not aware that the child wants to be able to say, cut their food up, but once the child has expressed this through using

the PEGS the parents are usually keen to work on it with the child. Sometimes they have tried to help the child in the past, for example to tie their shoelaces, but when this proved difficult would give up and resort to Velcro shoes that the child can manage independently. None of the teachers identified any self-care tasks as a main concern. Productivity activities that presented difficulties were pencil skills and finishing schoolwork on time and children, parents and teachers more commonly shared these areas as concerns. Play and leisure activities included playing sports, ball games, skipping and riding a bike but these were only identified by children and not adults. As with self-care tasks the adults were not unaware of the difficulties with these play and leisure activities they just did not identify them as a main concern.

Children, parents and teachers select different activities of daily living as being difficult for them and this reflects the findings of others.[243, 244] Adults made general comments about motor, psychosocial, cognitive or speech and language skills rather than linking them to specific activities. When they did link them to activities it was invariably in the area of productivity activities at school. This has been found to be the case even when adults are presented with activities including self-care, play and leisure tasks to choose from.[238] The top seven activities of concern for children were being able to tie shoelaces, finishing schoolwork on time, printing neatly, cutting up food, being good at sports, cutting with scissors and riding a bike. The top seven for parents were motor skills, academic/schoolwork skills, pencil skills, self-esteem/confidence, attention/organisation, "other" and social skills. The top seven for teachers were pencil skills, motor skills, academic/school skills, speech and language, attention/organisation and social skills with scissors, self-esteem and "other" all being in joint seventh place. Given the fact that the concerns were collected using different methods for the children and adults some caution needs to be exercised when comparing the concerns as noted previously. However there were some interesting points raised for consideration even using this imperfect method. There were only three areas where all three people shared the concerns, pencil skills, motor skills/sports and academic schoolwork concerns. Giving the children a voice through the use of the PEGS ensures that the full range of activities of daily living is considered and not just school based activities. The children's concerns give us much more information about self-care, play and leisure tasks such as dressing, using cutlery, playing sports and riding a bike. This is useful in helping to move away from an impairment-based model towards one that considers activity and participation as a focus for intervention. Parents and teachers appear to be more likely to use descriptors of difficulties that lead towards an impairment based approach. They will describe concerns about motor or cognitive skills rather than activities. Therapists may respond to these concerns by addressing them directly in a traditional way, for example working on motor skills in a general way. This may appear to be family centred practice as it responds to the

parents' concerns but by eliciting the child's goals as well therapists are more likely to take a functional approach. Listening to the voices of the also children reflects new directions in the education of children with special educational needs. The Code of Practice for Special Educational Needs states that children's views should be considered. Whilst the children do often want to improve their school based skills they have also given a clear message that independence in self-care and the ability to join in sport and leisure activities with their peers is also of great importance to them. It may be that the role of the therapist can be to advocate on behalf of the children to ensure that their voices are heard and their concerns are addressed.

The third objective is to develop an intervention method, which reflects child and parent/carer identified goals

This objective has four components. The first component is to establish a method of goal setting. The second component is to develop a task orientated intervention based on the goals that had been set. The third component is to develop an intervention that can be delivered to groups of children rather than individuals. The fourth component is to establish a sound rationale for the scheduling of the intervention.

Goal setting is seen as a core part of the assessment process once the diagnosis has been made. Using this approach the only standardised assessment used is the Movement ABC[41] whereas traditionally occupational therapists have spent a long time assessing component skills with a range of other tests that do not contribute to setting functional goals. Using the PEGS with the child to identify their goals starts the process of goal setting. The parent(s)/carer(s) are then asked if they are happy to go with the children's goals and if so are there any additional goals that they would like to add. At this stage the teacher's main concerns from the questionnaire are also considered as potential goals. Where more than five goals are identified then the top five most important goals are started with so that no more than five goals are being worked on at any one time. The therapist then moves into the COPM[217] process using the agreed goals and asks the parent and child where possible to rate importance, performance and satisfaction for each goal. The combination of doing the PEGS with the child followed by using the goals identified with PEGS to set COPM goals proved an effective method of goal setting. This method of goal setting allowed the child's goals to take priority with the therapist using negotiation skills to include parent and teacher goals with the child's consent.

Once the goals have been identified then a method of intervention that is suitable for meeting the goals is devised. First the motor learning difficulties that are evident in children with DCD need to

inform the content and structure of the intervention. We know that children with DCD seem to spend longer at the new learner stage with poor ability to detect and correct errors and use feedback mechanisms.[266] Children with DCD have difficulty with generalisation and transfer of skills.[332] Children with DCD have difficulty adapting and responding to environmental and situational demands and are poor at using knowledge of their performance to plan and activity.[266] Missiuna and Mandich have suggested that using knowledge of motor learning to provide intervention with appropriate feedback, opportunities to solve movement problems and appropriate practice, pitched at the correct stage of learning for the child is most likely to be successful.[333]

Each task was presented to the children with this advice in mind. For example football skills were practised during the groups. In order to play football you need to be able to control the ball with your feet as a basic skill before you can combine this with other skills to play a game of football as a member of a team. The children were at the stage where they were unable to dribble the ball with control and the group intervention gave the opportunity to practise this skill in a supportive and safe environment. The children's attention was drawn to which part of their foot they used to touch the ball, how much they moved their feet, how hard or softly they kicked the ball and where they were looking. Children were encouraged to comment on what worked and what did not for them. Praise was given for effort and individual improvement such as not using their hands to control the ball. Each task in the group was subjected to an activity analysis to identify the stages and component parts. Children were reminded of their goals and how this related to the task in hand. For example if a child was practising letter formation in handwriting they were reminded of their goal to have neater writing and how forming letters correctly will make their writing neater.

The rationale for selecting group rather than individual intervention was driven by a number of factors. These factors included a desire to be resource efficient, to give the children an opportunity to meet other children with DCD and to provide novice learner models. Establishing whether group intervention can be effective with children with DCD will inform service delivery models as it has the potential to increase efficiency, as children will be seen more quickly. The children were grouped by age with activities planned that were based on the goals. Although there was a wide range of goals identified it was possible to plan a group that ensured all the goals for each child were represented in an activity with only a couple of exceptions. The exceptions included swimming, riding a bike and trying new things on the playground. In order for the group to have some cohesion several of the activities were done by all the children together even though this meant some of the children were working on tasks they had not identified as goals. This did not present a problem in terms of the children's willingness to participate in the activities they had not

selected. There were several instances when children adopted tasks they had not initially selected as goals. For example, only one child out of four in Group 1 selected skipping but all children worked enthusiastically on their skipping skills and made considerable progress during the group. Given the fact that the children had selected the goals there was a greater emphasis on self-care and leisure tasks than would have been the case if goals only reflected parent/carer concerns. This made for very different groups than had been run previously where handwriting, balance and coordination would have been common goals. The third study examined the group intervention for eight children who set a total of 30 goals 22 of which were wholly met, five partially met and two were not met at all. The task-orientated group based on children's goals therefore appeared to be an effective intervention method.

