THE EFFECTS OF A GROUP EXERCISE PROGRAM ON PRIMARY SCHOOL CHILDREN AGED SIX TO TEN YEARS DIAGNOSED WITH DEVELOPMENTAL COORDINATION DISORDER (DCD)

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Declaration

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and I have not previously submitted it, in its entirety or in part, at any university for a degree.

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Signed: ……

Date: .....

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ABSTRACT

Background: Children who lack the motor coordination to perform the tasks that have usually been acquired at their age, given normal intellectual ability and the absence of other neurological disorders, are classified as having Developmental Coordination Disorder (DCD) according to DSM-IV. Limited professional resources prohibit individual therapy and these children are being treated in "gross motor groups" regardless of the fact that this has limited proven efficacy. This study aims to investigate whether group exercise physiotherapy does improve the gross motor function of children with DCD aged six to ten years old.

Methods: Thirty-nine children were assessed at pre and post intervention on the Movement Assessment Battery for Children (M-ABC) as well as the Perceived Efficacy and Goal Setting (PEGS) questionnaire by a blinded research assistant. They were randomly allocated to either a control (N=19) or an intervention group (N=20). The intervention group was then further subdivided into groups of four to six per group to attend group exercise sessions of 30 – 45 minutes three times per week. Group exercises were aimed at improving manual dexterity, ball skills and balance by incorporating aerobic exercises, strengthening exercises, coordination as well as task specific activities.

Results: There was a significant increase (p=.028) in the total scores tested by the experimental group on the M-ABC after the eight week intervention. Manual dexterity skills had improved significantly (p=.035). There was a trend for ball skills to improve (p=.088) but no improvement was recorded for static or dynamic balance post intervention. PEGS results indicated that subjects considered themselves as very competent regardless of their abilities.

Conclusions: The results of this study support the hypothesis that an eight week group exercise program can improve the gross motor skills of children with DCD. It would seem that implementing such an intervention is a viable option, especially where resources limit the availability of one to one therapy.

OPSOMMING

Agtergrond: Kinders wat ‘n gebrek aan motoriese koördinasie het om ouderdoms verwante take te verrig, gegewe dat hulle normale intellektuele vermoëns het en die afwesigheid van ander neorologiese abnormaliteite, word geklassifiseer as “Developmental Coordination Disorder” (DCD) volgens die DSM IV. Beperkte professionele menslike hulpbronne voorkom individele terapie en hierdie kinders word gewoonlik behandel in grofmotoriese groepe, ongeag dat daar min bewyse is dat dit ‘n effektiewe behandelings metode is. Die doel van hierdie studie is om vas te stel of ‘n fisioterapie groepsoefenprogram ‘n effektiewe behandelingsvorm is om die grofmotoriese vaardighede in ses tot tienjarige primêre skool kinders, met ‘n diagnose van DCD, verbeter.

Metodes: Nege-en-dertig kinders was geassesseer met die “Movement Assessment Battery for Children” (M-ABC) en die “Perceived Efficacy and Goal Setting” (PEGS) vraelys deur ‘n geblinde navorsingsassistent. Hulle is in twee groepe nl kontrole groep wat nie intervensie gekry het nie (N=19) en ‘n eksperimentele groep (N=20)verdeel deur eenvoudige ewekansige toewysing. Die eksperimentele groep was verder onderverdeel in groepe van vier tot ses om groepsoefeningsessies by te woon drie keer ‘n week vir 30 tot 45 minute. Die doel van die groepsoefeninge was om die volgende areas te verbeter: handvaardigheid, balvaardigheid en balans deur die inkorporasie van balansaktiwiteite, spierversterkingsoefeninge, koördinasie sowel as taak spesifieke aktiwiteite. Die deelnemers was weer geassesseer met die Movement-ABC en die PEGS na die agt weke lange intervensie program.

Resultate: Daar was 'n beduidende toename (p=.028) in die algehele telling deur die eksperimentele groep op die M-ABC na die agt weke deelname. Handvaardigheid het beduidend verbeter (p=.035). Daar was ‘n tendens vir balvaardighede om te verbeter (p=0.88), maar geen verbetering was aangedui vir balans na die ingryping nie. Die PEGS resultate was moeilik om te interpreteer aangesien die deelnemers hulself as baie vaardig gesien het ten spyte van hulle vermoëns.

Gevolgtrekking: Die resultate van hierdie studie ondersteun die hipotese dat 'n doelgerigte groepsoefeningsprogram wel die grofmotoriese vaardighede van kinders met ‘n diagnose van DCD verbeter. Fisioterapeute kan 'n groepsofeningsprogram met vertroue implementeer waar 'n tekort aan menslike hulpbronne een tot een terapie beperk.

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CHAPTER 1:
INTRODUCTION

Treatment of children with Developmental Coordination Disorder, or DCD, as it is more commonly referred to, is traditionally managed on an individual basis due to the complexity of the clinical presentation of the disorder. However, in the situation where there is a dearth of resources but where children have access to special education centres, a more viable option may be to treat these children in groups rather than on an individual basis. This project aims to explore this possibility. In this chapter a brief description of DCD is also given followed by typical intervention strategies therapists are and have been using to treat or manage children with DCD. A more detailed description of the problems experienced in our work setting in the Western Cape, South Africa, necessitating the exploration of alternative approaches to the management of children with DCD, will also be discussed.

1.1 Definition and characteristics of Developmental Coordination Disorder

According to international estimates, there is a prevalence of ~6 % of children aged 5-11 years who are diagnosed with DCD (American Psychiatric Association/APA, 1994; Peters et al, 2001; Dewey & Wilson, 2001; Miller et al 2001). However, these studies have all been conducted in first world countries, i.e. Canada and United Kingdom. South African statistics are unknown at present, but there is no reason to believe that the same is not true. The incidence is reported to be higher in boys than girls (Miller et al, 2001; Missiuna, 2003) although no explanation has been given for this. These children lack the motor coordination to perform the tasks that have usually been acquired at their age, given normal intellectual ability and the absence of other neurological disorders. This is in accordance with the definition found in the Diagnostic and Statistical Manual for Mental disorders (DSM IV) (APA, 1994). The process as to how the name DCD originated is discussed in more detail in chapter 3.

Problems experienced by children with DCD at school are varied. Untidy, slow handwriting and immature drawing are most common. Difficulty coping with cloakroom, lunchroom and bathroom routines means that they are messy eaters and exhibit poor dressing skills such as tying shoe-laces and doing buttons. Difficulty with participation in gym class (clumsy), difficulty in relating to peers and poor playground interaction, avoidance of structured and unstructured physical activities are some other features also described in the literature (Dewey & Wilson, 2001; Miller et al, 2001; Peters et al, 2004; Dunford et al, 2005).

The common characteristics that may be found in these children have been described in many articles but DCD is not a homogenous disorder (Kaplan et al, 1998; Dewey and Wilson 2001, Mandich et al 2001; Geuze, 2005). It may be comorbid with a variety of other disorders such as Attention Deficit (Hyperactive) Disorder (ADHD), a reading disability (RD) as well as developmental language disorders (Kaplan et al, 1998). In fact these authors believe that comorbidity is the rule rather than the exception.

A major cause for concern, even more so than the motor impairment experienced by children with DCD, is marginalization, which negatively influences self perception (Chen & Cohn, 2003; Rodger et al, 2003). Participation in typical activities of childhood e.g. in the classroom and on the playground, is an essential component of childhood development (Mandich et al, 2001; Mandich et al, 2003). Participation in physical activity also plays a vital role in the child's ability to belong in a peer group, maintain friendships and social interaction. The sense of self-worth in DCD children influences their motivation to participate in physical or social activities in many contexts. Skinner & Piek (2001) found that if people perceive themselves to be physically incompetent, they have decreased motivation to practice motor skills and therefore have decreased participation.

Losse et al, (1991) and Skinner & Piek (2001) found that children with DCD perceive themselves as less competent in physical appearance as well as physical, scholastic and social competence. Skinner & Piek (2001) also reported an association between motor coordination problems and low self esteem and anxiety. Losse et al (1991) and Cantell et al (1994) found that these children do not outgrow their problems and that they persist well into adolescence and are accompanied by other problems at home and school such as depression and or aggression.

1.2 Management of Children with DCD

There is disagreement in the literature about the underlying philosophies of interventions and approaches because there is so much conjecture as to the underlying physiology of DCD. Early intervention strategies arose from the view that DCD was a minimal form of cerebral palsy and so treatment was focused on sensory integration. Ayres (1972) defines sensory integration as the ability to organise sensory information for use, its function being to improve academic skills as well as motor skills without teaching specific skills. She argued that if the brain developed the capacity to perceive, remember and motor plan, these abilities could be applied to master academic and other tasks regardless of specific content.

Another treatment approach is a more cognitive based theory and suggests that the motor control difficulties with which these children present, is the problem solving aspect. This was put forward not as a new method of intervention but rather as a general set of principles

applicable to any method of training. More current understandings include the influence of task and environment on an individual's development (Missiuna, 2003).

No guidelines have been put forth as to when to intervene, at what age to intervene or who should intervene. Current recommendation according to Inder & Sullivan (2005), states that each child should receive holistic, child centered and individualised treatment. Hillier (2007) conducted a literature review for evidence of effectiveness of interventions that aim to improve movement ability of children with DCD. The author found that perceptual motor training and sensory integration therapy were the most widely investigated approaches and showed positive effects but that any intervention, regardless of approach, was better than no intervention for children with DCD. Only two of the 47 articles that were reviewed by Hillier (2007) incorporated group intervention. One study (Pless et al, 2000) compared a group intervention to a control group with no intervention and found no difference between the two groups. The other (Davies & Gavin, 1994) compared individual intervention and group/consultation and found that there was improvement in both groups.

1.3 Current situation at schools in South Africa

South Africa's education system makes allowance for schools for learners with special education needs (LSEN). Many of these children attend these schools because of the learning problems they have probably encountered and were unable to cope in mainstream education. Physiotherapy, Occupational Therapy, Speech Therapy and Psychological services are usually offered at special schools. However, due to limited funding and resources, the post allocation is often such that the therapists are unable to manage their case loads which traditionally allowed for individual treatment sessions. Children with minimal motor problems are now often considered low priority and priority is usually given to the children with physical disabilities who require a lot more hands-on management. Few of the parents of these children have the financial resources to send their children for additional private physiotherapy. Special needs pediatric services at Community Health Centres and Day Hospitals are also lacking and children are waitlisted in order to gain access to the schools which provide these essential services. In the Western Cape the children with a diagnosis of DCD are seen in groups – if they are fortunate to be receiving therapy at all.

The current situation regarding the treatment of children with a diagnosis of DCD at Eros School is largely therapist and case load dependent. Priority is given to the physically impaired as well as those where a special request has been made by the teacher. These children are given individual therapy slots. There are then so few time-slots left that a whole class (approximately 15 – 18 learners) is often seen together so that at least they are exposed to general exercise therapy session(s).

Current literature has primarily investigated various interventions / therapies on an individual basis of treatment but few studies have investigated the effectiveness of group therapy for children with DCD. In a study by Peens et al (2007), 58 children with DCD aged seven to nine years were divided into 4 subgroups: 20 children into a motor intervention (MI) group, 11 into a psych-motor intervention (P-MI) group, 10 into a self – concept enhancing (SC) group and 17 into a control group (CG). The MI group showed statistically significant ($p<0.01$) improvement post group intervention. However, the fact that the control group also showed significant ($p<0.01$) improvement questions the significance of the intervention. The researcher implemented the program as well as conducted the pre- and post intervention assessments, means that there could have been some tester bias in the results of the study. Although the sample was small, the power analysis indicated that each group was large enough (n=12) in order for the results to have statistical power. Pless et al (2000) conducted a study in Sweden to investigate if group motor skill intervention added to consultative services is an effective form of treatment for five to six year old children with DCD. This study compared an experimental group (n=17) with a DCD control group (n=20) after a ten week program (once a week) and found no significant difference between the groups post intervention but noted that more children in the 5^{th} to 15^{th} percentile ("at risk") in the experimental group than the control group had improved their category after intervention. These results look promising in support of group motor skill intervention in children with DCD, but would still need to be tested imperically. The program was compiled by a physiotherapist, but was conducted by a physical educator who may not have had sufficient understanding of normal vs. abnormal movement patterns to facilitate the children should they be experiencing difficulties. The educator may therefore not have assisted the children to reach their maximum potential during the exercises.

There are many other benefits to participating in groups. From an educational perspective the National Curriculum Statement (NCS) places great emphasis on group work for the following reasons: (a) more learners are helped at once, (b) learners acquires skills to socialise better, (c) motivates them in many ways. Perceived lack of motivation in learners with DCD is actually reflecting how hard it is for the child to learn a new task / skill and concentrate on new movement patterns a swell as to keep going when they are fatigued (Rivard & Missiuna, 2003). Therapy conducted in group format could therefore address the physical problems these children are experiencing but also help in other aspects, e.g. improve social interaction, develop self-confidence in their own abilities as they experience success in the group and they could learn to work in a team (Dednam, 1998). This is corroborated by Johnson and Johnson (2005) who believe that groups help shy children to gain confidence; they learn from their peers and are motivated by them. These authors also

consider groups to help children learn social skills which promote cooperation rather than conflict.

The current study therefore aims to contribute to the evidence supporting group exercise therapy in this population by investigating the effect of an eight week group exercise program on the motor function, specifically balance, ball skills and manual dexterity of children with DCD.

1.4 Research Question

Will an eight week group exercise program improve the gross and fine motor skills performance as well as the self perception of primary school children aged 6 – 10 years diagnosed with Developmental Coordination Disorder (DCD)?

1.5 Objectives

In a group of 6-10 yr old children with DCD, the specific objectives of the current study are to determine the effect of an eight week group exercise program on:

1. Ball skills – This is defined as the ability to catch or aim objects as tested on the Movement ABC (M-ABC) , a standardized instrument to identify children with motor impairment as well as assessing the efficacy of treatment programs (Hendersen and Sugden, 1992)

2. Manual dexterity – This is the ability to manipulate objects (M-ABC)

3. Balance – static and dynamic balance is a measure of one's ability to maintain a position both stationary or while moving (M-ABC).

4. Any change of category as measured on the M-ABC and the relation to the degree of severity at baseline testing

5. Self-perception as tested using the Perceived Efficacy and Goal Setting System (PEGS), a standardized instrument or questionnaire which allows children with disabilities to reflect on their ability to perform essential daily tasks, e.g. writing (Missiuna et al, 2004).

CHAPTER 2:
LITERATURE REVIEW

It is imperative that one has a good understanding of the children who are being investigated and have knowledge and an understanding of intervention possibilities, especially in resource scarce environments. This chapter will expand on the definition and clinical presentation of DCD and give more background on how the term DCD originated. The prevalence and aetiology is also described. The databases Pubmed, Cinahl, Ebscohost and Cochrane were searched and it is evident that researchers are trying to develop a better understanding of the development of these characteristics. There is also much description of the impact DCD has on the lives of these children. The latter half of this chapter will deal with traditionally prescribed intervention strategies, followed by the motivation for the current research.

2.1 Current understanding and description of Developmental Coordination Disorder

DCD has been described under many names which can be seen in Table 1 below. However, in 1994 an International Consensus Meeting on Children and Clumsiness was held in with the primary focus on reaching a decision on a definition and more importantly a name for the disability (International Consensus Statement, 1994). At this meeting it was decided that the DSM - IV term Developmental Coordination Disorder (DCD) would be used. It was described as a chronic and permanent condition characterized by functional motor performance deficits that were not explicable by the child's age, intellect or any diagnosable neurological or spatial-temporal organizational problems. (APA, 1994) There was a call for the development of a comprehensive diagnostic process in order to distinguish DCD from other disorders.

The **DSM – IV** diagnostic criteria are as follows: (APA, 1994)

Criterion A: Motor coordination

Performance in daily activities that require motor coordination is substantially below that expected given a 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.

Table 1: Various terms used in the past for DCD

TERM	AUTHORS
Clumsy, Developmental Clumsiness	British Medical Journal (1962) Walton et al. (1962) Gubbay et al. (1965) Gordon (1969) Dare & Gordon (1970) Gubbay (1975) McKinlay (1978) Keogh et al. (1979) Henderson & Hall (1982) Hulme et al. (1982) Knuckey & Gubbay (1983) Hulme & Lord (1986) Van Dellen & Geuze (1988)
Apraxia, Developmental Apraxia, Developmental Dyspraxia, Dyspraxia – Dysgnosia	Orton (1937) Walton et al. (1962) Gubbay (1978) Lesny (1980) Denckla (1984) Cermak (1985)
Physically Awkward	Wall (1982) Wall et al. (1990)
Poorly coordinated	Johnston et al. (1987)
Motor Infantilism	Annell (1949)
Delayed Motor Development	Illingworth (1968)
Children with movement Difficulties	Hendersen et al. (1989) Sugden & Keogh (1990)
Minimal brain damage	Forsström & von Hofsten (1982) Schellekens et al. (1983)
Minor neurological Dysfunction	Touwen (1993)
Perceptuo-motor dysfunction	Lazlo et al. (1988)

Adapted from Henderson & Barnett (1998): pg 451

Criterion B: Academic achievement or activities of daily living

The disturbance in Criterion A significantly interferes with academic achievement or activities of daily living.

Criterion C: Medical conditions

The disturbance is not due to a general medical condition (e.g. Cerebral Palsy, Muscular dystrophy etc.) and does not meet criteria for a Pervasive Developmental disorder.

Criterion D: Specificity and cognitive ability

Motor difficulties must be in excess of those usually associated with mental retardation.

The DSM IV classification is commonly assumed to be the equivalent to the Specific Developmental Disorder of Motor Function (SDDMF) in the ICD 10 coding (Geuze, 2005). The two major medical classification systems do not agree with each other about the label or classification of the "clumsy" child, and may be why DCD has been referred to as a "hidden" disability by some authors (Miyahara & Register, 2000; Gibbs et al, 2007). Miyahara & Register (2000) believe this is because of the lack of consensus regarding the name of the disability and despite the consensus reached around the term DCD, people still use the terms such as dyspraxia and clumsy. In fact, the American Academy of Paediatrics for prescribing therapy services for children with motor difficulties, have not included DCD among the list of conditions to be treated (Michaud, 2004) but this may be due to the paucity of studies addressing the role of physiotherapists in the management of DCD (Watemberg et al, 2007).

The World Health Organisation (WHO, 1992) has the following diagnostic criteria for "Specific Developmental Disorder of Motor Function" (SDDMF):

> *"The child's motor coordination, on fine or gross motor tasks, should be below the level expected on the basis of his or her age and general intelligence. This is best assessed on the basis of an individually administered, standardized test of fine and gross motor coordination. The difficulties in coordination should have been present since early in development (i.e. they should not constitute an acquired deficit.)"*

The WHO has also introduced the International Classification of Functioning, Disability and Health (ICF, 2001) which provides a framework for classification at three levels, i.e. the body function and structure (impairment), activity (activity limitations), and participation (participation restrictions). This model is based on the concept that impairments at level of

body function or structure influence a person's ability to perform activities and participate in daily life. The interactive framework is meant to be dynamic and interactive as they are all related and influence one another (Dahl, 2002). This is better explained in Figure 1.

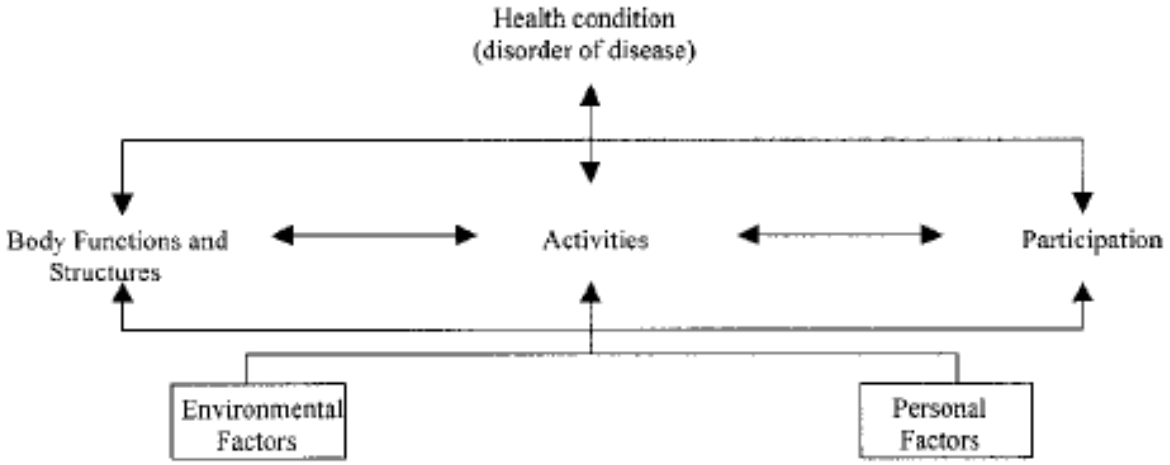

Figure 1: The framework of the ICF showing the interrelation between all the components. Reproduced from Dahl (2002)

Body functions and body structures encompass physiological functions, including psychological and anatomical parts of the body. Impairments describe problems in body function or structure as a significant deviation or loss and are often labeled as signs and symptoms. The next dimension encompasses the concepts of activities and participation. Activity is defined as the execution of a task or action by an individual. Activity limitations are problems that an individual may have in carrying out a task. Participation is defined as involvement in a life situation, although participation restrictions are difficulties that a person may experience in a life situation. Environmental factors are the physical, social, and attitudinal settings in which people conduct their lives.

The ICF for children and youth (ICF- CY) provides a framework for inter-disciplinary practice and it yields profiles of child functioning as well as helping to clarify clinical diagnoses and co-morbidity. It also provides a functional basis for planning individualized treatments/interventions, offers codes for identifying intervention outcomes and a way of documenting the gradient and hierarchy of change of functioning. However, implementation of the ICF-CY is dependent on the availability of measurement tools that can provide documentation for the specificity and severity of ICF-CY codes (Dahl, 2002).

For a child presenting with DCD, impairments might include difficulty with power of muscles of the trunk or with tone of muscles in the trunk or even poor muscle endurance functions. Activity limitations might include difficulty acquiring skills and carrying out multiple tasks.

Participation restrictions could probably include being excluded from social activities as well as receiving poor grades or problems with dressing. Underlying each of these elements are environmental factors. Environmental factors can be facilitators or barriers in each dimension, but they could also be mediators between different dimensions. For example, access to health services is an element of the environment that can hamper or facilitate the diagnosis and management of DCD. This can provide a link between the health condition and the impairment. Similarly, a competent teacher in a classroom setting might reduce the labeling of a child and provide an atmosphere in which any activity limitations do not create social exclusion.

The current focus on evidence-based practice would suggest that child outcomes of intervention or treatments reflect changes in participation. Thus the child's mastery of skills, personal independence, social integration and developmental or academic transitions would constitute outcomes of special education consistent with ICF participation codes.

Through the application of this framework to children with a diagnosis of DCD we can appreciate and predict the impact of DCD on the lives of children. It serves as a model to illustrate the relationship between the impairments of children with a diagnosis of DCD, and the activity limitations and participation restrictions experienced by these children. Often parents will identify that their child's motor impairments led to activity limitations and consequently to restrictions in their participation (Mandich et al, 2003). Parents also indicated that when the activity limitations were reduced, so were the participation restrictions and the child flourished. As a result of intervention, not only were social changes identified, personal changes were noted in the children.

2.2 Characteristics found in children with DCD

There are many common characteristics that may be found in these children have been well described in the literature and include the following:

- Poor handwriting and immature drawing skills is often exhibited in children with a diagnosis of DCD (Dewey & Wilson, 2001) as this requires continuous interpreting of the movements of the hand while planning new movements (Missiuna, 2003)
- Academic subjects such as mathematics, spelling, or written language prove to be difficult as it requires handwriting to be accurate and organized on the page and often they will trade speed for accuracy (Dewey & Wilson, 2001; Missiuna, 2003)). This may also be because of poor sequencing, poor visual perception and poor spatial organization (Campbell, 1994).

- Poor fine motor skills often affect their dressing skills with e.g. tying shoe-laces and doing buttons are difficult to do independently (Peters et al, 2004)
- Activities that require the coordination of both sides of the body is very complicated e.g. cutting with scissors, star jumps, eating with a knife and fork is a challenge as they have more difficulty maintaining their postural stability (Dewey & Wilson, 2001)
- Completion of class work within normal time frame is challenging since tasks require much more effort. They are more willing to be distracted and may become frustrated with a task that should have been straightforward (Missiuna, 2003)
- Organizing his/her desk, locker, homework or even space on the page is easier said than done (Miller et al, 2001; Missiuna, 2003). This may be due to poor visual perception and spatial organization (Campbell, 1994).
- Acquiring new motor skills is often difficult and therefore they avoid participation in gym class and on the playground (Miller et al, 2001)
- Poor participation in sport due to poor ball skills, slow reactions, poor balance, low endurance, weakness etc also limits participation. (Campbell, 1994; Miller et al, 2001)
- Soft neurological signs are commonly seen in children with a diagnosis of DCD, viz. poor strength, poor coordination and jerky movements. (Campbell, 1994)
- Campbell (1994) also list joint laxity, poor short and long term memory as impairments found in children diagnosed with DCD

Other characteristics are due to emotional or behavioral problems, for e.g.:

- The child may experience low frustration tolerance, poor self esteem and lack of motivation because he/she is constantly battling to cope with activities which are required in all aspects of his/her life (Campbell, 1994; Dewey & Wilson, 2001; Missiuna 2003)
- The child may avoid socializing with peers (Dewey and Wilson, 2001) and some even seek out younger children to play with while others will go off on their own (Missiuna, 2003)
- The child may seem dissatisfied with his / her performance, e.g. constantly erases written work or shows frustration with the work product (Missiuna, 2003)
- The child may be resistant to changes in their routine or environment. They often have to expend a lot of effort to plan a task and even a small change in how it is to be performed may present a large problem for the child. (Missiuna, 2003)
- Strained parent – child relationship is an unfortunate result of high levels of frustration from both the child and parent (Campbell, 1994)

2.3 Prevalence and aetiology of DCD

The international estimate is that as many as 6 % of school aged children suffer from DCD (Dewey & Wilson, 2001; Miller et al, 2001) with a higher incidence in boys than girls (2:1) being diagnosed with DCD (Miller et al, 2001; Barnhart et al, 2003). Although no published prevalence figures for the South African population could be found in the literature, there seems no reason why the numbers should differ. In addition, a higher incidence may be found among children with a history of prenatal or perinatal difficulties (Barnhart, 2003).

The precise mechanism underlying the condition is not known but initial theories from the neuropathological perspective, proposed that clumsiness was caused by a genetic/congenital macroscopic neurological pathology (McConell 1995). However, since children with a diagnosis of DCD do not display the hard neurological signs associated with macroscopic brain pathologies and clinical imaging techniques have not shown visible brain anomalies, this appears improbable (McConell 1995). Hadders-Algra (2000) argues that that there may be microscopic dysfunctions of the nervous system's neurotransmitter or receptor systems.

Earlier theories which were derived from a neuro-maturational perspective, propose that clumsiness is due to deficits with integrating sensory information (i.e. visual, tactile, vestibular, and proprioceptive information) in the central nervous system (CNS) (Ayres, 1972; McConell, 1995; Willoughby & Polatajko, 1995; O'Brien et al, 2008). However, proposed models of sensory integration disorders appear to lack strong evidence (Wilson, 2005). Also, there is no clear consensus on which sensory deficits predominate and whether these motor problems are a result of multi-sensory or uni-sensory factors (Willoughby and Polatajko, 1995; Wilson, 2005).

The more recent theory to emerge is from a motor programming perspective (McConell 1995). This theory suggests that children with a diagnosis of DCD experience difficulties with cognitive processes required for efficient motor planning, performance and control. Heterarchical theories have proposed that motor development is the result of an interaction of many interrelated components including genetics, individual task requirements and environment, as well as the opportunity to practice motor out put and movement decisions (Hadders-Algra 2000, Rostoft and Sigmundsson 2004).

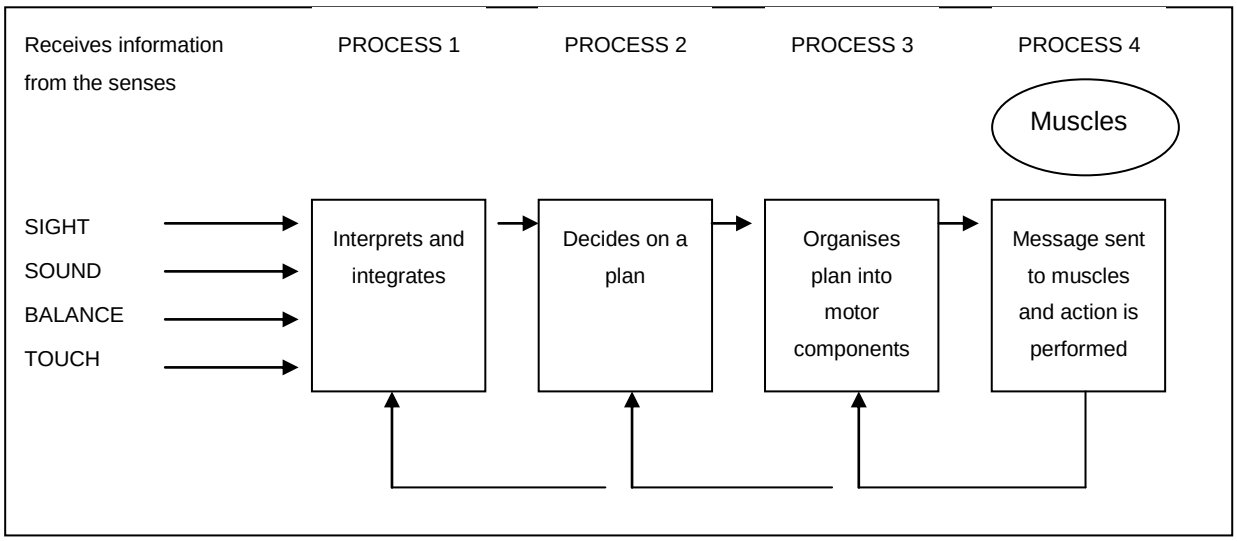

Figure 2: The Action Planning System (APS). Adapted from Missiuna (2003)

Missiuna (2003) has described aetiology of DCD as seen in to Figure 2: The Action Planning System (APS)

The APS describes the four processes that occur prior to a motor response and Missiuna (2003) states that at any of these processes information may be incorrectly interpreted. Difficulty interpreting and integrating the information that is being received through the senses i.e. vision, touch, balance, or the child lacks the ability to choose type of motor action appropriate to the situation, taking the context in which the action takes place into account. (E.g. when approaching a curb, the child must figure out that it will be like climbing stairs).

The child may have difficulty forming a plan of action in the correct sequence. The child is required to organize the motor requirements of the task into a sequence of commands in order for the muscles to perform the desired action (E.g. in order to go up the stairs, the child must figure out that they must first shift the weight onto one leg before lifting the other) or the message that is sent to the muscles does not accurately specify the speed, force, direction and distance that they are to be moved, when the child needs to move or to respond to something else that is changing in time or space. (E.g. in order to catch or hit a moving ball). A result of any of the problems described above will result in the child appearing clumsy and awkward and will have difficulty learning and performing new motor tasks.

2.4 How do coordination difficulties occur?

Motor coordination arises from a complex coordination between muscles, limbs and complicated neural circuitry. Motor coordination can be thought of as each physiological process that must be performed in order to achieve movement (Wikipedia.org). In other

words it is the skillful and effective interaction of movements which regulates diverse elements into an integrated and harmonious action. This is discussed in more detail below.

Skilled movements involve the precise control of voluntary movement initiation, execution and completion (Johnston et al, 2002), and is accompanied by postural adjustments, complex patterns of postural muscle excitation and inhibition in order to task performance to be efficient (Williams et al, 1983). Postural muscle activity provides the foundation for movement and it is an integral part of the neurophysiological mechanism that underlies motor coordination (Johnston et al, 1983). The ability to balance forms an integral component of most movement activities (Geuze, 2003). The main sensory systems involved in the control of balance are the visual, kinesthetic, and vestibular systems, as well as the pressure receptors of the somatosensory system (Geuze, 2003; Geuze, 2005). A lower sensitivity of these sensory systems result in slow feedback processing of the sensory information received (Geuze, 2003).

2.4.1 Contribution of the trunk

A clear understanding of the terminology used to describe motor performance is essential when trying to develop an understanding of the factors that contribute to impaired motor performance. Shumway-Cook & Woollacott (1995) define Motor Development as the process of acquiring normal motor skills by growth and development through normal stages. Motor Proficiency is defined as the skill with which a child performs a task. Motor Control is the mechanism that the child uses to stabilize the body with the balance and postural control mechanisms before moving it.

Williams et al (1983) found evidence of a lack of precise postural and balance control in motor impaired children. The development of postural control is an essential component of skill acquisition. Postural control requires an individual to organize sensory information, including visual, somatosensory and vestibular information (Peterson et al, 2006). Postural control is defined by Shumway-Cook & Woollacott (1995) as the regulation of body position in space for the purposes of stability and orientation, and it entails perceptual motor integration. The limbs are linked to the postural system and can only be freed from the postural system once sufficient trunk control has developed. Controlled mobility within a posture is vital for the development of a skill, and the performance of a skill is dependent on the stability of a position. Shumway- Cook and Woollacott (1995) also believe that anticipatory postural control which precedes voluntary arm movements in standing is mature by four to six years of age. Postural control requires the coordination of forces that enable the effective control of the position of the body in space. As this coordination becomes better there is a decrease in sway velocity; decrease in onset latency; improved timing and

amplitude of muscle responses; as well as a decrease in variability of muscle responses. Adult-like responses with minimal sway can only be expected after about six years of age (Shumway-Cook & Woollacott, 1995).

Information regarding postural muscle function in children with a diagnosis of DCD is limited but it appears that altered postural muscle function may be present which may contribute to the difficulties with upper limb coordination (Johnston et al, 2002). The authors investigated the neuromuscular components of postural stability and coordination in children with and without functional difficulties in upper limb motor skills by measuring response time to a pointing activity and electromyography testing on certain trunk muscles as well as surface shoulder muscles. Although the main objective of the study was to collect normative data on the timing of postural muscle activity and the resultant arm movement parameters, another objective was to compare the responses of children with and without a diagnosis of DCD. The authors aimed to determine if there are differences in postural preparation and movement control during voluntary upper limb movement. Children with a diagnosis of DCD took significantly longer to respond to visual signals and longer to complete the goal directed movements than the age matched children without a diagnosis of DCD. Children with a diagnosis of DCD also demonstrated altered postural muscle activity suggesting a deficient ability to contribute to stabilizing the trunk in order to provide a stable basis for movement. This lack of postural control may therefore explain why these children have difficulty in performing upper limb tasks such as reaching to grasp despite it being one of the most frequently performed tasks in daily life (Wang & Stelmach, 2001). They also reported that writing, dressing and sports are also affected.

Activation of anterior and posterior trunk muscles preceding or simultaneous to upper limb activity in adults has been attributed to the role of stabilizing the trunk prior to arm movements (Hodges & Richardson, 1996). In their study in children with a diagnosis of DCD Johnston et al (2002) showed later activation times in all the anterior trunk muscles and early activation times were demonstrated in posterior trunk muscles. Muscles of the trunk investigated by EMG in this study were: ipsilateral and contralateral internal oblique, contralateral external oblique, rectus abdominis and erector spinae. These muscles were chosen based on their role in postural control, particularly trunk stabilisation, during arm movement. Anticipatory postural activity was activated in only two of the five trunk (contralateral internal oblique, erector spinae) muscles. This evidence supports the theory that in children with a diagnosis of DCD, altered postural muscle activity may contribute to the poor proximal stability and therefore the poor arm movement control when aiming for specific targets. However, the tranversus abdominus was not tested which is reportedly the main trunk stabilizer.

Skilled movements involve the precise control of voluntary movement initiation, execution and completion (Johnston et al, 2002), and is accompanied by postural adjustments, complex patterns of postural muscle excitation and inhibition in order to task performance to be efficient (Williams et al, 1983). Postural muscle activity provides the foundation for movement and it is an integral part of the neurophysiological mechanism that underlies motor coordination (Johnston et al, 1983).

2.4.2 Alignment of the body segments

Correct alignment of body segments contributes to stability in the upright position (Tsai et al, 2008). In ideal alignment, the different parts of the body are held in a state of equilibrium with the least expenditure of energy. Children with DCD tend to fatigue easily with activity because of the effort involved in maintaining their posture (Rivard & Missiuna, 2003). In a study by Johnston et al (2002) it was found that when compared to children of similar ages, children with a diagnosis of DCD demonstrated greater amounts of muscular activity around the shoulder and hip musculature and that the muscular activity profiles were unlike those of the typically developing children.