Working on goals requires a different scheduling to the usual once a week intervention as the literature shows that intervention needs to be 3-5 times a week if using functional tasks in a group setting.[204] The group intervention took place 4 times a week. The motor learning literature tells us that the single most important variable is the amount of appropriate practice; the more appropriate practice, the more learning that takes place.[334] Getting the children to set their own goals covered pre-practice considerations such as motivation and goal setting. Instructions are a critical aspect of learning and one that therapists may not pay enough attention to. In the group intervention verbal instructions were often given and children were encouraged to talk about what they were doing and the therapists would pick up on the children's language and use this when giving future instructions. The OTs would also often check for understanding once an instruction was given by asking the child to repeat the instruction. The occupational therapists and other children performing the tasks provided models. The children watched each other with great interest and sometimes offered to show other children how to do things which was encouraged by the therapists. The next decision was whether the practice should be massed or distributed. In Chapter 7 this issue was discussed with the result that the intervention took place 4 times a week for two weeks, and one could argue whether indeed this was massed or distributed practice with the former term being preferable. This is different to the traditional OT delivery model but it proved to be effective and is offered as a flexible alternative to OTs and their services in response to any local demands that are placed on them.

The fourth objective is to conduct a pilot trial to explore how to measure the effectiveness of group occupational therapy intervention for children with DCD using a goal orientated approach

Traditionally outcomes have been measured in terms of improved motor skills or sensory integration. In this study the Movement ABC[41] was used as one of the outcome measures to identify changes in motor skills and gives the occupational therapist an objective measure to inform her clinical judgement. The results were pretty encouraging with children as a group improving significantly in their motor skills during intervention and this improvement was maintained over a period of four weeks with no intervention. This conclusion is presented with caution as there was no control group for comparison. However, in order to obtain more detail of the motor skill improvement individual analysis was conducted and this is discussed a little later in this chapter

However, when we intervene with children for anything we are not simply looking at the improvement or otherwise in a specific ability. We want to know whether there has been a change for the better in the overall well being of the child. In order to ascertain this, measures other than motor were required as well. An outcome measure that could respond to a variety of different goals was required and the COPM[217] was chosen as a suitable measure. The COPM[217] was used with all the parents and three of the children, which enabled them to rate performance and satisfaction with individual goals. This ensured that the parents' views and in some cases the children's views were taken in consideration as part of the outcome measurement. The parent's views did not always coincide with that of the therapist but the parent's assessment is seen as of equal value in family centred approaches. The Harter's[320, 321] was used to try and access the children's view and any changes in their views about their competence. This was not successful, as it did not identify any changes despite parents and children reporting changes in confidence. The Harter's[320, 321] did not pick up these changes either because they were not there in the children's view or it was not a suitable tool for capturing this. Clinical judgement suggested the reported changes appeared to be real and the children described feeling better so it is believed that it was not the correct outcome measure to capture this change. It may be that therapy intervention changes children's attribution of their successes to ability and effort rather than luck or task difficulty. The occupational therapist also used her own methods of observing the child perform the goals and evaluate how far they had been met. The therapist then considers the information from all the different outcome measures and makes a clinical judgement about whether the intervention was effective or not. The process of evaluating the general effect of intervention, referred to as clinical judgement is complex and requires more investigation. The process of clinical judgement may be partly assisted by using Goal Attainment Scaling. No one outcome measure captured the effect of intervention and therefore a range of outcome measures are needed to capture potential changes and reflect the views of all concerned, child, parent/carer and therapist.

The fifth objective is to explore the richness of information to show individual development and progressions

Group data provides mean changes in variables and probable differences before and after intervention but loses individual effects and outliers. The group can be broken down into sub groups and this showed three groups of children directly comparable to the groups found by Sugden and Chambers.[209] The first group's motor skills appeared to improve so that they no longer qualified for a DCD diagnosis even once intervention had stopped. A second group showed apparent improvement immediately after intervention but did not maintain this without intervention, and a third group whose motor skills remained below the fifth percentile throughout. Themes emerged from the case studies, which showed that changes occurred at the task and child level but not at the environmental level. The type of environment provided by the group was considered to play a part in changing the child and task factors. The intervention was not directed at changing the child's everyday environment and this should be considered in future interventions.

In order to really get a real feel for the effects of intervention then it is the individual children who tell the story. Each child has a unique response to the intervention experience. Intervention effects for each child are considered within the framework of the outcome measures using the person-environment-occupation model.[66]

Within person changes relates to changes within the individual child whether these relate to motor, cognitive or psychosocial changes. The children did not tend to comment on these changes even when they seemed quite dramatic. The children tended to relate changes to specific tasks or occupations. One father and son explained how he had started to learn to skate board with a friend next door, which he would not have felt confident enough to do previously. His father also reported that he joined in ball games in the swimming pool on holiday for the first time ever after the group. Observed changes within the children are improved motor skills and confidence. It is hypothesised that the children's attribution may have changed as a result of the group as they attribute success at meeting their goals to effort and skill rather than luck. Should this be true then the intervention effect will generalise to tasks other than those worked on during the intervention.

Within occupation changes relates to the achievement of goals and this was something that the children could more readily relate to. Twenty-two of the 30 goals were wholly achieved, five were partially achieved and two were not achieved at all. This demonstrates that the intervention was

effective in producing within task changes. Where there was partial achievement the children had made improvements in their skills but had still not totally achieved the task. The changes in occupations or goals for individual children had the most apparent effect. The children were proud of their new skills and liked to tell people and show people. One child who learnt to tie their shoelaces wanted to tie the laces for everyone they met for a while. The child who learnt to skip went home and taught his grandmother to skip. Many of the specific handwriting goals were met and one mother proudly told me she could now read what was written in his homework book, which had never happened before. Another child whose football skills had improved now went out and kicked a ball around with his father, which he could not do before. Yet another child was now keen to help prepare food in the kitchen at home after making sandwiches in the group.