2.4.3 Vision

Vision also plays a role in the development of postural stability. In the young child, vision is the most powerful sensory system in regulating posture, both in posture correction and anticipatory strategies. This dependency decreases with experience and the formation and control of postural synergies. As children mature, they become less reliant on vision and depend on their faster vestibular and proprioceptive systems to control postural activity. Among the visual problems reported in children with DCD are inaccuracies in estimating object size and difficulty locating an object's position in space (Schoemaker et al, 2001). Wilson & Maruff (1999) found that children with DCD had difficulty directing visual attention, and shifting one's gaze ahead of the hand is part of a natural process in accurate hand movements (Wilmut et al, 2006) affecting motor performance. Wann et al (1998) found that children with DCD exhibited a strong reliance on vision in maintaining balance.

Utley et al (2006) found that poor visual perception, or visuospatial anticipation and information processing may contribute to the fact that DCD children have problems with ball catching.

2.4.4 Postural Tone

Muscle tone is defined as the continuous contraction of the muscles in order to maintain posture (Wikipedia.org) and is considered as one aspect of postural control. It needs to be

high enough to provide antigravity control but low enough to allow mobility freely. Muscle tone is dependant on the intrinsic properties and the neural activation of the muscle. Children with a diagnosis of DCD often have relatively low muscle tone (Rivard & Missiuna, 2004) which contributes to their incoordination as they are unable to maintain a posture for long, especially up against gravity, with correct alignment.

2.4.5 Proprioception

Another contributing factor to impaired motor coordination is poor proprioception. Smyth & Mason (1998) found that children with a diagnosis of DCD have a specific deficit in using proprioceptive information to perform a task. In their study they tested an arm matching task (one arm placed in a set position and with their eyes closed, the children had to match the positioning with the other arm) as well as a non-visual aiming task (either a seen or felt position on top of the table had to be matched under the table). Compared with age matched controls, there was a higher degree of error on tasks requiring the use of proprioception to control movements displayed by the children with a diagnosis of DCD.

2.4.6 Balance

Poor balance also effects coordination as one needs to maintain balance in a weight bearing posture to perform an activity or move through a sequence of postures without falling (Johnston et al, 2002). Children with a diagnosis of DCD have been found to struggle to maintain single-leg stance (Forseth & Sigmundsson, 2003). Geuze (2003) and Williams et al (1983) found that children with a diagnosis of DCD show increased muscle activity around the ankles i.e. soleus and gastrocnemius, in order to maintain balance. They suggest that this is due to an insufficient improvement in muscle control over age in these children as opposed to the gradual refinement of muscle control found in typically developing children. Geuze (2003) also found an increased level of co-activation in the leg muscles resulting in increased stiffness which is likely to reduce the speed of correction of loss of balance.

The main systems involved in the control of balance are the visual, kinaesthetic, vestibular as well as the pressure receptors of the somatosensory system. The degree of balance and postural control determines the development of specific motor skills. (Geuze, 2005)

In a study on the elderly, Van Deursen (2008) found that the mechanical loading of the foot is related to inappropriate footwear and that footwear adjustments can influence balance and stability. This may be similar in children and should be taken into consideration as they are tested on the M-ABC with shoes as prescribed by the manual.

2.4.7 Cerebellar Dysfunction

The cerebellum is essential for the control of movement and posture and its dysfunction may disrupt balance and impair speech as well as limb and eye movements (Geuze, 2003; Geuze, 2005). Poor timing is also associated with cerebellar dysfunction (Williams et al, 1983). This role might point at cerebellar involvement in the motor problems of DCD. In a study by Nicholson et al (2001) a relationship was found between cerebellar dysfunction, muscle tone regulation and autonomous control of balance. Although this study was directed at the problems in dyslexia, the problems of balance control and timing (Piek & Skinner, 2001) and muscle tone regulation (Raynor, 1998) are known in the field of DCD. It may therefore be assumed that non-optimal cerebellar function affects the development of autonomous control of balance which may contribute to the problems experienced by children with a diagnosis of DCD and balance problems (Geuze, 2003).

2.5 Self concept

A major cause for concern, even more so than the motor impairment experienced by children with a diagnosis of DCD, is marginalisation, which negatively influences self perception (Chen & Cohn, 2003, Rodger et al, 2003). The sense of self-worth in children with a diagnosis of DCD influences their motivation to participate in physical or social activities in many contexts. Skinner & Piek (2001) found that if people perceive themselves to be physically incompetent, they have decreased motivation to practice motor skills and therefore have decreased participation.

Losse et al, (1991) and Skinner & Piek (2001) found that children with a diagnosis of DCD perceive themselves as less competent in physical appearance as well as physical, scholastic and social competence. Skinner & Piek (2001) also reported an association between motor coordination problems and low self esteem and anxiety. Losse et al, (1991) and Cantell et al (1994) found that these children experience problems that persist well into adolescence. Additionally some adults retaining motor difficulties may avoid activities such as driving and employment involving complicated tasks (Cantell, Smyth and Ahonen 2003). Rasmussen et al (2000) and Hellgren et al (1994) found that in adult life unemployment and poor interpersonal skills were present, but more disturbingly, so were psychiatric disorders, substance misuse and criminality.

2.6 Intervention Strategies for Children with DCD

There are many intervention approaches used to manage problems associated with DCD. Theories for treatment approaches are frequently placed into two categories: the bottom up and top down approaches (Barnhart et al 2003, Mandich et al 2001) (Table 2).

The bottom up approach was influenced by neuromaturational theories. These treatments are largely aimed at changing underlying impairments that theoretically contribute to poor motor performances i.e. decrease vision, kinaesthesis, proprioception and/or balance and strength (Mandich et al 2001; Missiuna et al. 2006; Wilson 2005). Targeting these components is thought to facilitate integration of sensory information in cortical regions of the brain to develop a more organised body schema (Willoughby and Polatajko 1995). The approach has been criticised for ignoring more current concepts and for lacking empirical evidence supporting its theories (Wilson 2005).

The top down approach proposes that both internal (i.e. motor planning) and external factors (i.e. environment, specific task/task context) influence a child's motor development (Barnhart et al 2003). This approach is aimed at improving cognitive or problem solving skills thought to be required for motor control and acquisition (Barnhart et al 2003, Wilson 2005). Top-down approaches appear promising, but investigations as to the effect on children with a diagnosis of DCD are limited in both quality and quantity (Hillier 2007) and the effectiveness of one approach over another is not well established.

Table 2: Common intervention strategies associated with bottom up and top down approaches

Approach	Examples	Approaches to treatment
Bottom up	Sensory integration intervention	Child is provided with sensory stimulation aimed at promoting motor adaption and higher cortical learning i.e. Sensory Integration Therapy (SIT) (Mandich et al 2001)
	Perceptual motor training (PMT)	Provides a child with a broad range of experiences with sensory and motor tasks,and an opportunity to practice (Barnhart et al 2003, Mandich et al 2001)
	Process-orientated treatment	Suggests that children with DCD have kinaesthetic problems therefore uses specific kinaesthetic training activities and positive reinforcement aimed at improving motor performance (Mandich et al 2001)
Top down	Cognitive approaches	Combination of cognitive learning, maturational and motor control theory. The approach emphasises participant problem solving. Involves developing a movement goal, planning how to accomplish the goal, execution of the goal and then re-evaluation of the success of the movement and how it will be attempted in the future e.g. mastery of concepts (Barnhart et al 2003, Wilson 2005)
	Task specific intervention	Based on dynamical systems theory. Training a target task is emphasised, with the premise that optimal performance comes with practice of the task to be learnt. The task is broken up into its components, taught separately and then as a whole (Barnhart et al 2003, Pless and Carlsson 2000)

In a systematic review Hillier (2007) identified 31 studies investigating the effectiveness of intervention on DCD. The most widely investigated approaches were perceptual motor training (PMT) and sensory integration therapy (SIT) and these approaches showed positive effects in 60-67% of the 16 high quality randomised controlled trials (RCTs) (Hillier 2007). Two well designed RCTs investigated motor skills and mastery of concepts. These studies reported positive effects in both motor skills and perceived physical competence in children with developmental motor delays (Hillier 2007). The review concluded that there was strong evidence to verify that intervention, regardless of the approach for a child with a diagnosis of DCD, is better than no intervention (Hillier 2007). Generally, these studies reported improved gross and/or fine motor scores (combination of improved body function and activity levels); some studies also considered participation measures and self concept. However, results were very varied.

Therapists treating DCD often use a combination of approaches to meet an individual child's needs (Mandich et al 2001) and it has been suggested that no single approach is appropriate for all children with the disorder because of its heterogeneity (Dewey and Wilson 2001, Mandich et al 2001). Studies supporting individualised approaches to improve motor skills in children with a diagnosis of DCD are mainly considered to be lower level, pre-post test clinical designs with small sample numbers (Dewey and Wilson, 2001; Mandich et al, 2001), therefore these results should be interpreted with caution.

An evaluation of the effects of physiotherapy for children who were then called "clumsy" was undertaken by Schoemaker et al (1994). Seventeen children were assessed on the Test of Motor Impairment (TOMI) before they received individual intervention over a period of three months for 45 minutes, twice a week by the same therapist who performed her own assessment so that she was kept blinded as to the results of the baseline assessment of the TOMI. The control group selected was matched for age and sex but subjects in this group were not classified as "clumsy". The aspects of treatment addressed included exercises to improve balance, coordination and generally the smooth execution of movement using the neurodevelopmental approach (NDT) (Bobath & Bobath, 1984). The results showed a significant ($p<0.01$) improvement in the TOMI.

Lee & Smith (1998) devised their own outcome measure to test 60 children diagnosed with dyspraxia. All 60 children were treated for eight weeks, individually, for one hour by a physiotherapist. The hour session was supplemented by a daily 15-20 minute home program. The subjects were tested after the eight week intervention and again after a further 12 weeks. The results of their study showed an improvement between 50% and 90% after the eight week intervention and between 47% and 97% at the end of the 12 weeks which essentially meant that not only had the subjects improved, they maintained the gains three

months after treatment. This is however a single study design as there were no controls and the outcome measure was not a standardized tool, so results should be interpreted with caution.

The above studies provide reasonable evidence to hypothesize that exercise can contribute to the improved motor skills in children with DCD although these exercise programs were in a one-to-one setting.

A meta analysis by Pless & Carlson (2000) was conducted to determine whether there was evidence in published research from 1979 to 1996 to support motor skill intervention for children with DCD or equivalent conditions and concluded that an intervention conducted in a group setting with a frequency of at least 3 – 5 times per week is recommended to improve the motor skills of children with DCD. Fifteen of the studies analysed used the NDT approach which consisted mainly of facilitation of balance and other physical abilities and training in specific perceptual, but also included motor tasks. Two of these studies also had an added sensory integration (SI) component. Besides the two studies just mentioned, another 10 studies used the SI approach but this also included a motor skill component. The studies using the specific skill (SS) approach were eight, but two incorporated the NDT approach as well and one included an SI component. The SS approach is based on task specific instruction but treatment is aimed at improving skilled movement.

Pless & Carlsson (2000) have provided evidence that group therapy can improve the motor skills of children with DCD and although the studies were mostly occupational therapy based, they all included a motor component and were aimed at improving the skilled movement of the children in the study. A group program incorporating exercises can therefore be hypothesized to be an effective method of treatment for children with DCD.

Group exercise may consist of exercises in the gymnasium, in the hydrotherapy pool or even in the classroom and can be used not only to exercise but to inform participants of their condition. The following table shows some advantages and disadvantages of group exercises:

Table 3: Advantages and disadvantages of group exercise. Adapted from Tidy's physiotherapy (2002) Pg 481

ADVANTAGES	DISADVANTAGES
• The competitive element may increase a participants performance	• Difficult pitching the exercises at the correct level for all participants

• A variety of exercises is possible	• Temptation to put inappropriate individuals to save time and relieve overburdened staff
• Can be fun if properly organized	• Difficult to monitor all of the participants all the time
• Participants may feel less isolated if meeting others with similar problems	• Difficult to progress all participants of the group appropriately
• Provides a good opportunity to educate and infirm the participants about the condition	• Competitiveness may be counterproductive
• Social support is offered to participants	• Some people do not respond well in a group situation

An extensive search for the benefits on group exercise brought forth few results with regards to DCD intervention. Group exercise used in other populations and those whose programs include similar exercise as used for individual therapy have reported many benefits i.e. increased aerobic capacity (Rogers et al, 2008), strengthening of muscles (Council on Sports Medicine and Fitness, 2008), especially core (Willardson, 2008), and balance (Anderson & Behm, 2005). Group exercise usually includes an aerobic component as well as specific core content – usually targeting strengthening and balance. Research on specific programs that combine strength and endurance training for children with physical disabilities however is sparse (Fragala-Pinkham et al, 2005). In a case report Darrah et al (1999) found that after a 10-week (thrice a week) strength, flexibility, and aerobic exercise program, 23 people (aged 11 – 20 years) with cerebral palsy had improved in strength, flexibility and perceived competence.

Burgeson et al (2001) report that exercise during childhood and adolescence have the following benefits:(1) builds and maintains healthy bones, joints and muscles, (2) reduces or maintains the body weight or body fat, (3) reduces depression and anxiety, (4) improves psychological well-being and (5) enhances work, recreation and sport performance. Aerobic exercise increases maximal oxygen consumption (VO_2max), increases blood supply to muscles and ability to use oxygen, improves the cardiovascular / cardiorespiratory function (heart and lungs) by reducing the workload on the heart.

Strengthening exercises will stimulate the muscles and tendons to adapt by becoming stronger and it may also improve the muscular control (Bird, 1992). He believes that the precise response, however, often depends on the individual, the intensity of the strengthening exercises as well as the number of repetitions performed. Strength training in youth has been found to have a positive influence on cardiorespiratory fitness, body

composition, bone mineral density, blood lipids and selected psychological measures (Faigenbaum, 2000). Faigenbaum et al (1996) reports strength gains following only 8 weeks of training in preadolescent boys and girls, even in children as young as six years.

Endurance training is one of the most important components of training (Hasson, 1994). He describes endurance as the sustained ability of the heart, lungs and circulatory system to take oxygen from the air and deliver it through the body. Rowland & Boyajian (1995) have found that minimal changes in maximal oxygen uptake occur following endurance training programs of 2-3 times per week for a period of at least 8 weeks for typically developing children. An eight week exercise program could therefore hypothetically improve the endurance and stamina of children with a diagnosis of DCD.

The degree of postural control and balance is often a constraint on the development of specific motor skills (Geuze, 2005). The main sensory systems involved in the control of balance are the visual, kinaestetic, and vestibular systems as well as the pressure receptors of the somatosensory system (Geuze, 2005). It could therefore be assumed that by working on these systems, one would be working to improve the control of balance.

2.7 Statement of the problem

As described in the introduction, reallocation of resources has resulted in fewer therapists at schools for children with special education needs in SA. In most instances children with DCD will be considered as low priority (due to their apparent independent gross motor functional ability). What is the best way to render a service to these children? Alternative approaches to managing children with DCD need to be found.

The literature indicates that the problems experienced by children with a diagnosis of DCD are vast and do not automatically improve with age which is why intervention is essential. Furthermore, treatment for these children is only sought once a “problem” arises. Individual intervention is not possible due to limited professional resources and therapists have resorted to treating children with a diagnosis of DCD in “gross motor groups”. Although there is some suggestion that group therapy in this population is effective, the evidence is scant / inconclusive. Group therapy has preliminary evidence for its effectiveness (Frigala – Pinkham, 2005; Peens et al, 2007)

To add further information on the effectiveness of group therapy for children with a diagnosis of DCD, this intervention program took on an eclectic approach in a group setting and included aspects of balance, strength, coordination as well as some task specific activities. It was aimed at improving the manual dexterity, static and dynamic balance and the ball skills of the children participating in the study.

The program was devised by the primary researcher and colleagues at her place of employment using a combination of clinical experience, literature (as reviewed above) and the responses the children have shown during therapy over the years of treatment. This pragmatic approach to devising intervention content is based on the evidence triad as proposed by Sackett et al (1996) in which best practice emerges from expert opinion, best available published evidence and the client/patient needs and preferences.

CHAPTER 3:
RESEARCH METHODOLOGY

This chapter will explain the methodology that was used in the study. A description of the study structure, study population and study sample including the inclusion and exclusion criteria is given. An explanation of the instrumentation and intervention program follows. The statistical analysis that was conducted and ethical aspects throughout this study concludes this chapter.

3.1 Study Structure

The study has taken the form of a quasi experimental design with randomised grouping into a control and an experimental group (Figure 3).

3.2 Study population

The study population included six to ten year old primary school children in the Western Cape diagnosed with DCD.

3.2.1 Study Sample

A sample of convenience was selected from a school for children with special education needs (LSEN)[*] where the principal researcher was employed. The names of all learners diagnosed with DCD were made available to the researcher by the physiotherapy department. The names of the prospective participants (N=49) were taken from the class lists of the school and all the learners who met the criteria below were included in the study sample. With the help of the statistician, a power analysis determined that each of the intervention and control groups should consist of at least 20 children in order for the detection of significant difference between the two groups for any of the outcomes measured (see 3.3.1)

Inclusion Criteria

To be included in the study, subjects had to:

- be diagnosed with DCD by school doctor / paediatrician
- be between the ages of 6 – 10 years

[*] EROS School, Athlone, Cape Town

- be in good general health
- have written parental /legal guardian consent
- assent to participation

Exclusion Criteria

Subjects were excluded if:

- they presented with any other associated mental or physical conditions which could affect their movement abilities
- they received any additional physiotherapy at school or private
- they received Speech or Occupational therapy (at school or private) that involved gross motor skills training

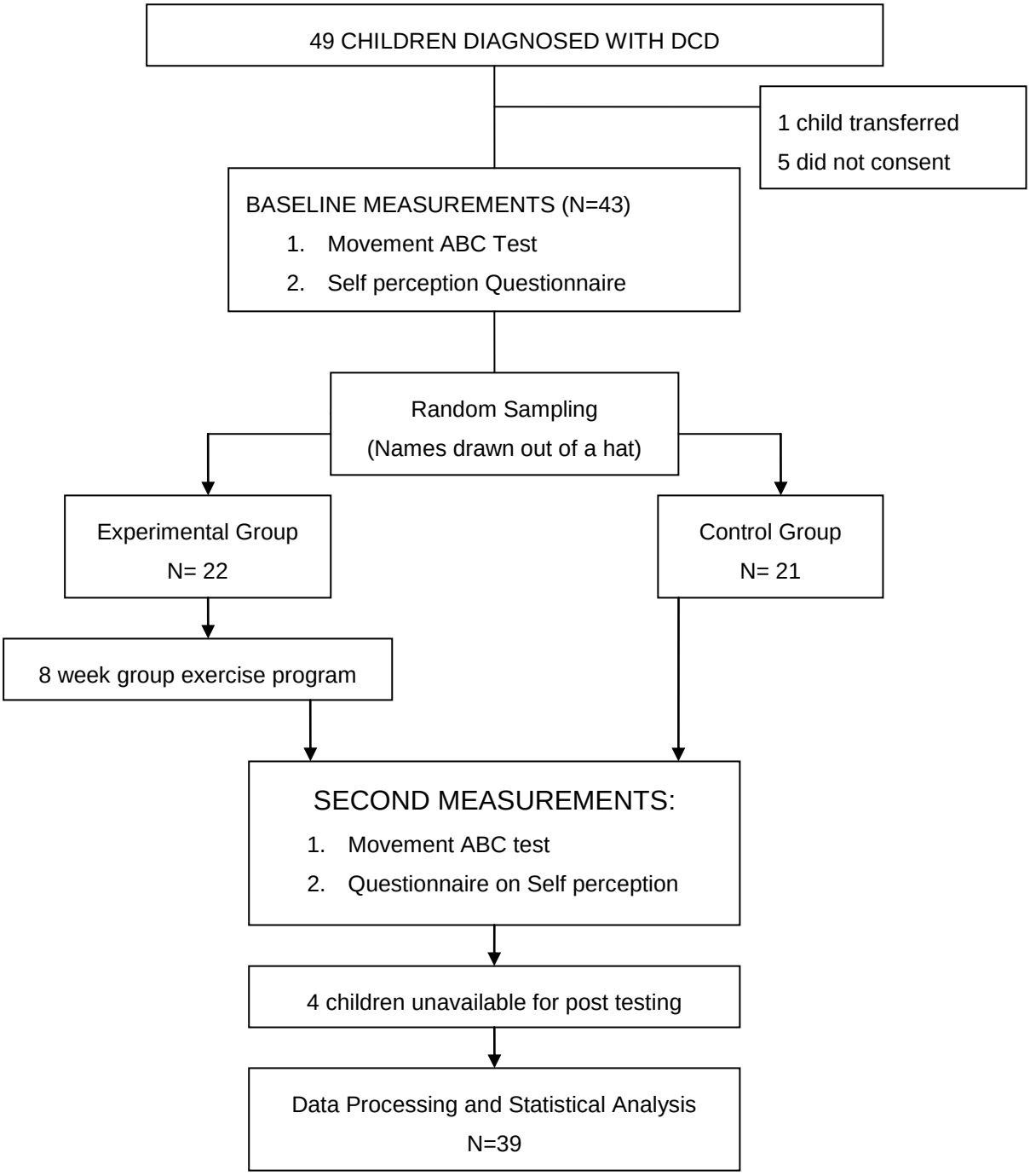

Figure 3: Study design

3.3 Procedure

Following project approval by the Committee for Human Research (CHR) at the University of Stellenbosch (N06/07/125) and the Western Cape Education Department (WCED) Education Research Directorate (Addendum A), as well as the principal of the school to utilise the facilities and resources available at the schools, the parents of all children who complied with all the inclusion criteria were approached to consent to their children's participation in this study.

The consent forms (Addendum B) were sent home with the children and all parents were given the contact details of the researcher if any further clarity was needed. Five consent forms were not returned and one child transferred to another school before testing, therefore a total of 43 children were included in the study. Motor proficiency using the M-ABC and self perception using the PEGS questionnaire was assessed at pre as well as post intervention. Testing was conducted during school hours by a research assistant* who was kept blinded as to whether the child was in the experimental or control group.

For the motor proficiency testing, the school gymnasium was set out by the researcher strictly adhering to the specifications as set out in the M -ABC manual (Henderson & Sugden, 1992). The subjects were randomly allocated into an experimental and control group. Random allocation was a simple "drawing names out of a hat" procedure and every second name drawn was allocated into the control group. The experimental group was further divided into groups of 4-6 subjects. This allowed for more children to be included but still allowed some individual attention should it be required. The experimental group followed a group exercise program for the duration of 8 weeks during the fourth term while the control group received no therapy during the same time period. The control group did receive the same intervention program after the final testing for the current study was completed (but those results were not analysed as part of this thesis due to time constraints).

3.3.1 Instrumentation

The following instruments were used at pre and post intervention testing in the current study:

a. M-ABC was used to determine the subject's level of motor proficiency at pre-intervention as well as at post intervention

b. Perceived Efficacy Goal Setting system (PEGS) was used to assess the learners self perception of what activities they experienced difficulty with.

Assessment of height and weight was also recorded at pre intervention testing, using:

c. Safeway Digital Scale to determine the subject's mass*

d. The subjects were all weighed in the morning with shoes removed.

* The research assistant has extensive training in paediatric neurology and has attended courses in administering both the Movement - ABC as well as the Bruininks Oseretsky Test of Motor Proficiency (BOTMP)

e. Height*† of learner was measured to check for normal development along with the weight.

f. After the weight measurement, the learners were measured for height – shoes removed – using the SECA height measuring tool which the school doctor keeps in her office at the school.

3.3.1.1 Movement Assessment Battery for Children (M-ABC)

In the absence of a "gold standard", Ayyash & Preece (2003) suggest that the M-ABC or the Bruininks Oseretsky Test of Motor Proficiency (BOTMP) be used. Both are used to identify children with motor impairment as well as assessing the efficacy of treatment programs. The M-ABC has been used worldwide in both a clinical and a research field (Crawford et al, 2001). A systematic review was conducted by a fellow student to evaluate which outcome measure purporting to assess gross motor skills in children with a diagnosis of DCD was the most robust (Plummer, 2008). The results showed clearly that the M–ABC and the McCarron Assessment of Neuromuscular Disorders (MAND) were the top two choices in identifying motor impairments in children. The M–ABC has been found to be reliable and valid as well as responsive and precise (Plummer, 2008). The user centredness was appropriate and acceptable and the tester centredness was deemed feasible according to Table 3. (A full appraisal of the M-ABC and its properties can be found in Addendum C) The M–ABC was accessible at the University of Stellenbosch, thus this outcome measure was chosen.

The M-ABC has three domains: Manual dexterity (3 items); Ball Skills (2 items) and Balance (1 static balance and 2 dynamic balance items). The M-ABC test has four different age appropriate tests for the four different age groups between 4 and 12 years, namely 4-6 years; 7-8 years; 9-10 years and 11-12 years. A different set of items is used for each age band in order to ensure that the items are sensitive and appropriate for each category, but the items still measure similar skills. A section is also provided where the examiner can make notes of any postural observations while the child is performing the test items. According to M-ABC manual (Hendersen & Sugden, 1992) test-retest reliability of M-ABC test at any age is 0.75, even after 1 month. In a Dutch study by Van Waelvelde et al (2003) the test – retest reliability and inter-rater reliability of the total score of the M – ABC are reported to be high, with intra class correlation coefficients of 0.91 and 0.99 respectively. Van Waelvelde et al (2004) confirmed the validity of the M-ABC total impairment score but no values were given. The total impairment scores of the M-ABC were correlated with the BOTMP composite score in America and the coefficient was found to be 0.53 which was deemed to be moderate. The

† This was deemed essential as body structure may impact on the learners' ability to perform exercise.

United States validation formed part of the standardization of the M-ABC (Henderson & Sugden, 1992).

The M-ABC has not been standardized for South African context, so we are unsure of its suitability in a different cultural context. However, the M-ABC has been used in a study by Peens et al (2007) in Potchefstroom South Africa to detect motor impairment adequately, and the researchers made no comments regarding possible discrepancies, nor did they make any recommendations that the tool be standardized for the SA context.

The M-ABC has a rigid format as it has strict instructions on the administration of the test, the equipment setup and layout of the testing area, even the layout of the stationery on the desk is fully described (see Addendum D). Each test item is explained in detail. Following a visual demonstration, it allows for a specified number of practice trials before the final activity is scored. Only during the practice trials one is allowed to motivate or guide the child as to their performance. For the scoring, no guidance is allowed at all.

Raw scores are recorded on the score sheet and have to be matched with the corresponding scaled score using a six point scoring system. Each child has a booklet where space is provided to record any behavioural influences should this be impacting on the child's motor performance (Addendum E)

Table 4: Scores on Measures from the Measure Critical Appraisal Tool

Test	Validity achieved (population in brackets)	Reliability achieved (population in brackets)	Responsiveness	Precision	User centeredness		Tester centeredness		MCAT Score (/12)
					Appropriate	Acceptable	Feasibility	Utility	
BGMA	• Content (partially – expert opinion only) • Construct (all norms 7 -12 y.o)	• Internal consistency (all norms) • Test retest (special ed & phys ed - age unknown) • Inter-rater (referred for MI – age unknown)	X	✓	✓	✓	Partial -? time admin	Partial- scoring difficulties	
Scores	**1 ½/3**	**3/3**	**0/1**	**1/1**	**1/1**	**1/1**	**½ /1**	**½ /1**	**9**
BOT-2	• Criterion (gen pop 6-24 y.o) • Content (all norms,4-21 y.o) • Construct (DCD & gen pop 4-12 y.o)	• Internal consistency (representative sample) • Test retest (gen pop 4-21 y.o) • Inter-rater (gen pop 4-21y.o)	X	✓	✓	Partial- long admin	Partial -training + long admin	Partial- scoring difficulties	
Scores	**3/3**	**3/3**	**0/1**	**1/1**	**1/1**	**½ /1**	**½ /1**	**½ /1**	**9 ½**
M-ABC	• Criterion (DCD & gen pop 4-12y.o) • Construct partial- known group methods only (MI, 4 y.o)	• Internal consistency (gen pop in 4 y.os) • Test retest (4-8 y.os DCD, 8-12 y.os gen pop) • Inter-rater (DCD/MI all ages)	✓ (4 -8 y.o DCD)	✓	✓	✓	✓	✓	
Scores	**1 ½/3**	**3/3**	**1/1**	**1/1**	**1/1**	**1/1**	**1/1**	**1/1**	**10 ½**
MAND	• Criterion (MI 4-10 y.o & norms 7y.o) • Content (gen pop, 7.y.o) • Construct (gen pop, 7.y.o only)	None	Partial, (MI sensitivity only)	✓	Partial -interpret probs	Partial – Task probs, ? time admin	Partial- training + ?time admin	Partial- scoring difficulties	
Scores	**3/3**	**0/3**	**½ /1**	**1/1**	**½ /1**	**1/1**	**½ /1**	**½ /1**	**7**
PDMS-2	• Criterion (part norms & MI, 4-5 y.o) • Content (all norms, 4-5 y.o) • Construct (norms & phys disable 4-5 y.o)	• Internal consistency (all norms) • Inter-rater ('at risk' for MI only in 4y.os)	X	✓	✓	partial –long admin	Partial- training +	Partial- scoring difficulties	
Scores	**3/3**	**2/3**	**0/1**	**1/1**	**1/1**	**½ /1**	**½ /1**	**½ /1**	**8 ½**
TGMD-2	• Criterion (gen pop elementary school) • Content (all norms) • Construct (all norms)	• Internal consistency (all norms) • Test retest (gen pop & children attending a special program not specified 3-10y.o) • Inter-rater partial - with converting previous scored sheets (part norms 3-10y.o)	X	✓	✓	✓	✓	✓	
Scores	**3/3**	**2 ½/3**	**0/1**	**1/1**	**1/1**	**1/1**	**1/1**	**1/1**	**10 ½**
ZNA	None reported, content appears to be based on previous tests	• Test retest (gen pop, 7-10 y.o) • Inter-rater (gen pop, 6-12 y.o) • Intra-rater (gen pop, 6-12 y.o)	X	✓	✓	✓	Partial- training +	Partial- scoring difficulties	
Scores	**0/3**	**3/3**	**0/1**	**1/1**	**1/1**	**1/1**	**½ /1**	**½ /1**	**7**

LEGEND- for Table 4

BGMA – Basic Gross Motor assessment

BOT 2 – Bruininks Oseretsky Test of Motor Proficiency 2nd edition

M-ABC – Movement Assessment Battery for Children

MAND – McCarron Assessment of Neuromuscular Development

PDMS 2 – Peabody Developmental Motor Scale 2nd edition

TGMD-2 – Test of Gross Motor Development 2nd edition

ZNA – Zurich Neuromotor Assessment

Gen pop= general population (representing typical children or unspecified group of children)

All norms = entire sample used to establish normative data

Part norms= part of sample used to establish normative data

MI = motor impaired

Special ed & phys ed = special education and/or special physical education classes

✓ = adequately achieved in the area

X = did not adequately achieve in the area

? = unknown

Interpret probs = interpretation problems from test scores for patients

Long admin = long administration time of the testing procedures

Training+ = Large amount of extra training required to use test efficiently

Task probs = Some task do not appear to be important for children

**** NOTE****All of the measures had normative data for their entire age bands and used ordinal measurements.

3.3.1.2 Procedure for testing using the M–ABC

The following items were tested and scored. (A full description of all activities can be seen in Addendum F).

For ages 4, 5 and 6

Manual Dexterity : posting coins, threading beads, bicycle trail

Ball Skills: catching a bean bag, rolling ball into a goal

Static balance: 1 leg standing balance

Dynamic Balance: jumping over the cord, walking heels raised

For ages 7 and 8 years

Manual dexterity: placing pegs, threading lace, flower trail

Ball Skills: one-hand bounce and catch, throwing bean bag into a box

Static Balance: stork balance

Dynamic Balance: jumping in squares, heel-to-toe walking

For ages 9 and 10 years

Manual Dexterity: shifting pegs, threading nuts on a bolt, flower trail

Ball Skills: two hand catch, throwing bean bag into the box

Static Balance: one board balance

Dynamic Balance: hopping in the squares, ball balance

All the balance activities were tested with shoes which may influence results as Van Deursen (2008) found that the mechanical loading of the foot is related to inappropriate footwear and that footwear adjustments can influence balance and stability. Although the study was related to the elderly, there's no reason why it could not apply to children.

3.3.1.3 Perceived Efficacy and Goal Setting System (PEGS)

This instrument or questionnaire allows children with disabilities to reflect on their ability to perform essential daily tasks (Missiuna et al, 2004). These tasks are age appropriate and reflect skills that have normally been acquired by 6 years of age, e.g. tying shoe-laces or doing buttons, printing neatly, task completion and playground participation. The test can be administered to children with learning disorders, ADHD, cerebral palsy, spina bifida, DCD, autism, medical syndromes and other functional motor impairments. This tool also helps to and is used to identify goals for therapeutic intervention.

The PEGS is based on a self-report measure of motor performance 'All About Me'. Psychometric properties of the 'All About Me' are reported in the PEGS manual with internal consistency reported as 0.91, and test retest reliability coefficients ranging from 0.77 to 0.79. There is little research, however, on the psychometric properties of the PEGS itself. The manual reports that it does appear to discriminate between children with and without

disability, and that the goals selected are adequately stable over a 2-week period. The Pegs was validated on 117 Canadian children with DCD.

Parents and teachers also play vital role by completing a short questionnaire as to their interpretation of challenges facing the child regarding the same 24 tasks, and outline their priorities for intervention. Parent questionnaires (Addendum H) and teacher questionnaires (Addendum I) were requested for each child at baseline and post intervention.

3.3.1.4 Procedure for administering PEGS

The test has a specific administration procedure. A forced choice format is used in which the child is asked to make two choices. First, the child has to identify which card best describes him/herself, (i.e., the “more competent” child or the “less competent” child.) They then indicate whether they are “a lot like” or “a little like” the chosen card. Because the cards in each pair are arranged randomly so that the child cannot discern a pattern, the manner in which the cards are placed on the placemat varies, but the card with the asterisk is always placed on the left in front of the child. To begin administration the children are told that a card game will be played so that one can get to know them better and that it is in no way a test so there are no right or wrong answers. During administration, the score for each item is recorded on the Child Score Sheet (Addendum G).

The child’s responses are recorded as follows:

1 = a lot like the less competent child

2 = a little like the less competent child

3 = a little like the competent child

4 = a lot like the competent child

The items asked in the test are grouped into three categories: self – care, school/productivity and leisure. The distribution of these items into these categories can be seen in Table 4.

Table 5: Distribution of items tested on the PEGS into categories

Item	Activity	Self – Care	School/ Productivity	Leisure
1	Catching Balls			X
2	Cutting Food	X		
3	Being good at Sports			X
4	Playing video games			X
5	Finishing schoolwork		X	
6	Making things		X	
7	Playing rather than watching sports			X
8	Tying shoes	X		
9	Using scissors		X	
10	Trying new playground activities			X
11	Buttoning	X		
12	Working on the computer		X	
13	Organising numbers on the page		X	
14	Riding a bicycle			X
15	Getting dressed	X		
16	Playing ball games			X
17	Printing/writing		X	
18	Zipping	X		
19	Keeping the desk tidy		X	
20	Painting		X	
21	Drawing		X	
22	Skipping – child actually skipping			X
23	Kicking a ball			X
24	Running			X
25	Skipping – child turning the rope			X
26	Toileting	X		
27	Keeping up with other kids	X		

Priorities for intervention are those tasks that the child identifies as most challenging. The test can be administered to children with learning disorders, ADHD, cerebral palsy, spina bifida, DCD, autism, medical syndromes and other functional motor impairments.

Parents and teachers also play vital role by completing a short questionnaire as to their interpretation of challenges facing the child regarding the same 24 tasks, and outline their priorities for intervention. Parent questionnaires (Addendum H) and teacher questionnaires (Addendum I) were requested for each child at baseline and post intervention.

However, there are no prescribed instructions, only guidelines that may be used, although it has a specific administration procedure. The researcher therefore uses her own phrases during testing and this is constant for all subjects. As the researcher is fully bilingual, she repeated the same phrases in Afrikaans for those who had a better understanding in the Afrikaans language.

3.3.2 Intervention

Subjects in the experimental group participated in an exercise program which the researcher devised based on the common lacking movement components seen in this population. The program was specifically aimed to improve ball skills, balance, and bilateral hand function as well as on postural control and core stability. Care was taken that activities in the program were not those that were tested with the M-ABC but it would improve the execution of similar activities. The children were grouped according to their scores on the M-ABC so that those with similar abilities were in same group. This proved to be problematic in the school setup. Class work became too disrupted and it was therefore decided to group children by their classes instead.