Environmental changes were not the target of this intervention as it did not take place in the child's everyday environment. However the intervention may have had some indirect impact on the child's everyday environment by changing the responses of the adults in that environment. The way that the adults around the child such as parents, carers and teachers view response to intervention also contributes to the overall intervention effect. Firstly adult's responses to the child's behaviour may have changed through an increased understanding of the child's difficulties as a result of the assessment and goal setting process and subsequent report. Secondly the adults will respond to the child's newfound skills. The father who can now kick a ball around with his son spends more time with him or the mother who now sees her son as more of a social animal will consider a different range of activities for him. In a dynamic way the changes in the adults behaviour will effect how the child feels and behaves in a more general way. There were occasions when the parents seemed to be saying "this is more like the child we were expecting to have".

The sixth objective is to propose models for service delivery by combining the results of studies 1-3, current practice and the literature

The three studies are sequential in nature and all have implications for service delivery. Services start with referral followed by assessment, diagnosis, intervention, evaluation and discharge. The first study showed that many referrals could be inappropriate which raises the question of screening referrals. This study also showed that diagnosis requires some interpretation and therefore services need to make decisions on how they are going to do this and which professionals will be involved. Intervention can demand high levels of resources and services need to select intervention methods that are effective and efficient. The second study showed that children, parents and teachers appear to have different priorities for intervention. Giving the

children a voice showed that self-care, play and leisure tasks may be ignored if we do not listen to children's concerns. The third study examined a new style of intervention. Services need to consider the forms of intervention, which they are willing to support and present a rationale for doing so.

There is also a rationale for considering a staged approach with low level intervention offered to children initially and only those who do not respond to this being referred on to occupational therapy. This is very much in line with the three-tiered approach to intervention that is now being used in some reading schemes. In this children are first exposed to the experience of the activities without direct teaching and only if this fails do they engage in a more intensive form of a direct taught regime. Sugden and Chambers' work shows that parents and teachers can implement programmes at this level that are effective in improving the motor skills of some children.[299] Missiuna and colleagues have also advocated a model of service delivery that offers training, advice and education of parents and teachers in the first instance with referral on to an occupational therapist only after more generic strategies have been tried.[4]

The first step in designing a service delivery model for children with DCD is to identify all the people, professionals and others who have input with this group of children in a given area. This will usually include health and education professionals, parents and the voluntary sector. Social services are rarely involved with these children. A meeting needs to be called with representatives from all areas. This meeting would aim to identify existing care pathways for identification and subsequent service provision. Agreement needs to be made on who can make the diagnosis and then the second step can be considered.

The second step in designing a service delivery model for children with DCD is to reach a consensus about how to identify and diagnose DCD. This should be guided by the literature on DCD, DSM-IV[8] (1994 and 2000), London, Ontario Consensus statement (1995)[9] and the Leeds Consensus statement[10]. There is a rationale for a graduated response.[336] Firstly not all children considered to have coordination difficulties have DCD so an initial screening process to identify those children who do have, or are at risk of having, coordination difficulties. The new Movement ABC-2 checklist[295], Early Years Checklist[335] or DCD-Q[267] could be used as screening tools. The first two are particularly amenable to identifying IEP targets for intervention for children identified with or at risk of, motor difficulties.

In the first instance someone will raise a concern about the child's coordination this often a parent or teacher. When the parent identifies the concern they are likely to go and talk to the child's

teacher or their GP. In either case the coordination concern needs to be noted by the school so where the first point of contact is the GP then they need to direct the parents to the school or contact the school themselves. Once the school notes a concern then the first step is to check that there is a coordination difficulty, using checklist such as the Movement ABC-2[274]. Children identified as having coordination difficulties should have an Individual Education Plan (IEP) drawn up to enhance their motor skills. It may be that additional training or support from a professional with knowledge about motor learning may be required to enable the school to draw up a suitable IEP. This may be delivered by a learning support assistant (LSA) on a 1:1 basis or schools may wish to set up groups run by LSAs to promote motor skills. Alternatively they may wish to use the PE curriculum to address motor IEP targets. Sugden and Chambers work has shown that many children can improve their motor skills with a programme delivered by teachers or parents with support from a professional with expertise in children with motor impairments.[262] Following this school based intervention the child's motor skills should be reviewed and a decision made as to whether further intervention or referral to outside agencies such as occupational therapy is required.

The children who do not respond to this type of intervention are probably those with the more complex or severe difficulties and therefore should be referred on to specialist services. The process for this will vary according to local arrangements. In some areas the child may be referred to a paediatrician for assessment, in other areas the occupational therapist or physiotherapist may be the first port of call. This would then lead to a consideration of the diagnostic criteria including a standardised assessment of their motor skills with the Movement ABC-2[274] or similar test.

The third step is the assessment and planning the programme. Assessment includes, but goes beyond diagnosis. It identifies who is currently involved with the child and collates information from various sources including the child, parent(s) and teacher plus any professionals who already know the child such as speech and language therapist or educational psychologist. Using all this information a profile of the child is drawn up identifying strengths and weaknesses and key individuals. Priorities for intervention are agreed, objectives and goals set with an action plan for individuals involved with the child. Children's concerns should be noted as well as their parents', teacher's and any other significant people. The goals set should be specific, measurable, achievable, realistic and time limited with the name of the person with key responsibility for each goal. The programme should also provide education to parents, teachers and others about relevant strategies for helping children with DCD. The M.A.T.C.H. strategies have been shown to be effective helping children with DCD.[336] M.A.T.C.H. stands for modify the task, alter your expectations, teach strategies, change the environment and help by understanding. Using these

techniques addresses the child's resources, adapting the environment and modifying tasks. Providing those who see the child on an everyday basis with strategies to help them has the potential to be much more powerful and effective than the best therapy in the world which only happens once a week in a setting which is not part of the child's everyday life.