3.3.2.1 Group composition and duration

Learners in the experimental group participated in an eight week training program three times per week, during school hours. Each session lasted 45 minutes except for the six year old group(s) as this age group were unable to sustain concentration for this time period and their session times were reduced to 30 minutes. Groups were comprised of four to six learners from the same class.

Pless and Carlsson (2000) in a meta-analysis on the effects of motor skill intervention on DCD concluded that intervention for DCD be conducted in a group setting or in a home program, with intervention frequency of at least three to five times per week. In a South African study, Peens et al (2007) found that a group program twice a week for a period of eight weeks yielded significant ($p>0.01$) improvement in the motor skills of children aged seven to nine years who had been diagnosed with DCD. Also, as a school term is usually approximately 10 weeks each, eight weeks was therefore considered to be an ideal period to implement the program, leaving the first and last weeks for the pre and post testing. It was then decided to implement the exercise program three times a week for eight weeks.

3.3.2.2 Exercises (Addendum J)

The exercises and activities included in the program were devised and modified by the primary researcher and the physiotherapists[‡] at the school. Literature was consulted and

[‡] NDT trained therapists with >25 years clinical experience in paediatrics, as well as the principal researcher (>10 years clinical experience in paediatrics) All three are qualified in the Neurodevelopmental Therapy approach.

personal work experience and the responses the children have shown during therapy over the years also contributed to decision-making regarding final program composition. This pragmatic approach to devising intervention content is supported by the evidence triad as proposed by Sackett et al (1996) in which best practice emerges from expert opinion, best available published evidence and the client/patient needs and preferences.

The exercises were broken down into six categories: (1) Mat Activities to address strength, (2) Big Ball Activities to address balance and strength, (3) Hoop activities to address coordination, (4) Throw and Catch Activities to address ball skills, (5) Balance activities to address balance, and (6) 'combination treatments' – usually a game - to address everything that was covered during the week as reinforcement. Each session was initiated with a warm-up that consisted of: two minutes of running on the spot (varying paces), two minutes of star jumps, two minutes of stride jumps and three minutes of cross crawls. This activity is taken from the "Brain Gym ®" exercises (de Jager, 2001).

At least two categories of exercises were executed for 15 minutes each per session, i.e. (1) and (2) in session 1, (3) and (4) in session 2, and (5) and (6) in session 3 etc. All the sessions ended in five minutes of cool down activities which included deep breathing and stretches. The sessions for the six-year-olds were shortened so that warm up was five minutes, activities ten minutes each and five minutes for cool down.

3.3.2.3 Equipment

Hula hoops, beanbags, tennis balls, therapy balls, soccer balls, soccer cones, trampolines, balance beam, exercise mats and lots of imagination was used during the training sessions. Purposeful and enjoyable motor play activities were chosen to enhance the children's willingness to practice, and the activities included a large amount of repetition. Successful outcomes motivated the child to try new challenges. The child actively participated in the training process and was invited to give input whenever possible. When children are learning motor skills, it is essential that they actually want to learn the task as well as understand what to learn and are guided to successful achievement of the outcome (Pless et al, 2000).

3.3.2.4 Level of risk

All sessions were conducted under the supervision of the principal researcher. The sessions were all done in the physiotherapy gym which is carpeted and has mirrors all around. Equipment was positioned to enable exercises to be executed by all the participants at the same time except Category 6 which was in circuit form. A school nurse on the premises was easily accessible in case of an emergency.

3.3.3 Data processing and Statistical Analysis

The total impairment scores on the M-ABC is the sum of the scores measured on each individual test item. These results are then converted into a percentile rank using the table provided in the assessment manual (pg 109). The two are inversely proportional - the higher the total impairment score, the lower the percentile rank. The subjects were also categorized into those who scored below 5th percentile, 5th -15th percentile and above 15th percentile on the M-ABC in order to determine how the severity of the condition affected the improvement as measured on the M-ABC. In other words, did the improvement move the subject from one category into another (higher) category? For the PEGS questionnaires, the scores for each item were combined to give a total PEGS score out of 96.

Data was analysed using the Statistica 2008 software with the assistance of a statistician at the University of Stellenbosch. A one way analysis of variance (ANOVA) was used to test the effect of randomization pre intervention to ascertain any differences between the intervention and control groups. These results are discussed in the next chapter. Repeated measures ANOVA was done to determine the effect of participation of an eight week exercise program on the following variables: total M-ABC scores, percentile rankings, manual dexterity, ball skills, balance and PEGS scores. Post hoc analysis used was the Fisher LSD. Because there was a significant ($P<0.05$) difference between the control and intervention group post intervention despite the small sample size, it can be assumed that the results have statistical power. This is due to the fact that the smaller the sample size, the less likely to find a significant difference between the two groups after an intervention.

3.3.4 Ethical Considerations

The following ethical considerations were addressed:

1. Permission was requested from Western Cape Education Department to conduct the study in the schools. (Addendum A)
2. Confidentiality was assured to all participants. All personal information would be used solely by the researcher and should there be any publications, the participant's identity would not be disclosed. (Addendum B)
3. Permission was sought from the Human Research Ethics Committee at the University of Stellenbosch before the research was undertaken. (N06/07/125)
4. Participation was entirely on a voluntary basis and refusal or discontinuation was allowed without affecting standard treatment.
5. Informed consent was obtained from parents of all potential participants. (Addendum A)

6. Informed assent from all those participants was sought. (Addendum A)
7. Consent to use any photographs taken during testing or participation in any presentations or publications was also obtained from parents and participants.
8. Permission was obtained from the Physiotherapy department to use their M-ABC assessment tool.
9. The results will be made available to Eros School, and to the parents upon request.
10. A registered nurse or doctor was available at the school in the event of any accidents or injuries that may have occurred during or as a result of the exercise program.
11. The control group received the same program of intervention that the experimental group had been given once final testing of the study was completed.

CHAPTER 4:
RESULTS

Following a brief description of participant demographics, the effect of the group exercise program on manual dexterity, ball skills and balance, as measured by the M-ABC, as well as the perception of self as determined by the PEGS questionnaires, will be reported on. Sub-group analysis was done to compare pre-test classification of M-ABC scores impact on outcome.

Furthermore, the control and intervention groups were compared regarding the subjects who had changed their category regarding the severity of their motor difficulties. The three categories are based on the M-ABC norms and are (1) below 5th percentile, (2) between 5th and 15th percentile (3) those scoring above the 15th percentile. Children scoring between the 5th and 15th percentile on the M - ABC are considered “at risk” and these are the children who are usually referred for therapy.

4.1 Demographics

A total of 49 children were identified for possible participation in the current study. Of these children, five parents did not consent to participation and 1 child was transferred to another school before the study commenced. A further five children were excluded from the statistical analysis (N=39) as four were absent on the days of post intervention testing and 1 child was excluded due to prolonged absenteeism due to illness during the intervention phase. These results were excluded as the researcher was of the opinion that a zero result for five subjects would impact grossly on the interpretation of the results as the sample size was very small.

The demographic data for the 39 participants included in the study can be seen in Table 6.

Table 6: Demographic data measured on subjects in the control and intervention groups in the study.

		CONTROL GROUP (N=19)			INTERVENTION GROUP (N=20)		
	(p)*	Mean		Standard Deviation	Mean		Standard Deviation
		F (n=6)	M (n=13)		F (n=7)	M (n=13)	
Age (years)	**(.42)**	8	8	1.2	8	8	1.2
Weight (kg)	**(.94)**	30.8	30.9	8.2	31	30.5	8.7
Height (m)	**(.65)**	1.4	1.3	0.08	1.4	1.4	0.09

BMI	**(.57)**	16.1	16.2	2.9	16.2	16.1	3.1
Sessions		0	0		23	23	11.5
%ile ABC scores	**(.47)**	9.5	18	13.2	8	9	12.6
Total PEGS scores	**(.85)**	84	84	11.2	84	85	11.2

*p = effect of randomization (experimental group vs control group)

Table 6 shows the baseline data for the control and intervention groups. A one way ANOVA was done to test the effect of randomization, which indicated that experimental and control groups did not differ at baseline and therefore did not influence any further analysis (Table 6).

4.2 Effect of group exercise on Motor Performance

The M-ABC assessment pre-intervention ranged between the 1st percentile and the 49th percentile. The post intervention scores ranged from the 1st to the 70th percentile rank.

Table 7: Comparison of scores in the control and intervention groups at baseline as measured on the M-ABC

	CONTROL GROUP (N=19)		INTERVENTION GROUP (N=20)	
	Range	Mean	Range	Mean
%ile ABC scores	1% - 49%	9%	1% - 26%	7%
Manual dexterity	0.5 - 15	8	1.0 - 14	7
Ball Skills	0.5 - 9	4	1.0 - 10	4
Balance	1 - 13.5	6	1.0 - 12.5	6
Total PEGS score	66 - 96	84	51 - 96	84

There was no significant difference between male and female total scores over time (p=.76), but post-hoc analysis suggest there seemed to be a trend that gender played a role in the group and that males are more effected than females.

The relationship between the groups over time is depicted in Figure 4. It can be seen that the scores of the control group subjects increased slightly which means that their motor abilities were actually regressing, while the scores of the intervention group decreased. Their motor abilities had improved over the eight week period. The difference between the control and experimental group was significant (p<.03)

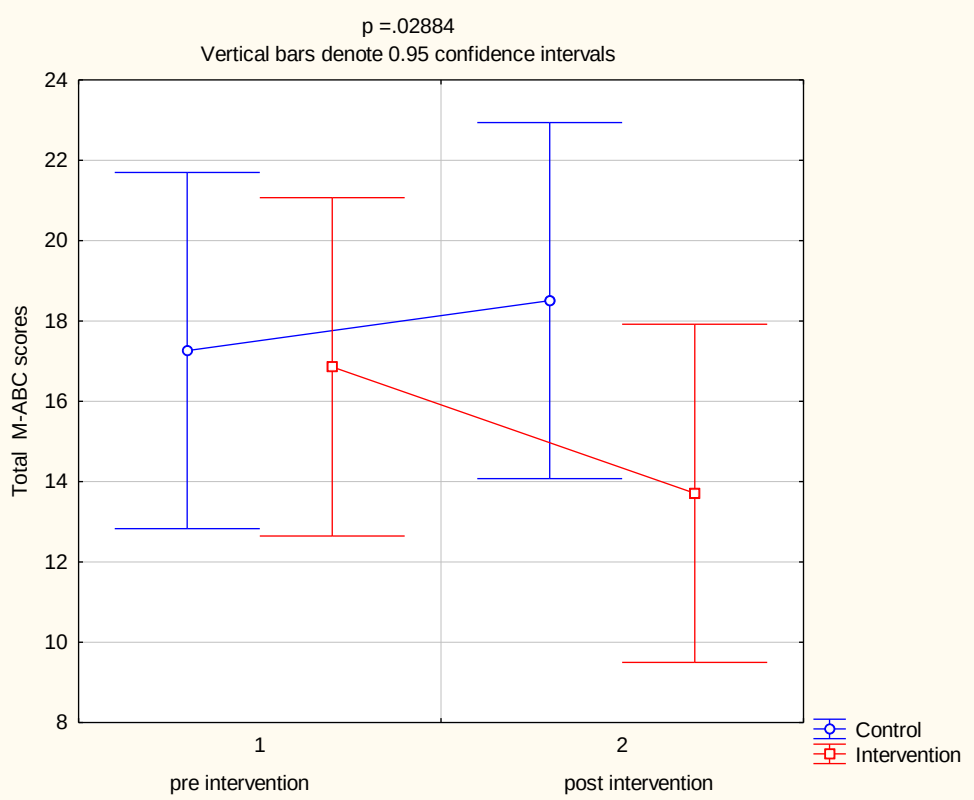

Figure 4: The total M-ABC scores for the control and intervention group before and after the 8 week program

Figure 4 shows the total M-ABC scores for the control and intervention group before and after the eight week program.

4.2.1 Effect of Group Exercise on Manual Dexterity

Over the 8 week period the manual dexterity of the children in the control group remained fairly constant with an average of approximately 8. The scores of the children differed significantly between the control and the intervention group (p=.035) over the 8 week period. The scores for the intervention group decreased from an average of 7 to 5, which denotes an improvement of 2 points on the M-ABC test (Figure 5).

The results of the manual dexterity subsection of the M-ABC also show that on average, the girls' dexterity was better than the boys. The average score for the girls was 7 compared to the boys, which measured 7.8. However the difference between boys and girls was not statistically significant.

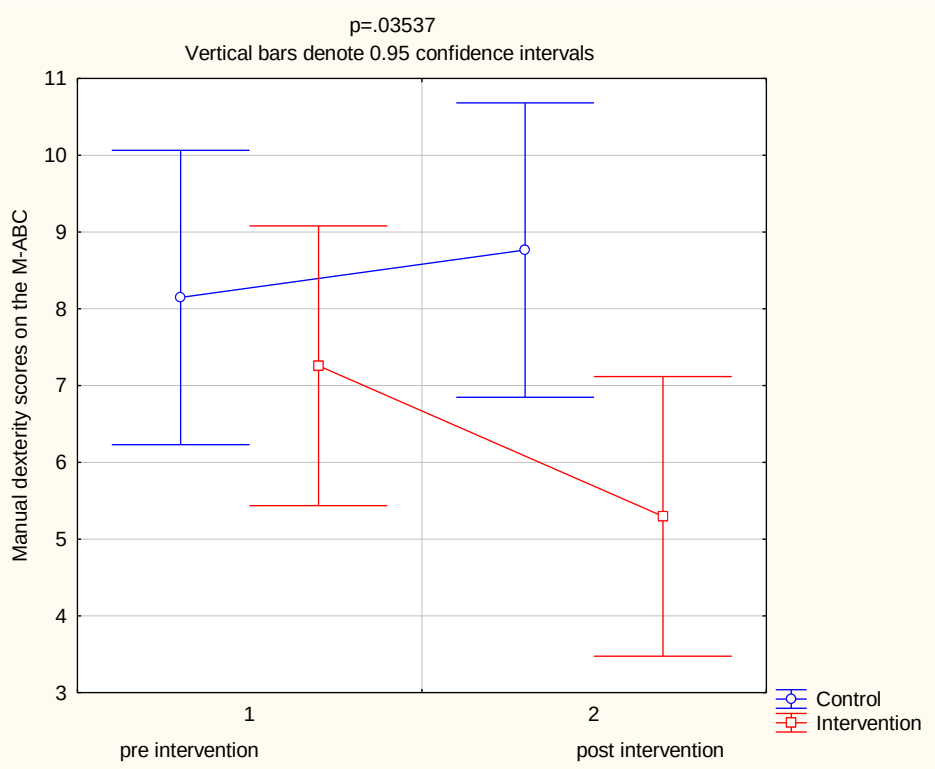

Figure 5: The effect of an 8 week exercise program on manual dexterity

Figure 5 depicts the results of the Manual dexterity subtest of the M-ABC for the control and intervention group before and after the 8 week exercise program

4.2.2 Effect of Group Exercise on Ball Skills

As can be seen in Figure 6, the scores of the children in the control group increased slightly while the scores of the children in the intervention group decreased slightly. This in essence means that the ball skills of those in the control group decreased, and in the intervention group increased. However, both the changes within the groups as well as the difference between the two groups (p= .077) was not significant.

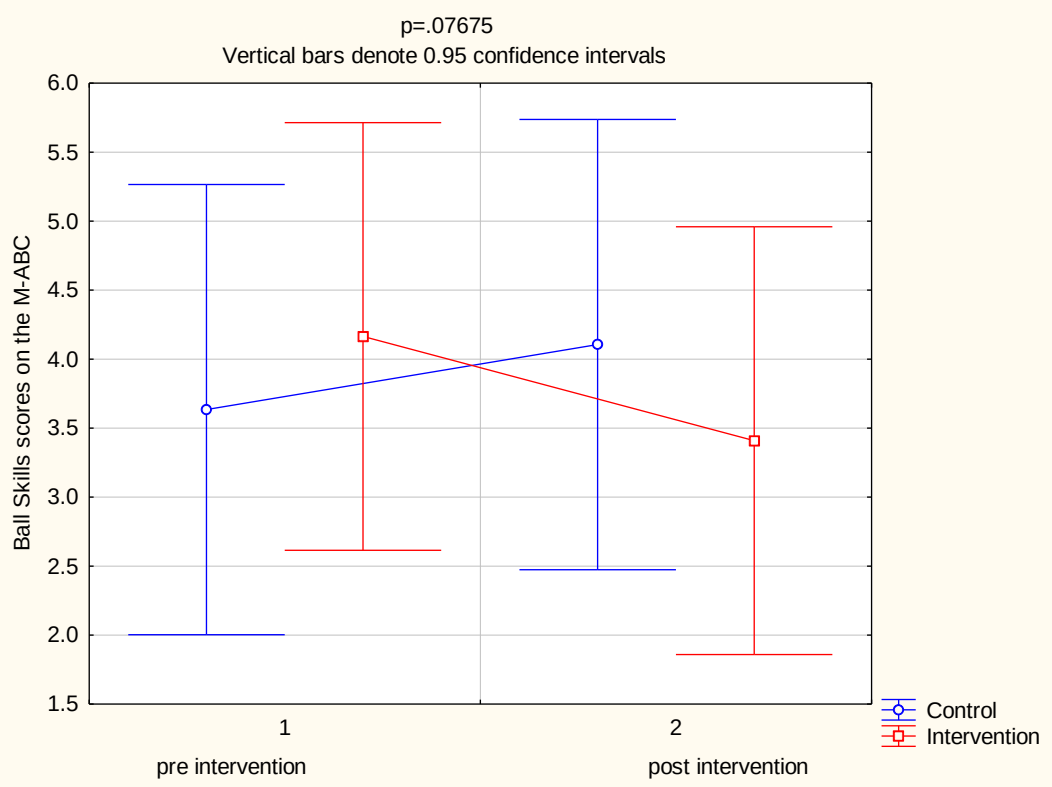

Figure 6: The effect of an 8 week exercise program on ball skills

Figure 6 shows the changes in the scores of the ball Skills subtest of the M-ABC for the control and intervention group after the 8 week exercise program

4.2.3 Effect of Group Exercise on Balance

On this subtest of the M-ABC, the girls performed far better than the boys at baseline testing but this was not significant. (p=.71) The girls scored an average of approximately 4 and the boys scored about 6.5. The 8 week exercise program however did not affect balance performance in either the girls or the boys and scores remained fairly stagnant after the eight week exercise program. The same was seen in the control group (Figure 7)