The fourth step is to describe and deliver an intervention plan. Only those children who have already received some input from school and still meet the DSM-IV[8] diagnostic criteria for DCD will receive direct occupational therapy and/or physiotherapy intervention. These are likely to be the children with the most significant motor impairments. Specific goals for therapy sessions need to be identified based on functional everyday tasks that are of importance and relevance to the child and their family. In the first instance it is suggested that the children attend a group intervention session similar to the one described in Chapter 7. The group should be task orientated and delivered at least three times a week for a minimum of eight sessions. Whilst the children are attending the group the parents could be offered workshops where they can learn about M.A.T.C.H.[267], share experiences and ideas, meet other parents and ask therapists for specific advice and information. After the group the therapist visits the child's school to discuss with the child's teacher the strategies that have been found to be helpful in the group. The child is then seen individually to review the goals and plan any further intervention if goals have not been met or new goals have been identified. A suggested model of service delivery that could be adapted to local conditions is proposed in Table 9:1.

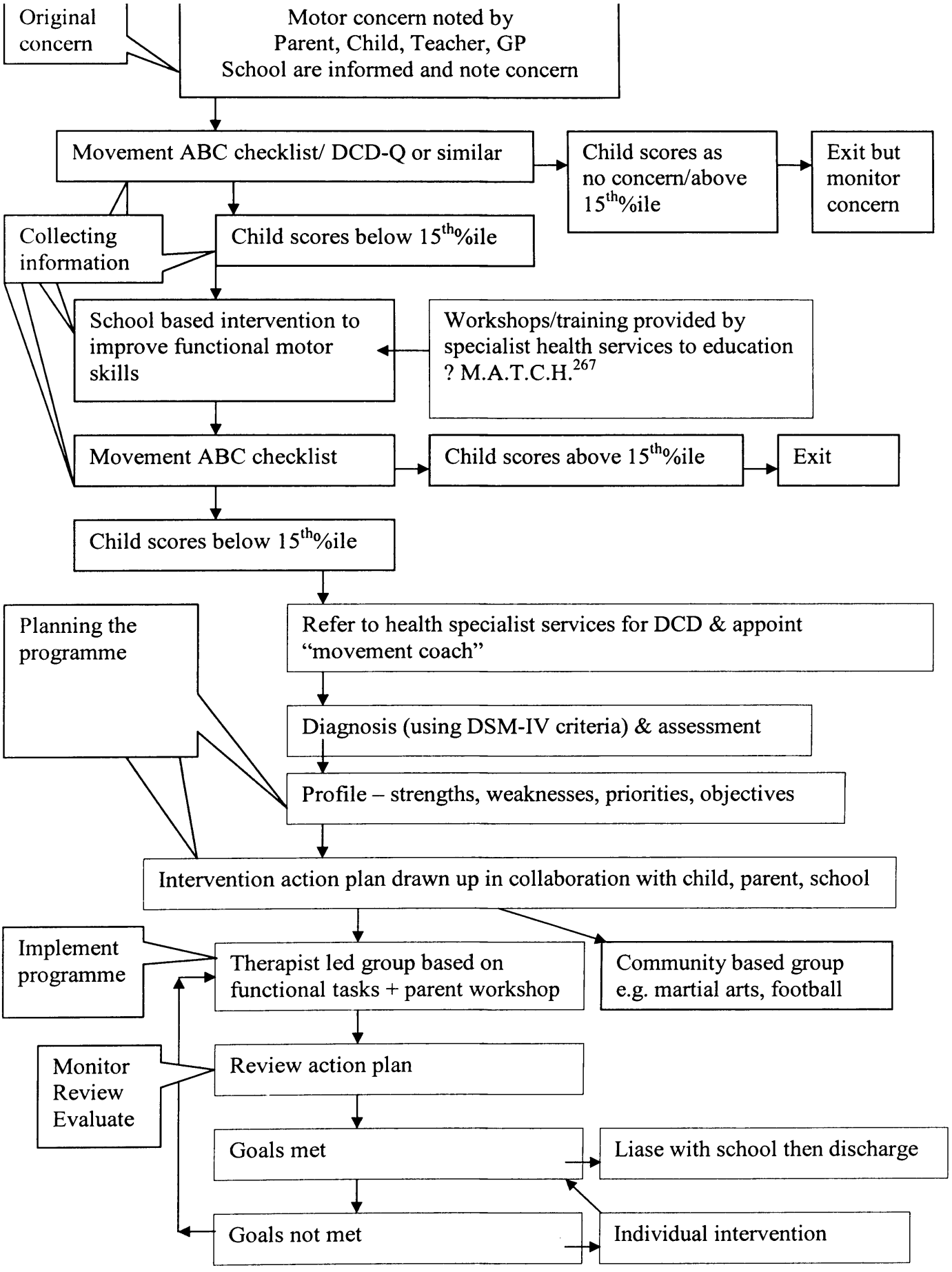


Table 9:1 Service model

Limitations

- The first study is limited by the fact that the sample only comes from one healthcare Trust and may only be representative of practice in that Trust. It would be useful to have data from other parts of the UK to establish whether this is typical of other services. However this data was collected from three different children's centres which reduces the possibility that it was due to any individual's poor referral practice. The addition of the DCDQ would have been beneficial as an additional screening procedure.
- Only one quarter of the children had an IQ score and it was not possible to obtain the others. As already mentioned because of this, Criterion D is not formally completely fulfilled. The IQ cut-off of 85 is a conservative measure but is not supported by the subsequently published Leeds Consensus statement[10], which recommends an IQ cut-off of 70. This would probably have resulted in a few more children being included but at the time the study was designed the recommendations of Geuze and colleagues article[30] was to use an IQ cut-off of 85 for research purposes.
- Comparing the child, parent and teacher concerns was compromised by the fact that for the adults the concerns were collected using a questionnaire and for the children using the PEGS.
- Due to the low numbers of children identified with DCD the sample for the second study ended up being smaller than anticipated which leads to caution about making generalisations to all children with DCD. The intervention study can be more correctly viewed as pilot as it had a sample with only eight children due to ongoing recruitment difficulties.
- The lack of control group for the intervention study is also a limitation. It had been hoped to compare the new intervention regime with a traditional, once a week group and a control group but this was not possible. The children therefore acted as their own controls by retesting the children after a period of 8-11 weeks with no intervention and comparing this with their scores after intervention.

Future Work

All of the study samples only provide a snapshot in time of the children and this cannot give a picture of the progression of DCD. The question parents often ask is "What will happen to my child when they are older?" and data that would help to answer this would be of interest. Longer-term follow up to establish the stability of the observations would be of great interest. For example retesting the children every six months over several years to observe how their DCD status changed or stayed the same would inform us about stability of the condition over time. It

would inform future practice to see whether the improvements the children made with intervention were maintained over time. The children who still had ongoing issues could have been given more intervention to see if it was simply not enough intervention for them or whether their skills were not amenable to intervention.

Implications for practice

All of the key findings of the three studies have implications for everyday occupational therapy clinical practice. Occupational therapists could consider their role in the process of diagnosing DCD and draw up local protocols based on the current literature. The findings from these studies could be seen as challenging to some traditional occupational therapy practices. Not all children are referred appropriately so services should not automatically offer intervention to every child who is assessed, as happens in some services. However it requires a certain amount of confidence to say to the parent of a child who has waited many months, maybe years, to see an occupational therapist that they do not need any occupational therapy intervention. Data from these studies and others that appear to support managers' decisions not to treat all children will hopefully be useful to occupational therapy service planning. Services can then write clear criteria about which children are to be offered intervention and ensure resources are directed where they will be most effective.

There is an argument for a graduated approach to intervention with more generic school based support initially. Again this fits in nicely with the current approaches in reading intervention such as the three-tiered approach that is popular in the USA.[337] This type of intervention could be directed and guided by an occupational therapist but not delivered by them as described in the suggested service delivery method described in the sixth objective above. Only those children who do not respond to this approach get referred on to health professionals for further assessment and intervention. Intervention should aim to enable children to succeed in performing activities of daily living that have meaning and value for them. It should also include educating parents and teachers to enable them to understand the condition of DCD and develop effective strategies to mange the condition on a daily basis. Adults can also learn how to help the children develop problem solving strategies and techniques for working around their difficulties. The more that professionals give away their skills to those who are with the children every day then the greater the potential benefit to children. It is the height of professionalism to give away your skills to others as far as possible.

Enabling the children's voice to be heard has shifted the focus of therapy intervention. Collecting information in the same way from children, parents and teachers would enable direct comparisons

to be made between specific, individual concerns about daily activities. This was a limitation of Study 2 that would require addressing in future studies. Using the child, parent and teacher versions of the PEGS would be one way of doing this. Parents and teachers tend to focus on school-based skills such as handwriting and component skills such as motor coordination. In contrast children tend to identify self-care, play and leisure tasks for the goals of intervention. This means that occupational therapists need to be skilled at activity analysis of task such as dressing, using cutlery and ball skills. This leads to using task specific, goal orientated approaches to intervention. These approaches need to be guided by the motor learning literature.[270]

One of the issues raised from reading the motor learning literature was that of scheduling of practice and from this literature there was little evidence to support the traditional occupational therapy practice of seeing children once a week. The minimum amount of time that seemed to be effective was three times a week for learning a new motor skill. This is potentially a big challenge to change practice to reflect this. Personal experience has shown me this as just after I completed analysing the third study I attended a planning meeting where I planned a once a week group simply because that was what had been done in the past. Habits are not always easily broken even when the evidence for doing so is compelling. Finally, my hope is that this thesis, and lessons learned from the studies, have gone some way in helping occupational therapy practice and through this better address the needs of children with difficulties in the future.

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Appendices 1-9

Appendix 1

Teacher Questionnaire

	First name	Family name	Date of birth
Child's name:			
Address:			

The above named child has been referred for an occupational therapy and/or physiotherapy assessment. Could you please fill in the form below answering as many questions as possible. This will help us to provide a better assessment for this child. The information you provide will be discussed with the parent/carers and may be used in our report.

School	
Address	**Post Code**
Telephone number	
Head teacher	
Class teacher	
Classroom assistant	

Does this child have a statement of special educational need? **YES / NO**

Is this child being assessed for a statement of special educational need? **YES / NO**

Is this child on the Code of Practice at school? **YES / NO**
If "yes" School Action or School Action Plus? Please circle: School Action School Action Plus

Does this child receive any extra help in school? **YES / NO** If "yes" please describe.

.....

.....

Has this child been seen by an educational psychologist, advisory teacher or specific learning difficulty service? **YES/NO** If "yes" please give name(s)

.....

Please list your main concerns for this child:

1.....

2.....

3.....

Please circle the words below which describes any areas of **difficulty** this child is having compared to other children of their age. The child may be too old or too young for some of the areas.

SELF CARE

Changing for PE Tying shoelaces Doing buttons Zipping up coat Tying tie

Using toilet independently Blowing nose Looking tidy Eating Drinking

HANDWRITING and PENCIL SKILLS

Colouring Writing name Pencil control Pencil grip Legibility

Writing quickly Letter formation Spacing words/letters Presentation/tidiness of work

Copying from the blackboard Discrepancy between writing and other skills

ACADEMIC AND OTHER SKILLS

English Welsh Maths Science Technology History Geography Art Music PE

Spelling Reading Academic progress Cutting with scissors Using a ruler Memory

Finishing work on time Speech and language Using money Telling time Needs adult support

PLAY and LEISURE SKILLS

Playing with friends Following rules Fearful Watches rather than plays Swimming

Able to occupy themselves Football Skipping Safety in playground

MOVEMENT and BALANCE

PE skills Gross motor skills Fine motor skills Motor control Walking Running Hopping

Jumping Playing ball games Climbing Falling over Fatigue/tiredness

Strength Pain Going upstairs Going downstairs Walking on uneven surfaces

Please circle the words below which describes any areas of **difficulty** this child is having compared to other children of their age. The child may be too old or too young for some of the areas.

SOCIAL, EMOTIONAL AND BEHAVIOUR

Social skills Self esteem Always in trouble Behaviour Confidence Making friends

Concentration/attention Avoiding danger Asking for help Cries a lot

Poor opinion of self Listening Following rules Temper tantrums Frustration

Making relationships with adults Making relationships with peers

Preferred hand: Please circle Right / Left / Swaps

Does this child have an individual educational programme (IEP)? **YES/NO**

If "yes" what are the main IEP target areas?.....

.....

Please give the results of any educational testing e.g. IQ, SATS results, reading age, spelling age and/or your opinion of this child's academic potential. (Please send us copies of any relevant reports.)

.....

.....

.....

.....

Please write other any comments or information you think may be helpful.

Signed:

Designation: **Date:** ***Thank you.***

We will send you a copy of our report following the assessment, provided the parents agree.

Parent Questionnaire

Your child has been referred for an occupational therapy assessment. Could you please fill in the form below answering as many questions as you can.