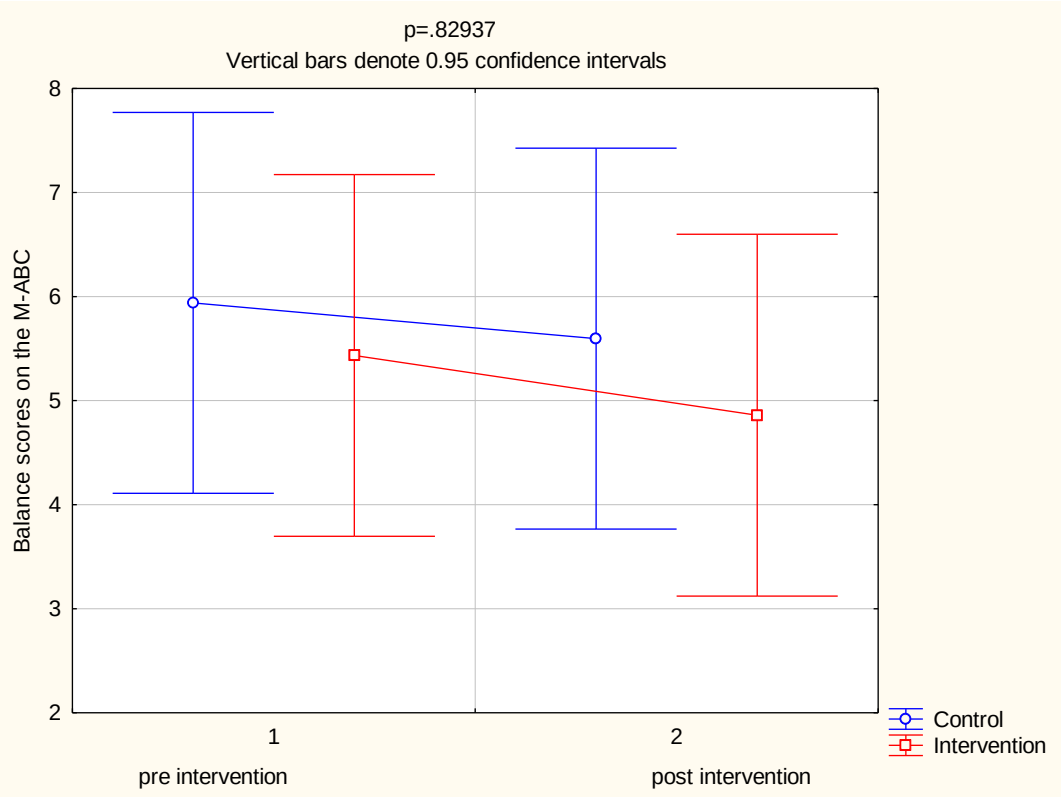

Figure 7: Impact of an 8 week exercise program on balance

Figure 7 shows that an 8 week exercise program had no impact on the scores of the balance subtest of the M-ABC

4.2.4 Subgroup analysis

In this study only five (12.8%) children fell into the “at risk” category between the 5th and the 15th percentile at pre intervention. Of these five children, one was in the control group and four in the intervention group. Three of the four in the intervention group had improved motor skills post intervention (Figure 8) and 1 had the same score after the eight weeks. The one child in the control group also had an improved score post testing.

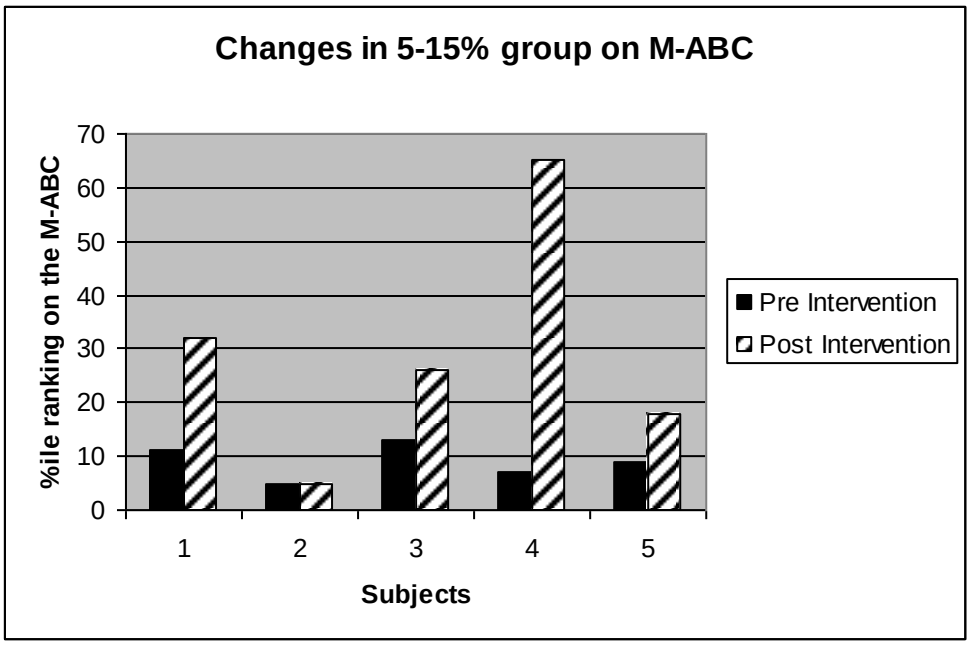

Figure 8: Changes measured in the "at risk" children after intervention period

Figure 8 shows the changes measured in the "at risk" children after the intervention period. **NOTE**: Subject 5 was in the control group.

The results for the children below 5th percentile were also separately analysed. Figure 9 shows results pertaining to the 14 subjects in the control group and figure 10 is for the 12 subjects in the experimental group.

In figure 9, it can be seen that two of the subjects in the control group had improved over the eight week period (subjects 10 and 11) while two scored lower percentile rankings post intervention (subjects 6 and 12). Ten subjects had remained constant in their M–ABC scores at post testing.

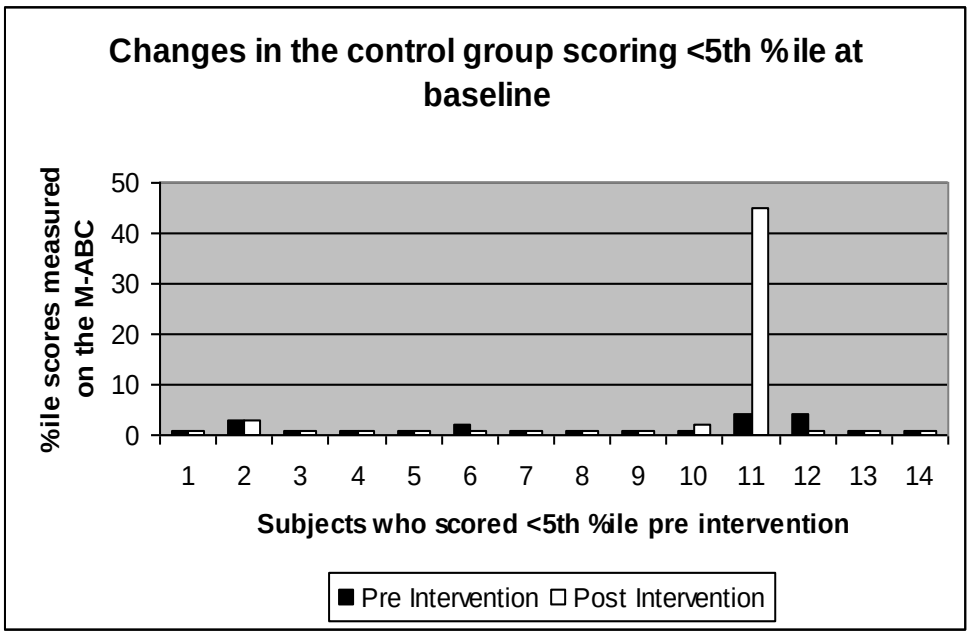

Figure 9: Changes measured in the control group who scored <5%ile at baseline, after the intervention period

Of the 12 subjects in the intervention group scoring below the 5th percentile, six had shown improvement – three of which had moved up to the next category. The remaining six maintained the same scores. This can be seen in Figure 10 below.

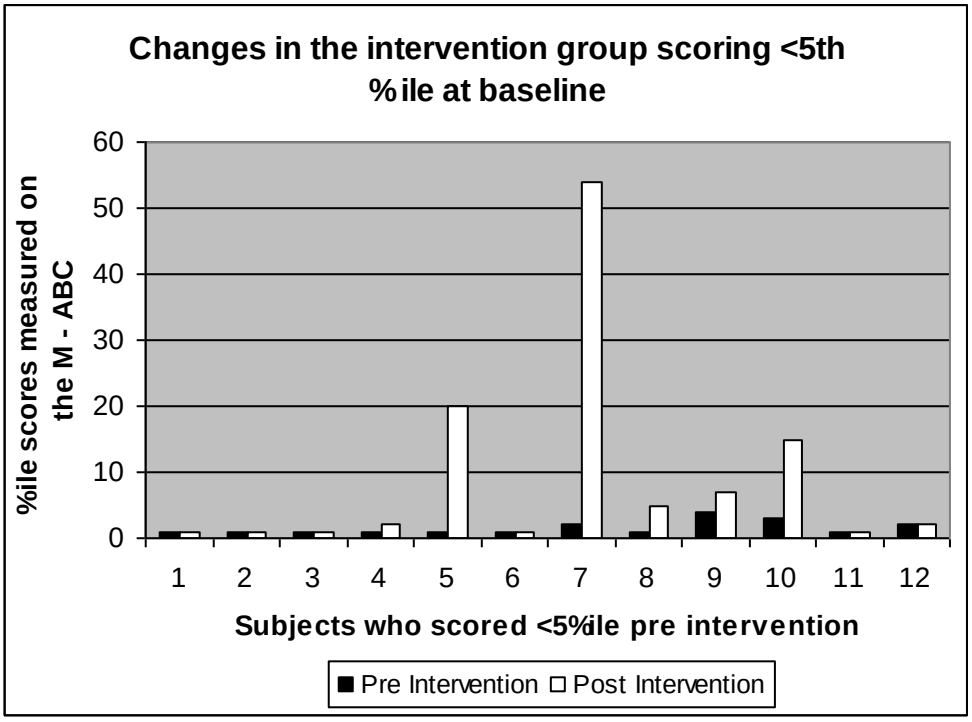

Figure 10: Changes measured in the intervention group who scored <5%ile at baseline after eight weeks

The changes in the group scoring >15% on the M-ABC consisted of eight children – four in the control and four in the intervention group (Figure 11). In the control group one subject (2) had improved their ranking on the M-ABC and the three remaining all had lower scores after the eight weeks. All four in the intervention group (subjects 5, 6, 7 & 8) showed considerable improvement following the eight week intervention.

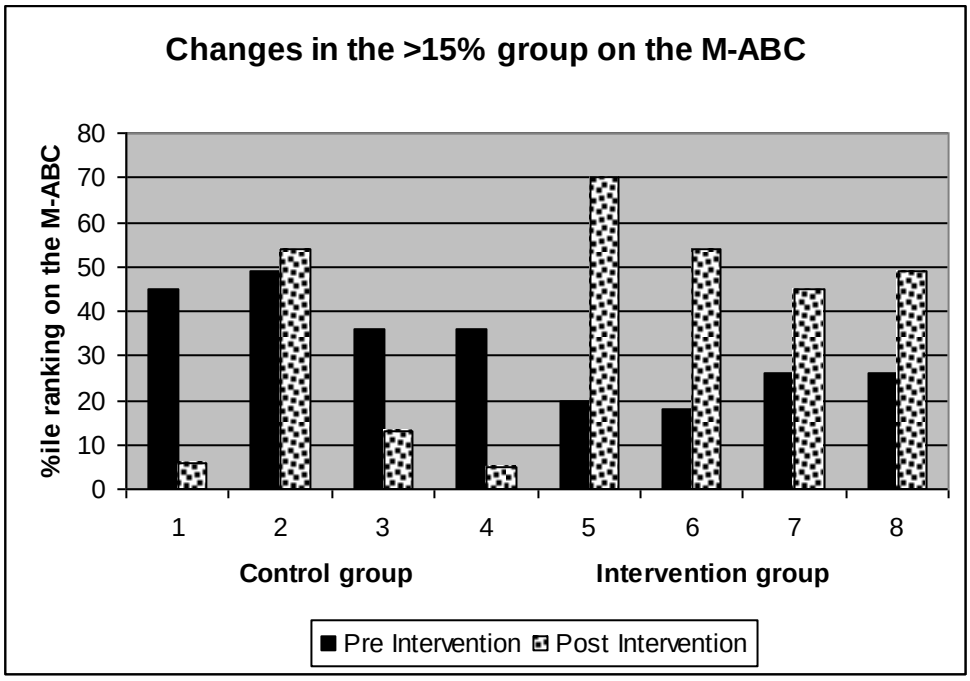

Figure 11: Changes measured in the control and intervention group who scored >15%ile at baseline after eight weeks

4.3 Effect of Group Exercise on the Perception of Self

The teacher and caregiver of each child were given a questionnaire to complete pre intervention and another post intervention. Of the teacher questionnaires (Addendum I), 11 questionnaires were completed pre intervention and 27 post intervention. Only nine subjects' questionnaires corresponded and of these five children were in the intervention group. Six caregiver questionnaires (Addendum H) were returned pre intervention and 20 post intervention but only three subjects' questionnaires corresponded. Several requests were sent to both teachers and parents to return outstanding questionnaires but did not increase response rate. The teacher and parent score sheets were therefore not analyzed in the study as a valid conclusion would be difficult to determine. Thus only the child score sheet was used. 38 score sheets were analyzed as 1 child was absent on the day of re- testing, so his

results were not included in the analysis. He could not be retested as he was absent the entire week and it was the last week of the fourth term.

As explained in the methodology, responses to the questions on the PEGS tool were categorized into these 3 categories: (A) Those children who perceived their abilities to have improved, (B) those who perceived that their motor abilities had remained constant and (C) the children who thought their abilities had regressed.

According to the responses, 21 children (55%) were sorted into category A - 13 of those were in the control group and eight in the intervention group. Of those in the control group who believed that they had improved, six scored the same results on both the pre intervention and post intervention M-ABC scores, 5 had actually regressed in motor abilities and 2 had improved according to their results as tested on the M-ABC. Of those in the intervention group who believed that they had improved, 6 had in fact improved according to the M-ABC and 2 remained unchanged.

Nine children (24%) were grouped into category B and of these nine, three were in the control group and six were in the intervention group. Of the three control group children, one child's M-ABC scores had improved, one remained the same and one's scores decreased on the movement assessment.

Category C consisted of eight children (21%) - three in the control and five in the intervention group. Of the five children in the intervention group, 1 child had the same scores on the M-ABC and four had improved. Two children's motor abilities had remained constant in the control group and the other 1 had improved on the movement assessment (Table 8).

Table 8: The post intervention PEGS scores correlation to the post intervention M-ABC scores.

PEGS Scores		**M-ABC scores**		
Category A*		**Improved scores**	**Same scores**	**Decreased scores**
Control	13	2	6	5
Intervention	8	6	2	0
Category B*				
Control	3	1	1	1
Intervention	6	3	2	1
Category C*				
Control	3	1	2	0
Intervention	5	4	1	0

*A = those children who perceived their abilities to have improved, *B = those who perceived that their motor abilities had remained constant and *C = the children who thought their abilities had regressed.

4.4 Summary

From this study it could be concluded that a physiotherapy group exercise program three times a week for a period of eight weeks does improve the general gross motor skills of six to ten year old children with a diagnosis of DCD, specifically the manual dexterity of these children. This study showed no improvement in the balance abilities of children diagnosed with DCD and a slight trend for ball skills to improve. Children considered “at risk’ benefited more from the program than those who were more severely affected (< 5th percentile) as well as the learners who scored above the 15th percentile.

There was no change noted in the self perception of the children in the study. In fact, the study found that the children, although they were all diagnosed as having motor impairments, perceived themselves as competent in almost all areas that had been tested.

CHAPTER 5:
DISCUSSION

The purpose of this study was to determine the effect an eight week group exercise program would have on the gross motor ability of children with DCD as measured on the M-ABC. Statistically significant improvement was noted in the intervention group at post intervention testing as compared to the control group. The improvement was noted in the total M-ABC scores and the manual dexterity subtest. There was a trend for ball skills to improve but no significant improvement was measured in the ball skills after the eight week program. The PEGS results were inconclusive as the subjects considered themselves to be far more competent on the questionnaire than their scores showed on the M-ABC. The children in the present study were not able to accurately assess their own performance on the PEGS questionnaires. This chapter will discuss probable reasons for these results.

5.1 Baseline data

The children chosen for the study were typically presenting with the common characteristics of DCD and were consistent with the current official definition of DCD according to the DSM-IV. (APA, 1994) None of the children were mentally retarded or had any neurological disorders but they were not able to perform activities usually acquired at their age which was interfering with the child's activities for daily living. There were twice as many boys than girls in the sample (26 boys: 13 girls) which concurs with reports (Barnhart, 2003; Hillier, 2007) that the prevalence of DCD is higher in boys than girls in a 2:1 ratio. The age range in this study is larger than what have been used in previous studies. Pless et al (2000) used only five to six year olds and Peens et al (2007) used seven to nine year olds in their studies. Peens et al (2007) also found significant improvement following group intervention. Albeit that they found significant improvement in all subtests as well, not only the manual dexterity as was found in the present study, the difference in age range was not relevant as children were scored age appropriately allowing for comparison within subjects across time. The current study design did not compare between subjects.

The total scores as measured on the M-ABC differed at baseline for the control and intervention groups with respect to ranges of the percentile rankings, but there was no significant difference in any of the variables according to the analysis of variance conducted. However, the degree of severity of motor skill impairments at baseline testing in this sample as measured on the M-ABC was rather high, the majority (26) scoring below the 5^{th} percentile. Five subjects scored between the 5^{th} and 15^{th} percentile, and eight scored above

the 15th percentile. This brings into question if DCD is the correct diagnosis for all of these children or what other conditions may be comorbid with DCD in the majority of this sample?

5.2 Accuracy of diagnosis

The children that participated in the current study were all included because they met the inclusion criteria that the researcher had set prior to testing, namely diagnosis of DCD by the school doctor. Following analysis of the M-ABC scores at baseline testing, accurate diagnosis was questioned. It may be possible that some of these children may have a different developmental disorder, e.g. ADHD which may also present with delayed developmental abilities.