	First name	Family name	Date of birth
Child's name:			
Address:			
Post code:		**Telephone no.**	
Mother's name			
Father's name			
Who has parental responsibility?			
List people living at home			
School			
G.P. & Practice			

Does your child have a statement of special educational need? **YES / NO**

Is your child being assessed for a statement of special educational need? **YES / NO**

Is your child on the Code of Practice at school? **YES / NO**

If "yes" School Action or School Action Plus? Please circle: School Action School Action Plus

Does your child receive any extra help in school? **YES / NO**
If "yes" please describe.
.....
Is your child seeing any other health or education professionals?

Profession	Name	Date last seen
Educational psychologist		
Speech and language therapist		
Paediatrician (children's Dr.)		
Other		

Please list your main concerns for your child:

1. .....

.....

2. .....

.....

3. .....

.....

MEDICAL & DEVELOPMENTAL HISTORY

Do you think your child took a long time deciding which hand to use? **YES / NO**
Was this **right** OR **left** OR **still both**

Has your child's hearing been tested? **YES / NO** Result.....

Has your child's vision been tested? **YES / NO** Result.....

Has your child had any:

Serious illnesses **YES / NO**
.....

Serious injuries **YES / NO** Please state.....

Surgery **YES / NO** Please state
.....

Apart from typical childhood illnesses has your child been diagnosed by a doctor with any other conditions **YES / NO** Please state.....

Allergies? **YES / NO** Please state e.g. nut, latex, hay fever.....

Are the allergies intermittent or all the time?.....

Convulsions or fits? **YES/NO** If yes, are fits controlled? **YES no fits / NO fits sometimes. Last fit**.....

Is your child taking any medication/medicine at present? **YES / NO**

If yes what for?

.....

ACTIVITIES OF DAILY LIVING

Please circle the words below which describes any areas of **difficulty** your child is having compared to other children of their age. Your child may be too old or too young for some of the areas.

HOME and SELF CARE

Using a knife/fork/spoon Drinking from a cup Eating neatly Opening packets e.g. crisps

Wiping after toilet Washing hands Showering/Bathing Using telephone

Dressing quickly Doing up zips Doing buttons Brushing teeth Tying tie Tying shoelaces

Blowing nose Cutting/cleaning nails Brush/comb hair Using money



Telling time Doing household chores Sleeping



SCHOOL

English Maths Science Technology History Geography Art Music PE

Pencil skills Writing quickly Writing neatly/tidily Reading Scissors Sequencing

Finishing work in time Falling behind others Ruler Memory Speech and language

Favourite subject:.....Least favourite subject:.....

PLAY and LEISURE



Making things e.g. Lego, art & craft Playing ball games Sports Gymnastics

Playing with brothers/sisters Playing with friends Cannot occupy themselves

Safety in playground Breaks toys Joining clubs Roller blades/skates

Not safe left alone for short periods Football Rugby Swimming Riding a bike

Favourite activities:.....

MOVEMENT AND BALANCE

Hopping Jumping Falling over Walking Running Pain in legs

Gets tired quickly Walking on uneven surfaces Fatigue Strength Bendy feet/hands

Going upstairs Going downstairs Shoes wear out unevenly/quickly Carrying things

SOCIAL, EMOTIONAL AND BEHAVIOUR

Social skills Self esteem Always in trouble Behaviour Confidence

Concentration/attention Avoiding danger Asking for help Cries a lot

Listening Following rules Temper tantrums Frustration

Which things do you find most difficult with your child on a day to day basis?

.....

.....

Describe the things you can praise your child about.

.....

.....

Please list the things you would like an occupational therapist to help your child with.

1. .....

.....

2. .....

.....

3. .....

.....

Any other information you think we should know.

Are you happy for us to contact / request reports / discuss your child with professional colleagues in health or education?
Please circle **YES/NO**

Signed:.....Relationship to child:.....

Date:

Thank you.

Appendix 2: Charles

Table A: Harter's Self Perception Profile

Domain	SCORE
Scholastic competence	1.7
Social acceptance	2.3
Athletic competence	2.5
Physical appearance	3.2
Behavioural conduct	1.7
Global self worth	2.8

Scores: 1 = low, 2.5 = medium, 4 = high

Table B: Movement ABC

Subtest	Test 1	Test 2	Test 3	Test 4
Manual dexterity	4	2	2.5	1
Ball skills	9	7	4.5	3.5
Balance	9	8	0	7
Total impairment score	22	17	7	11.5
Percentile rank	Below 1st	2nd	29th	9th

Table C: Harter's Self Perception Profile for Children across the Duration of the Intervention

Domain	Test 1	Test 2	Test 3	Test 4
Scholastic competence	1.7	1.5	2.17	1.5
Social acceptance	2.3	3.5	3.5	2.83
Athletic competence	2.5	3.17	3	3.17
Physical appearance	3.2	3.2	3.67	3.83
Behavioural conduct	1.7	1.83	2.83	1.83
Global self worth	2.8	3	3.17	3.33

Table D Canadian Occupational Performance Measure

Goal	**Test 1**	**Test 2**	**Test 3**	**Test 4**
Handwriting	3	3	4	4
Finishing schoolwork on time	2	2	4	2
Organisation	3	2	5	3
Shoelaces	6/7	5	7	6
Mean score	**3.63**	**3**	**5**	**3**

Performance 1= not able - 10 = able to do well

Goal	**Test 1**	**Test 2**	**Test 3**	**Test 4**
Handwriting	1	3	4	4
Finishing schoolwork on time	1	1	4	2
Organisation	4	2	6	3
Shoelaces	8	5	8	6
Mean Score	**3.50**	**2.75**	**5.5**	**3.75**

Satisfaction 1 = not satisfied at all - 10 = extremely satisfied

Appendix 3 Patrick

Table A: Movement ABC Checklist

Section 1	Section 2	Section 3	Section 4	Section 5
21	30	22	22	8

Table B: Movement ABC

MABC	**Test 1**	**Test 2**	**Test 3**	**Test 4**
Manual dexterity	8.5	8	9	9
Ball skills	2	6	1	2
Balance	11.5	10	6.5	7
Total impairment score	22	24	16.5	18
Percentile rank	Below 1st	Below 1st	2nd	1st

Table C: Harter's Self Perception Profile

Domain	**Test 1**	**Test 2**	**Test 3**	**Test 4**
Scholastic competence	1.33	2.33	2.33	2
Social acceptance	2	3.33	2.83	3.5
Athletic competence	1.5	1.83	2.33	1.67
Physical appearance	4	3.83	3.83	4
Behavioural conduct	1.5	2.33	3.67	4
Global self worth	3.5	3.5	3.33	4

Table D: COPM - carer's view
Performance 1= not able - 10 = able to do well

Goal	Importance	Test 1	Test 2	Test 3	Test 4
Laces	10	1.00	10.00	8.00	8.00
Running	10	6.00	7.00	8.00	7.00
Household chores	10	5.00	6.00	8.00	8.00
Kicking balls	10	7.00	8.00	10.00	10.00
Mean score		**4.80**	**7.75**	**8.50**	**8.25**

Satisfaction 1 = not satisfied at all - 10 = extremely satisfied

Goal	Importance	Test 1	Test 2	Test 3	Test 4
Laces	10	1.00	7.00	10.00	10
Running	10	6.00	1.50	7.00	10
Household chores	10	4.00	8.00	9.00	10
Kicking balls	10	6.50	3.00	10.00	10
Mean score		**4.40**	**4.90**	**9.00**	**10**

Table E: COPM Patrick's view
Performance 1= not able - 10 = able to do well

Goal	Importance	Test 1	Test 2	Test 3	Test 4
Laces	10	1	4	8	9
Running	10	5	7	7	10
Household chores	10	5	6	9	9
Kicking balls	10	7	8	10	10
Mean score		**4.5**	**6.25**	**8.5**	**9.5**

Satisfaction 1 = not satisfied at all - 10 = extremely satisfied

Goal	Importance	Test 1	Test 2	Test 3	Test 4
Laces	10	1	2	10	10
Running	10	5	5	5	10
Household chores	10	3	5	7	8
Kicking balls	10	7	3	10	10
Mean score		**4**	**3.8**	**8**	**9.5**

Appendix 4: Liam

Table A: Movement ABC

MABC	Test 1	Test 2	Test 3	Test 4
Manual dexterity	13	15	12.5	12.5
Ball skills	6	10	7	7
Balance	8.5	13.5	11.5	11
Total impairment score	27.5	38.5	31	30.5
Percentile rank	Below 1st	Below 1st	Below 1st	Below 1st

Table B: Harter's Self Perception Profile

Domains	Test 1	Test 2	Test 3	Test 4
Scholastic competence	2	1.25	1.67	2.33
Social acceptance	3	3.67	3.2	3.5
Athletic competence	1.17	1.17	1	1.17
Physical appearance	3	3	2	2.33
Behavioural conduct	2.5	3.33	3.25	3.5
Global self worth	3.17	3.5	3.8	3.33

Table C: COPM - carer's view

Performance 1= not able - 10 = able to do well

Goal	Importance	Test 1	Test 2	Test 3	Test 4
Laces	10.00	1.00	1.00	3.00	5.50
Cutlery	10.00	1.00	1.00	8.50	10.00
Ball skills	9.00	2.00	2.00	8.00	9.50
Drawing	10.00			6.00	9.00
Mean score		**1.33**	**1.33**	**6.38**	**8.50**

Satisfaction 1 = not satisfied at all - 10 = extremely satisfied

Goal	Importance	Test 1	Test 2	Test 3	Test 4
Laces	10.00	1.00	1.00	5.00	10
Cutlery	10.00	1.00	1.00	10.00	10
Ball skills	9.00	3.00	2.00	10.00	10
Drawing	10.00			9.00	10
Mean score		**1.67**	**1.33**	**8.50**	**10**

Appendix 5: Peter

Table A: Movement ABC

MABC	Test 1	Test 2	Test 3	Test 4
Manual dexterity	5.5	5.5	5	5
Ball skills	9	9.5	7.5	6
Balance	8	6	6	7
Total imp. score	22.5	21	18.5	18
Percentile	Below 1st	Below 1st	1st	1st

Table B: Harter's Self Perception Profile

Domains	Test 1	Test 2	Test 3	Test 4
Scholastic competence	1.33	2	1.67	1.67
Social acceptance	3	3.33	3.83	3.17
Athletic competence	1.33	1	1	1.33
Physical appearance	2	2	2.5	2.33
Behavioural conduct	3.5	3.5	3.67	3.5
Global self worth	2.83	2.67	3.5	3

Table C: COPM- father's view

Performance 1= not able - 10 = able to do well

Goal	Importance	Test 1	Test 2	Test 3	Test 4
Laces	9	4.00	5.00	8.00	9.00
Writing	10	5.00	6.00	6.00	8.00
Tidier maths	6	5.00	4.00	5.00	8.00
Bike	7	6.00	7.00	8.00	8.00
Mean score		**5**	**5.5**	**6.75**	**8.25**

Satisfaction 1 = not satisfied at all - 10 = extremely satisfied

Goal	Importance	Test 1	Test 2	Test 3	Test 4
Laces	9	2.00	4.00	10.00	10
Writing	10	3.00	4.00	8.00	9
Tidier maths	6	3.00	2.00	5.00	9
Bike	7	3.00	6.00	8.00	9
Mean score		**2.8**	**4**	**7.75**	**9.25**

Table D: COPM Peter's view

Performance - child's view 1= not able - 10 = able to do well

Goal	Importance	Test 1	Test 2	Test 3	Test 4
Laces	8	3	2	9	9
Writing	10	5	5	3	7
Tidier maths	10	5	1	3	5
Bike	5	2	1	7	6
Mean score		**3.8**	**2.3**	**5.5**	**6.75**

Satisfaction - child's view 1 = not satisfied at all - 10 = extremely satisfied

Goal	Importance	Test 1	Test 2	Test 3	Test 4
Laces	8	1	1	10	10
Writing	10	4	5	2	8
Tidier maths	10	3	1	3	5
Bike	5	1	2	8	7
Mean score		**2.3**	**2.3**	**5.75**	**7.50**

Table E: Handwriting speed

Writing	Test 1	Test 2	Test 3	Test 4
Letters/min	72.5	75	87.5	67.5

Appendix 6: Sally

Table A: Movement ABC

MABC	Test 1	Test 2	Test 3	Test 4
Manual dexterity	4.5	5	0.5	5.5
Ball skills	8	9	6	5.5
Balance	8.5	8.5	4.5	5
Total impairment score	21	22.5	11	16
Percentile rank	Below 1st	Below 1st	11th	2nd

Table B: COPM- mother's view
Performance 1= not able - 10 = able to do well

Goal	Importance	Test 1	Test 2	Test 3	Test 4
Dressing	8	6.00	7	8.00	8.00
Having a tidy desk	8	1.00	3	5.00	7.00
Using scissors	6/7	5.00	3.5	6.00	7.00
Mean score		4.00	4.50	6.33	7.33