Several arguments have been put forward in the literature as to why this may have occurred. Dunford et al (2003) contributes inappropriate referrals to the fact that (1) referrers not considering the DSM IV criteria when making referrals, (2) the methods for establishing when coordination skills are the primary cause of the child's difficulties are not reliable, (3) reliable methods are not used to establish when a child's motor skills are in line with their developmental level and (4) referrers often do not get all other relevant information from other health professionals. Gibbs et al (2007) also feel that referrers are often unfamiliar with the normal variation in motor skills throughout childhood as well as the formal testing of these skills. Furthermore, Dunford et al (2004) believe that there is need for clearer guidelines on applying the DSM-IV criteria. They felt that the diagnostic criteria were difficult to determine in clinical practice as limits were not set and terms were not clearly defined, such as academic achievement and activities of daily living. Another problem, as stated by Henderson & Henderson (2003), is the lack of conclusive evidence that the features of DCD are reliably distinguishable from the features of other developmental disorders. Dewey & Wilson (2001) report that the comorbidity of DCD and Learning Disability (LD) is quite significant as 29 – 33% of children with LD also exhibit coordination difficulties and there are several learners at Eros who have a diagnosis of LD.

As the sample had such a broad spectrum of severity, opportunity arose for the researcher to determine how the severity of the condition, assuming diagnosis was correct, affected response to the intervention as measured on the M-ABC. Can exercise therapy in group format result in enough improvement to move the subject from one category into a higher category? In this study four of the five children considered "at risk" and therefore requiring physiotherapy intervention moved up into the next category which meant by definition (Henderson and Sugden, 1992) that they no longer needed physiotherapy intervention. Pless et al (2000) found that a significant number of learners with borderline motor difficulties had changed category and no longer exhibited any motor difficulties after a 10 week intervention.

However the long term outcome, i.e. can these children maintain 'normal' motor function – still needs to be investigated.

5.3 Comorbidity and subtypes

As Kaplan et al (1994) pointed out subtypes of children differ with regards to comorbidities. McNab et al (2001) in their analysis of clinical trial data identified 5 different subtype profiles of DCD. The first subtype consisted of children with better gross motor than fine motor abilities although both skills were still below normal. Children in subtype 2 exhibited very good upper limb speed and dexterity, visual motor integration and visual perception skills but poor kinesthetic ability and balance. The third subtype included children with the greatest overall motor involvement accompanied by difficulty in both kinesthetic and visual skills. Children who performed well on kinesthetic tasks but performed poorly on tasks requiring visual and dexterity skills were classified as subtype 4. Subtype 5 was those children who demonstrated poor performance on measurements of running speed and agility but performed well in visual perception tasks. The subjects in the present study were not divided into these subtypes which may have had an influence on the degree of improvement after the exercise program.

5.4 Outcome measures

Several factors may influence results in a study and one of these is the reliability of the measuring instrument. Tools used to detect change attributable to intervention should measure what it claims to measure i.e. demonstrate validity and should be repeatable - have the same outcome over time or between testers. Although the M-ABC has not been standardized in the South African population, it has been used in one other SA study (Peens et al, 2007). These authors used the M-ABC because it was considered the international gold standard for measuring motor coordination difficulties experienced by children.

The PEGS was standardized for the Canadian population and although the items were not deemed by the researcher to be culturally specific, the test was not helpful in detecting change in the perception of self of the children in the present study as the children overestimated their abilities and did not perceive themselves as incompetent. One reason could be that these children have a skewed impression of themselves, which could be further investigated. In a special school like Eros, children with different diagnoses – from cerebral palsy to DCD to ADHD -are in one class. The children with DCD are then performing better than the physically disabled learners in their class although they may not be performing at the appropriate age level. This leads to a skewed self perception of their physical abilities. Secondly the questions may well be inappropriate in our culture, e.g. the question regarding

the riding of a bicycle may be inappropriate as all learners do not have a bicycle. Similarly, the item regarding climbing onto playground equipment is irrelevant if they never visit the playground.

5.4.1 Movement Assessment Battery for Children (M-ABC)

The M-ABC is an internationally accepted test of motor coordination (Henderson & Sugden, 1992; Henderson & Henderson, 2003) and has been purported to be a good indicator for incidence of DCD (Dunford et al, 2004). Scores below the 5th percentile are thought to be those who require intervention by a health professional, between 5th and 15th percentile are considered "at risk" and may need intervention later in life and those above the 15th percentile as not needing intervention (Henderson & Sugden, 1992). However, the studies were not conducted in developing countries.

There were five subjects in the "at risk' group of which four improved so that they were in the higher category (>15th percentile) and were then considered as "normal" and requiring no physiotherapy intervention (Henderson & Sugden, 1992). This is consistent with findings by Pless et al (2000) who found that those with borderline motor difficulties showed improvement with group exercise intervention. One of the subjects in the control group had improved quite dramatically. The reason for this is unclear, although when questioned about activities during the eight week period, she mentioned that she had started attending weekly "Hip Hop" classes. This may have led to the increase in her gross motor abilities as the dance sport demands balance, abdominal control as well as coordination. Whether a dance program could improve the gross motor abilities in this population should possibly be further explored as participation in dance is very popular amongst even very young children.

One subject although having had eight weeks of intervention, did not improve on her M-ABC scores. Although speculative, she comes from a very poor social background and often lacked motivation compared to the other participants to perform activities in the groups. Another subject had a remarkable improvement in his M-ABC scores – from 7th percentile to the 65th percentile - and subsequent informal discussions revealed that he was now playing recreational soccer for a local team in his area.

Twenty six subjects scored below the 5th percentile as measured on the M-ABC. Fourteen were in the control group and 12 in the intervention group. A low percentage (11.5%) moved into the next category (5th – 15th percentile) and the same amount moved above the 15th percentile. This could be an indication that those who score below the 5th percentile require more specific and individualized treatment in a one-to-one setting. Possibly they also needed treatment for a longer duration than what was given in this study. These subjects may benefit

more from individual treatment until they reach between the 5th and 15th percentile before being treated in groups.

Of the eight subjects who scored above the 15th percentile, all four in the intervention group showed improved scores post intervention along with one from the control group. The three left in the control group had actually regressed and were now in the lower category, i.e. 5th - 15th percentile. The question that can be posed is did the program increase the level of motor skills or did it just increase their confidence to challenge movement tasks? What would be interesting to determine is whether this group requires specialized intervention by a therapist, or if a structured regular extra-murals like swimming, martial arts or dance as suggested by Rivard and Missiuna (2004) will show similar results.

5.4.2 M-ABC subtests

The items tested on the M-ABC for manual dexterity included activities requiring speed and dexterity of a manual task and accuracy of handwriting. The *manual dexterity* also improved significantly at post intervention testing. This may be due to the fact that lots of arm exercises were incorporated into the exercise program (Addendum J) such as throwing balls, juggling balls, walking on hands over the big ball as well as activities for hand-eye coordination. This could have resulted in an increase in arm muscle strength and shoulder girdle strength which may have contributed to an increase in manual dexterity.

The *ball skills* items of the M-ABC involved catching a ball /beanbag and a target throw. Although the exercise program incorporated several catching activities and some target throwing, a trend for ball skills to improve was noted but no significant improvement was measured on the M-ABC post intervention. This may be because the exercises were conducted in a fairly stable and restricted environment / situation and there was not enough practicing of ball skills in an unpredictable situation. Tsai et al (2008) believe that DCD children are slow to develop the capacity to process proprioceptive input and to effectively integrate visual and proprioceptive information.

The *balance* items were divided into static balance and dynamic balance. Static balance activities tested involved a one legged activity and dynamic balance was a jumping activity and an activity whilst moving. Lots of jumping was included in the exercise program both on a trampoline and into hoops, but no improvement was measured on the M-ABC. Possibly there needed to be more activities that require more complex information processing. There should possibly have been activities with eyes closed, e.g. balance on one leg with eyes closed or on a wobble board with eyes closed in order to challenge the child's balance more. Wann et al (1998) found that children with DCD showed a strong reliance on vision in

maintaining balance. Therefore closing eyes during an activity will challenge their balance systems by isolating the vestibular system. Geuze (2003) found that eyes closed increased postural sway by 70% which means the fact that their eyes were closed altered their sense of balance greatly. Rotational movements like rolling and spinning also stimulate the vestibular system (Peterson et al, 2006) and enough rotational components were not included into the exercise program in this study. Peens et al (2007) did include this into their study and found a significant improvement in the balance subtest of the M-ABC.

Van Deursen (2008) found that the mechanical loading of the foot is related to inappropriate footwear and that footwear adjustments can influence balance and stability. Although the study was related to the elderly, there's no reason why it could not apply to children so the fact that they practiced all the balance activities barefoot but were tested with shoes on (as the test prescribes) may be a possible reason why the balance scores only showed a trend but no significant improvement.

As the sample in this study was not categorized into subtypes, the possibility exists that a majority of the subjects may be subtype 2 as classified by McNab et al (2001) who exhibit poor balance abilities and would therefore have needed extra input on balance for an improvement to be effected.

The girls' scores on the balance subtest were lower than the boys' scores, meaning that the girls' balance was better than the boys. This can be explained by superior vestibular function Hirabayashi and Iwasaki (1995). These authors found that girls performed better in balance tasks at seven to eight years than boys.

Most treatment programs assume that postural control is a prerequisite for mature motor control (Geuze, 2005). The author concluded from his study that altered postural muscle activity can contribute to poor proximal stability and consequently to poor upper limb coordination of children with DCD. The improvement could therefore possibly be linked to the fact that the subjects may have improved core stability and postural control following the intervention as this formed part of the program but this needs to be proven empirically. Improved core stability has been found to benefit sports performance by providing a foundation for greater force production in the upper and lower extremities (Willardson, 2007). Consequently, it may therefore have contributed to the improvement in the subjects' ball skill ability as well as the handwriting abilities, both subtests on the M-ABC. This could be an area for future research.

5.4.3 PEGS

The PEGS test enables the child to express his / her concerns regarding the effect of coordination difficulties on self care and leisure activities (Gibbs et al, 2007) and is supposed to be a good indicator of what the children's goals would be for themselves (Missiuna et al, 2004). The current researcher assumed that this tool would give an indication of what the children participating in the study felt they needed help with, as well as screening their perceptions of their abilities and was therefore considered appropriate for the present study.

Surprising results however were found on the PEGS test in this study as children who were motorically weak perceived themselves as capable of doing most physical activities well. There are several possible explanations for this. The school where the study was conducted has a population consisting of learners with different abilities / disabilities ranging from cerebral palsied to learners with ADD / ADHD and reading difficulties. Therefore, learners with a diagnosis of DCD are in fact better than the cerebral palsied learners and are often better at the activities than those in the classroom and this may have contributed to their skewed perception of their own functional abilities.

Another explanation could be that the school, especially the Foundation Phase (children aged six to ten/eleven years), uses positive reinforcement in the classroom so that all children are their own "controls". This means that they are always told how well they are doing and not compared to the others in the class who may be doing better.

Other studies investigating perception of functional ability in children with DCD have also shown similar results as was found in the current study. In a study by Fragala-Pinkham et al (2004) the effect of a fitness program on a group of disabled children was tested after a 14 week group exercise intervention as well as after a 12 week individual home exercise program. There were no significant changes in self perception after the 14 week group exercise intervention or after the 12 week individual home exercise program. Another study by Watson and Knott (2006) also found that self concept /esteem in children with a diagnosis of DCD may not necessarily be low. A study by Klein and Magill-Evans, (1998) found that young children (aged five to six years) appear to rate themselves as very competent regardless of their ability, consequently self perception tests should be interpreted with caution. Another reason is that no normalization/reliability studies been conducted in SA making comparison between studies difficult.

5.5 Exercise Program

Learners in the experimental group participated in an eight week training program three times per week, during school hours. Each session lasted 45 minutes except for the six year old group as subjects in this age group were unable to sustain concentration for this time period and their session times were reduced to 30 minutes. Groups were comprised of four to six learners from the same class.

Time management in a school context could be challenging, but since positive outcomes can potentially be seen after 8 weeks, it is possible to plan a roster so that all children could be allocated to a program for the year.

Participation in the groups proved to be enjoyed by all the children not only because they were invited to contribute to the program but also because it was devised so that each subject would be guided to a successful achievement of the outcome. Successful outcomes motivated the child to try new challenges. The children actively participated in the training process and were invited to give input whenever possible. Purposeful and enjoyable motor play activities were chosen to enhance the children's willingness to practice, and the activities included a large amount of repetition.

There was a high adherence to the program because it formed part of the school routine in the physiotherapy department, so the children would attend all sessions unless they were absent from school. No injuries were reported due to the exercise program. All sessions were conducted under the supervision of the researcher. All the sessions were done in the physiotherapy gym which is carpeted and has mirrors all around. Equipment was positioned to enable exercises to be executed for all session. The group was very safe for all the children and no injuries were reported. The high adult–to-child ratio (1 therapist to 4-6 children) contributed to a relatively safe exercise environment. A school nurse on the premises was easily accessible in case of an emergency, but their services were never required throughout the duration of the study.

Hula hoops, beanbags, tennis balls, therapy balls, soccer balls, soccer cones, trampolines, balance beam, exercise mats and lots of imagination was used during the training sessions. A home program could be implemented but would have to be strictly adhered to and would be dependent on the compliance of both the child as well as the adult responsible for the supervision of the program. Equipment would have to be sent home as most of the subjects would not have access to any of the equipment. Another important consideration would be if there was sufficient space available in the home environment for the execution of any

activities. A school program could be better monitored by the physiotherapist and more readily progressed with improvements achieved in the subjects' ability.

Fragala-Pinkham et al, (2005) found that group therapy intervention compared to a home program was better for motivational reasons. Both children and parents in the Frigala-Pinkham et al (2005) study reported high levels of satisfaction with the group exercise program. Parents felt that their children were more motivated in the group setting as it was very difficult to get them to do the home program. The children enjoyed the social component that the group setting offered. However, the number of exercise programs designed for children with disabilities is rather limited and the principal researcher, assisted by her colleagues, developed an exercise program to use at the school based on their experiences of the common problems that children with DCD exhibit. This program was used in the present study.

5.6 Clinical implications

This study does contribute to the evidence that supports an eight week small group exercise program is beneficial to children with DCD. Although the six to ten year old children in the current study did improve their scores for gross motor skills as tested on the M-ABC, it is unknown whether the improvements obtained will still be evident later in their lives. The exercises were conducted in a fairly stable environment and it is uncertain if the improvements obtained would be sufficient to meet the requirements of activities like sport and games that require more complex information processing. Even though the exercises were regularly progressed as the children became better at any activity, the environment remained the same, i.e. the physiotherapy gym. This limited the exposure to activities which are more complex e.g. tennis.

Furthermore the results of this study indicate that those children who score below the 5th percentile will probably require more intensive individual therapy to bring them up to the 5th percentile before they can be treated in group format. Children scoring above the 15th percentile also improve with group therapy but this group could be a bit larger as they do not require as much hands-on management as those in the lower categories. Learners in this category may also do well at a gymnasium to strengthen muscle groups with the help of a trainer, or in a class offered at the gymnasium aimed at core stability, e.g. step or kata-boxing class. They will be more challenged in this situation as expectation / equipment used is different than the hoops / skipping ropes used at the school. It is often difficult to decide when to discharge a learner from therapy, but once a learner is able to perform an activity without any difficulties and has no problems functioning in the classroom or outside, he / she

is discharged from physiotherapy at Eros and monitored by the therapist. If problems arise at a later stage, the learner may then be reassigned to a group.

CHAPTER 6:
CONCLUSION

Although the results of this study support the hypothesis that a targeted eight week group exercise program can improve the gross motor skills of children with DCD as measured by the M-ABC, the results cannot be extrapolated to the entire DCD population as the sample was one of convenience and should therefore be interpreted with caution.

The gross motor skills of children with DCD as measured by the M-ABC total scores showed a significant improvement after the eight week group exercise intervention. A significant improvement was also found with the manual dexterity subtest of the M-ABC but there was only a trend for ball skills to improve and no significant change was measured for balance on the M-ABC post intervention. However, Leemrijse et al (1999) evaluated the standard error of the M-ABC and concluded that although the total score of the test was sufficiently sensitive, the item scores were inadequate to monitor individual change.

Subjects scoring in the “at risk” category showed some improvement into the higher category after the eight week intervention and those above the 15th percentile had also improved. Interestingly, those in the control group scoring above 15th percentile dropped into the “at risk” category after eight weeks. Those scoring below the 5th percentile, except for five who moved into the next category, all remained below 5th percentile at post intervention.

6.1 Study Limitations and Recommendations

The situation of the convenient sampling may have been avoided if all prospective candidates from the three LSEN schools were assessed to be included in the study but due to time and budget constraints, this was not within the scope of the present study. Also, a score of below 15th percentile should have been an inclusion criterion to eliminate any doubt as to the correct diagnosis of the subjects.

The exercise program may need to include more dual-task activities to integrate visual and proprioception information as well as more rotational elements in the exercises to stimulate the vestibular system. Possibly some activities should be performed blind folded to really challenge the balance system by eliminating vision from the equation.

A major limitation in this study was that the data collected using the PEGS questionnaires were inconclusive. The researcher did try to collect all teacher and caregiver questionnaires but rather unsuccessfully. It was hoped that this test would link a better gross and fine motor score on the M-ABC with improved classroom activities or better execution of activities of

daily living as measured on the PEGS questionnaire but so few questionnaires were returned that interpretation was impossible. Perhaps the researcher should have waited for the questionnaires while the teacher completed them or telephoned the caregivers more often to return their questionnaires.

It is also recommended to investigate the effect of participation in a dance class or structured sport such as swimming or martial arts on motor ability. These sport codes and type of exercise classes are regularly available after school hours and demand similar movement and exercise as is utilized in the group therapy classes. As Hillier (2007) stated that any intervention is better than no intervention at all.

Another area of study which is to investigate the link between postural control / core stability to improved gross motor ability / function as this is a widely utilised principle in therapy but for which the evidence is not yet conclusive.

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ADDENDA

ADDENDUM A

Permission to conduct the study at Eros School

Navrae
Enquiries
IMibuzo
Dr RS Cornelissen

Telefoon
Telephone
IFoni
(021) 467-2286

Faks
Fax
IFeksi
(021) 425-7445

Verwysing
Reference
ISalathiso
20060914-0045

Wes-Kaap Onderwysdepartement

Western Cape Education Department

ISebe leMfundo leNtshona Koloni

Mrs Roshaan Salie
2 Moira Road
SURREY ESTATE
7764

Dear Mrs R. Salie

RESEARCH PROPOSAL: THE EFFECT OF A SPECIFIC GOAL DIRECTED EXERCISE ON THE GROSS AND FINE MOTOR SKILLS PERFORMANCE AND SELF PERCEPTION IN PRIMARY SCHOOL CHILDREN AGED 6 – 10 YEARS WITH DEVELOPMENTAL COORDINATION DISORDER (DCD).