Satisfaction - mother's view 1 = not satisfied at all - 10 = extremely satisfied

Goal	Importance	Test 1	Test 2	Test 3	Test 4
Dressing	8	6.00	8	8.00	8
Having a tidy desk	8	1.00	3	5.00	8
Using scissors	6/7	5.00	5	5.50	8
Mean score		4.00	5.33	6.17	8.00

Table C: COPM - Sally's view
Performance 1= not able - 10 = able to do well

Goal	Importance	Test 1	Test 2	Test 3	Test 4
Dressing	10	3	5	5	5
Having a tidy desk	10	1	2	2	5
Using scissors	10	1	1	1	5
Mean score		1.67	2.67	2.67	5.00

Satisfaction - child's view 1 = not satisfied at all - 10 = extremely satisfied

Goal	Importance	Test 1	Test 2	Test 3	Test 4
Dressing	10	3.5	4	6	4
Having a tidy desk	10	1	1	1	4
Using scissors	10	1	4	3	4
Mean score		1.83	3.00	3.33	4.00

Table D: Harter's

Domain	Test 1	Test 2	Test 3	Test 4
Scholastic competence	1.2	1	1.17	1.5
Social acceptance	3	3.17	3.17	3
Athletic competence	2.3	2.5	2.33	2.5
Physical appearance	2.6	4	4	4
Behavioural conduct	2.6	3.83	3.33	3.83
Global self worth	3.5	3.67	3.83	4

Appendix 7: Paul

Table A: Movement ABC

MABC	Test 1	Test 2	Test 3	Test 4
Manual dexterity	9	3	3.5	4
Ball skills	2	2	0.5	2.5
Balance	3.5	2.5	2.5	2
Total impairment score	14.5	7.5	6.5	8.5
Percentile rank	4th	26th	32nd	20th

Table B: Harter's Self Perception Profile for Children

Domain	Test 1	Test 2	Test 3	Test 4
Scholastic competence	3.67	3.5	3.83	3.17
Social acceptance	3.5	4	3.4	3.5
Athletic competence	3	3.33	2.83	3.83
Physical appearance	3.83	4	4	4
Behavioural conduct	4	4	4	4
Global self worth	3.83	4	4	4

Table C: COPM- mother's view

Performance 1= not able - 10 = able to do well

Goal	Importance	Test 1	Test 2	Test 3	Test 4
Laces	4.00	6.50	6.50	9.00	8.00
Writing	10.00	4.00	4.00	7.00	8.00
Scissors	9.00	2.50	2.50	6.00	8.00
Skipping	5.00	3.00	3.00	7.00	7.00
Mean score		**4.00**	**4.00**	**7.25**	**7.75**

Satisfaction 1 = not satisfied at all - 10 = extremely satisfied

Goal	Importance	Test 1	Test 2	Test 3	Test 4
Laces	4.00	7.50	7.50	10.00	9
Writing	10.00	2.00	2.00	8.00	8
Scissors	9.00	2.50	2.50	6.00	9
Skipping	5.00	8.00	8.00	7.00	8
Mean score		**5.00**	**5.00**	**7.75**	**8.50**

Table D: Handwriting speed

Writing	Test 1	Test 2	Test 3	Test 4
Letters/minute	41	43	57.5	58.5

Appendix 8: Mark

Table A: Movement ABC

MABC	**Test 1**	**Test 2**	**Test 3**	**Test 4**
Manual dexterity	7	6	2	7
Ball skills	2	7	2	6
Balance	6.5	5	3.5	5
Total impairment score	15.5	18	7.5	18
Percentile rank	3rd	Below 1st	26th	Below 1st

Table B: Pictorial Scale of Perceived Competence & Social Acceptance

Domains	Test 1	Test 2	Test 3	Test 4
Cognitive competence	3.33	2.67	3	3.16
Peer acceptance	3	3	2.83	2.17
Physical competence	3.5	2.33	3.67	3.33
Maternal acceptance	2.83	2.33	2.33	2.33

Table C: COPM- mother's view

Performance 1= not able - 10 = able to do well

Goal	**Importance**	**Test 1**	**Test 2**	**Test 3**	**Test 4**
Laces	8	1.00	2.00	1.00	2.00
Bike	10	1.00	1.00	1.00	1.00
Writing	10	3.00	1.00	3.00	3.00
Swimming	10	1.00	1.00	1.00	1.00
Mean score		**1.5**	**1.25**	**1.50**	**1.75**

Satisfaction 1 = not satisfied at all - 10 = extremely satisfied

Goal	**Importance**	**Test 1**	**Test 2**	**Test 3**	**Test 4**
Laces	8	1.00	1.00	1.00	1
Bike	10	1.00	1.00	1.00	1
Writing	10	1.00	1.00	1.00	1
Swimming	10	1.00	1.00	1.00	1
Mean score		**1.00**	**1.00**	**1.00**	**1**

Appendix 9: Gary

Table A: Movement ABC

MABC	Test 1	Test 2	Test 3	Test 4
Manual dexterity	10	8	1.5	4
Ball skills	0	2.5	1.5	0
Balance	5	5	1	0.5
Total impairment score	15	15	4	4.5
Percentile rank	3rd	3rd	54th	49th

Table B: Pictorial Scale of Perceived Competence & Social Acceptance

Domain	Test 1	Test 2	Test 3	Test 4
Cognitive competence	3.5	3.5	3.33	4
Peer acceptance	1.33	3.5	4	3.5
Physical competence	1.5	3.33	4	3.83
Maternal acceptance	1.17	2	2	3

Table C: COPM- father's view

Performance 1= not able - 10 = able to do well

Goal	Importance	Test 1	Test 2	Test 3	Test 4
Writing	10.00	3.00	4.00	5.00	5.00
Laces	10.00	4.00	1.00	8.00	8.00
Ball games	10.00	5.00	4.00	7.00	8.00
Mean score		**4.00**	**3.00**	**6.67**	**7.00**

Satisfaction - father's view 1 = not satisfied at all - 10 = extremely satisfied

Goal	Importance	Test 1	Test 2	Test 3	Test 4
Writing	10.00	1.00	2.00	6.50	6
Laces	10.00	1.00	1.00	8.00	9
Ball games	10.00	1.00	3.00	7.00	9
Mean score		**1.00**	**2.00**	**7.17**	**8.00**