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **23rd January 2007 to 23rd June 2007**.
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December 2006).
7. Should you wish to extend the period of your survey, please contact Dr R. Cornelissen at the contact numbers above quoting the reference number.
8. A photocopy of this letter is submitted to the Principal where the intended research is to be conducted.
9. Your research will be limited to the following schools: **Eros, Paarl and Vista Nova**.
10. A brief summary of the content, findings and recommendations is provided to the Director: Education Research.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

    The Director: Education Research
    Western Cape Education Department
    Private Bag X9114
    CAPE TOWN
    8000

We wish you success in your research.

Kind regards.

Signed: Ronald S. Cornelissen
for: **HEAD: EDUCATION**
DATE: 14th September 2006

ADDENDUM B

Participant consent form (includes Assent form)

English and Afrikaans

PARTICIPANT INFORMATION LEAFLET AND CONSENT FORM FOR USE BY PARENTS/LEGAL GUARDIANS

TITLE: A study to evaluate the effects of a specific goal – directed group exercise program on the gross and fine motor skills performance and self perception in six to ten year old Primary school children with Developmental Coordination Disorder (DCD)

REFERENCE NUMBER: N06 / 07 / 125

PRINCIPAL INVESTIGATOR: Roshaan Salie

ADDRESS: 2 Moira Road
Surrey Estate
Athlone
7764

OR

Eros School
Tarentaal Road
Bridgetown
7764

CONTACT NUMBER: 083 267 6739

Your child is being invited to take part in a research project. Please take some time to read the information presented here, which will explain the details of this project. Please ask the study researcher any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how you and your child can be involved. Also, your child's participation is **entirely voluntary** and you are free to decline his / her participation. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw your child from the study at any point, even if you do agree that your child may take part.

This study has been approved by the **Committee for Human Research at Stellenbosch University** and will be conducted according to the ethical guidelines and principles of the International Declaration of Helsinki, South African Guidelines for Good Clinical practice and the Medical Research Council (MRC) Ethical Guidelines for Research.

The study will be conducted at your child's school during the first and second terms. A total of approximately 40 children from two schools will be asked to participate in the study.

The research objective is to measure the effect of a specific group exercise program on (1) motor skill performance - in other words can such an exercise program have an effect on ball skills, handwriting and balance, and (2) on self perception - how does the child feel about him / herself after participating in a group exercise program.

I have undertaken this study because although there is evidence that exercise can benefit children with DCD, there are no studies evaluating the added benefits of group exercise. Should participating in group exercise sessions have a positive outcome, it will help physiotherapists to provide better treatment to children with difficulties similar as to what your child is currently experiencing. Managing and treating these children in groups could further benefit more effective service delivery within our schooling system as many more children can simultaneously be targeted.

All children will be tested on a movement assessment test before starting the exercise program. They will also complete a self-perception questionnaire. The exercise program will run during the first and second terms next year. The children will be divided into two groups. One will receive the exercise program in the first half of the year while the others will serve as a control group. The control group will receive the same group exercise in the second half of the year. At the end of the second term the movement test and questionnaire will be re-administered.

I have invited your child to participate because he / she has already been identified by their current physiotherapist for exercise therapy in order to address movement and or handwriting difficulties that we will be addressing in the exercise program. Participation in this project will not lead to any costs for yourself nor will you benefit financially. All that would be expected of you is to ensure your child is not unnecessarily absent from school so that they won't miss out on their sessions.

You are assured of complete confidentiality. Participants will remain anonymous. Only my supervisors, the statistician and I will have access to the data. Results and other information may be used for publication in a thesis, or journal and or presentation at professional workshops, meetings or congresses. You may contact the Committee for Human Research at 021- 938 9207 if you have any concerns or complaints that have been adequately addressed by the study staff.

You will be given a copy of this information and consent form for your own records

Declaration by parent/legal guardian

By signing below, I ..... agree to allow my child. ..... who is ..... years old, to take part in a research study entitled "The effects of a goal - directed group exercise program on the gross and fine motor skills performance and self perception of six to ten year old learners with Developmental Coordination Disorder (DCD)"

I declare that:

- I have read or had read to me this information and consent form and that it is written in a language with which I am fluent and comfortable.
- If my child is older then 7 years, he/she must agree to take part in the study and his/her ASSENT must be recorded on this form.
- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to let my child take part.
- I may choose to withdraw my child from the study at any time and my child will not be penalised or prejudiced in any way.
- My child may be asked to leave the study before it has finished if the study doctor or researcher feels it is in my child's best interests, or if my child does not follow the study plan as agreed to.

Signed at..... on the.....day of..... 2006.

....

Signature of parent/legal guardian **Signature of witness**

Declaration by investigator

I, Roshaan Salie ..... declare that:

- I explained the information in this document to .....
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understand all aspects of the research, as discussed above
- I did/did not use an interpreter

Signed at ..... on the .....day of..... 2006.

.....
Signature of investigator

.....
Signature of witness

Declaration by interpreter

I..... declare that:

- I assisted the investigator, Roshaan Salie, to explain the information in this document to ..... using the language medium of Afrikaans/Xhosa.
- We encouraged him/her to ask questions and took adequate time to answer them.
- I conveyed a factually correct version of what was related to me.
- I am satisfied that the parent/legal guardian fully understands the content of this informed consent document and has had all his/her questions satisfactorily answered.

Signed at ..... on the .....day of..... 2006.

.....
Signature of interpreter

.....
Signature of witness

Assent of minor

I ..... have been invited to take part in the above research project.

- The study doctor/nurse and my parents have explained the details of the study to me and I understand what they have said to me.
- I also know that I am free to withdraw from the study at any time if I am unhappy.
- By writing my name below, I voluntary agree to take part in this research project. I confirm that I have not been forced either by my parents or doctor to take part.

....

Name of child **Independent witness**

DEELNEMERINLIGTINGSBLAD EN -TOESTEMMINGSVORM VIR GEBRUIK DEUR OUERS/WETTIGE VOOGDE

TITEL: 'n Studie om die effekte van 'n doelgerigte groep-oefeningsprogram op grof en fynmotoriese vaardighede en self persepsie te bepaal in ses tot tien jarige kinders met Ontwikkelings - Koordinasie Disfunksie (Developmental Coordination Disorder/DCD).

VERWYSINGSNOMMER: N06/07/125

HOOFNAVORSER: Roshaan Salie

ADRES: Moiraweg 2
Surrey Estate
Athlone
7764

of

Eros Skool
Tarentaalweg
Bridgetown
7764

KONTAKNOMMER: 083 267 6739

U kind word genooi om deel te neem aan 'n navorsingsprojek. Lees asseblief hierdie inligtingsblad op u tyd deur, aangesien die besonderhede van die navorsingsprojek daarin verduidelik word. Indien daar enige deel van die navorsingsprojek is wat u nie ten volle verstaan nie, is u welkom om die personeel daaroor uit te vra. Dit is baie belangrik dat u ten volle moet verstaan wat die navorsinsprojek behels en hoe u en u kind daarby betrokke kan wees. U en u kind se deelname is ook **volkome vrywillig** en dit staan u vry om deelname te weier. U sal op hoegenaamd geen wyse negatief beïnvloed word indien u sou weier om deel te neem nie. U kind mag ook eniger tyd van die projek onttrek, selfs al het u ingestem om deel te neem.

Hierdie navorsingsprojek is deur die **Komitee vir Mensnavorsing van die Universiteit Stellenbosch** goedgekeur en sal uitgevoer word volgens die etiese riglyne en beginsels van die Internasionale Verklaring van Helsinki en die Etiese Riglyne vir Navorsing van die Mediese Navorsingsraad (MNR).

Die studie sal by u kind se skool uitgevoer word gedurende die eerste en tweede kwartaal. 'n Totaal van ongeveer 40 kinders vanaf twee skole sal vir deelname aan die studie genooi word.

Die doel van die studie is om die effek van 'n doelgerigte groeps-oefeningprogram te bepaal op (1) motoriese vaardigheid – m.a.w. kan so 'n oefenprogram 'n effek hê op balaktiwiteite, handskrif en balans, en (2) op self-persepsie, d.w.s. hoe voel die kind self na deelname aan so 'n oefenprogram.

Ek het hierdie studie onderneem omdat, alhoewel daar bewys is dat oefening van waarde is by kinders met DCD, daar geen studies is wat die bydraende effekte van oefening uitgevoer in groepsverband beskryf nie. Indien deelname in 'n groep 'n positiewe effek gaan het, sal dit fisioterapeute help om beter behandeling aan ander kinders met soortgelyk probleme as die wat u kind huidiglik ervaar, te kan bied. Hantering en behandeling van kinders in groepe kan verder bydra tot meer effektiewe dienslewering binne ons skoolsisteem, deurdat meer kinders gelyktydig behandel kan word.

Al die kinders sal 'n bewegings-evalueringsproses deurgaan voordat hulle aan die oefenprogram gaan deelneem. Hulle sal ook 'n self-persepsie vraelys moet invul. Die oefenprogram sal in die eerste en tweede kwartale uitgevoer word. Die kinders sal in twee groepe verdeel word. Een groep sal die oefeningsprogram eerste volg in die eerste helfte van die jaar, terwyl die tweede groep as kontrole gaan dien. Die kontrole groep sal dieselfde oefeningprogram in die twede helfte van die jaar volg. Aan die einde van die tweede kwartaal sal al die kinders weer getoets word en moet die vraelys ingevul word.

Ek het u kind genooi om deel te neem omdat hy/sy alreeds deur hul huidige Fisioterapeut geidentifiseer is vir deelname aan oefenterapie om sy/ haar probleme met beweging en handskrif aan te spreek – soortgelyk as die oefening wat in die studie aangebied gaan word. Betrekking tot hierdie projek het geen koste verbonde nie en u gaan ook nie finansieel hierdeur baat nie. Daar sal net van u verwag word om te verseker dat u kind nie onnodig afwesig is van die skool sodat hy / sy nie van die oefensessies sal mis nie.

Dit mag voordelig wees vir toekomstige pasiënte wat groepterapie sal bywoon. U moet net asseblief seker maak dat u kind altyd die groepsessies bywoon.

Alle inligting sal heeltemal vertroulik hanteer word. Slegs ek, my studieleiers en die statistikus sal toegang hê tot die data. Resultate en ander inligting kan vir publikasies soos bv in 'n tesis, of journaal en of vir 'n professionele werkswinkel, vergadering of kongress voorgedragte gebruik word . Foto's sal geneem word vir voorgedragte maar al die gesigte sal onherkenbaar gemaak word.

U kan die Komitee van Mensnavorsing kontak by 021- 938 9207 indien u enige bekommernis of klagte het wat nie bevredigend deur die studieleier hanteer is nie.

U sal 'n afsrif van hierdie inligtings- en toestemmingsvorm ontvang vir u eie rekords.

Verklaring deur ouer/wettige voog

Met die ondertekening van hierdie dokument onderneem ek, ..., om my kind....., wat ..... jaar oud is, te laat deelneem aan 'n navorsingsprojek getiteld "'n Studie om die effekte van 'n doelgerigte groep-oefeningsprogram op grof en fynmotoriese vaardighede te bepaal in ses tot tien jarige kinders met Ontwikkelings - Koordinasie Disfunksie (Developmental Coordination Disorder/DCD)."

Ek verklaar dat:

- Ek hierdie inligtings- en toestemmingsvorm gelees het of aan my laat voorlees het en dat dit in 'n taal geskryf is waarin ek vaardig en gemaklik mee is.
- My kind moet instem om aan die navorsingsprojek deel te neem as hy/sy ouer as 7 jaar is, en dat sy/haar INSTEMMING op hierdie vorm aangeteken sal word.
- Ek geleentheid gehad het om vrae te stel en dat al my vrae bevredigend beantwoord is.
- Ek verstaan dat deelname aan hierdie projek **vrywillig** is en dat daar geen druk op my geplaas is om my kind te laat deelneem nie.
- My kind te eniger tyd aan die projek mag onttrek en dat hy/sy nie op enige wyse daardeur benadeel sal word nie.
- My kind gevra mag word om aan die projek te onttrek voordat dit afgehandel is indien die studiedokter of navorser van oordeel is dat dit in sy/haar beste belang is, of indien my kind nie die ooreengekome studieplan volg nie.

Geteken te ..... op die .....van.....,..... 2006.

....

Handtekening van ouer/wettige voog **Handtekening van getuie**

Verklaring deur navorser

Ek, Roshaan Salie, verklaar dat:

- Ek die inligting in hierdie dokument verduidelik het aan

  .....

- Ek hom/haar aangemoedig het om vrae te vra en voldoende tyd gebruik het om dit te beantwoord.
- Ek tevrede is dat hy/sy al die aspekte van die navorsingsprojek soos hierbo bespreek, voldoende verstaan.
- Ek 'n tolk gebruik het/nie 'n tolk gebruik het nie.

Geteken te..... op die.....van..... 2006.

....

Handtekening van navorser **Handtekening van getuie**

Verklaring deur tolk

Ek ..... verklaar dat:

- Ek die navorser, Roshaan Salie, bygestaan het om die inligting in hierdie dokument in Afrikaans/Xhosa aan ..... te verduidelik.
- Ons hom/haar aangemoedig het om vrae te vra en voldoende tyd gebruik het om dit te beantwoord.
- Ek 'n feitelik korrekte weergawe oorgedra het van wat aan my vertel is.
- Ek tevrede is dat die ouer/wettige voog die inhoud van hierdie dokument ten volle verstaan en dat al sy/haar vrae bevredigend beantwoord is.

Geteken te..... op die .....van ..... 2006.

....

Handtekening van tolk **Handtekening van getuie**

Instemming van minderjarige

Ek ..... is genooi om deel te neem aan bogenoemde navorsingsprojek.

- Die fisioterapeut en my ouers het die besonderhede van bogenoemde navorsingsprojek aan my verduidelik en ek verstaan wat hulle aan my gesê het.
- Ek weet ook dat ek te eniger tyd aan die navorsingsprojek kan onttrek indien ek ongelukkig is.
- Deur my naam hieronder in te vul, onderneem ek om **vrywillig** aan die navorsingsprojek deel te neem. Ek bevestig ook dat ek nie deur my ouers of studiedokter gedwing is om deel te neem nie.

....

Naam van kind **Onafhanklike getuie**

ADDENDUM C

Full appraisal of the Movement ABC assessment tool

Reproduced with permission from Plummer, 2008

Full Name of Outcome measure	Movement assessment battery for children	
Abbreviated name	M-ABC	
Designer of Outcome measure	Henderson and Sugden (1992)	
**** Henderson and Sugden (1992) reference for information in table unless otherwise stated.		
		Score
Purpose:	• To objectively assess and identify children with substantial motor co-ordination, and to grade or describe performance of children with motor co-ordination problems. • Provides quantitative data on performance. Its score indicates the extent to which a child falls below the level of their aged peers by comparing to norms. (no attempt has is made to differentiate between children who perform above this level). • Provides framework to identify a child's strengths and weaknesses to indicate directions for further assessment or remediation.	Cont? YES
Background:	Fundamental movement skills and performance based.	Cont? YES
Population: Age and sample size	**Manual:** 4- 12 year olds. **Tests in manual:** Concurrent validity: 4 years 6mths- 12 years (N=63). Construct validity: 4years (N=870). Test-retest reliability: 5-9 years (N=92). **Populations from studies – age and sample size:** • 4 year olds (N=91) (Haga, Pedersen and Sigmundsson 2008). • 4-12 year olds (N=9) (Smits-Engelsman et al 2008). • 6-8 year olds (N= 20) (Deconinck et al 2008). • 4-5 year olds (N=31) (Van Waelvelde et al 2007a). • 4-5 year olds (N=33) 24:9 boys:girls (Van Waelvelde et al 2007b). • 4-6 year olds, Hong Kong (N= 255) or Taiwan (N=544) general population (Chow et al 2006). • 7-9 year olds (N= 133) (Van Waelvelde et al 2004a). • 9-10 year olds, (N=72) (Van Waelvelde et al 2004b). • 4- 6 year olds (N= 79) for inter-rater reliability, (N=75) for test re-test (Chow and Henderson 2003). • Mean age 13.92 year olds, SD =1.26 (N= 31) from Hong Kong from general school pop (Chow et al 2002). • 8-17 year olds (N=202) (Crawford, Wilson and Dewey 2001).	Cont YES

	• 4 years, 8months and 10 years, 8 months (N=69) (Tan, Parker and Larkin 2001). • No age in both study 1 and 2 (Dewey and Wilson 2001). • 5-12 year olds (N=106) general population (Croce, Hovart and McCarthy 2001). • 5-11 year old boys (N=14) (High et al 2000). • 6-8 year olds (N= 23) (3 girls, 20 boys) (Leemrijse et al 1999). • 5-13 year olds N=–208 (Smits-Engelsman et al 1998). • 5- 8 year olds (N= 73 DCD and 73= control) (Smyth and Mason 1998). • 8-18 year olds N= 379 (Kaplan et al 1998). * Note: These details and references for studies analysing normative data in other countries are detailed in the "Normative data/scores" row.	
Pathology:	**Manual:** Children with minimal motor impairments from various aetiologies. **Tests in manual:** Concurrent validity: General population. Construct validity: MI and learning disabilities, LBW and children born pre-maturely. Test-retest reliability: Normative sample. **Populations from studies:** • General population (Haga, Pedersen and Sigmundsson 2008). • Motor impairments +/- ADHD, LD, haemophilia, 1 with pervasive developmental disorder not otherwise specified (Smits-Engelsman et al 2008). • DCD & typical; children for control (Deconinck et al 2008). • Referred due to observed MI, no cognitive/ neurological problems (Van Waelvelde et al 2007a). • Poor motor performance, most at the 15th percentile or below (Van Waelvelde, Peersman, Lenoir, Smits-Engelsman 2007b). • General population (Chow et al 2006). • 44% ≤15th percentile on M-ABC, 24% were poor ball catchers, 32% typically developing children control (Van Waelvelde et al 2004a). • 50% DCD, 50% typical children (Van Waelvelde et al 2004b). • General population with 7.6% ≤5th percentile on motor tests (Chow and Henderson 2003). • General school population, children were excluded if they had a known physical or intellectual disability (Chow et al 2002). • DCD with LD and/or attention problems and LD and/or attention problems as a control – matched pairs (Crawford, Wilson and Dewey 2001). • Referred with concerns of motor skill disorders and control (N=69) and then confirmed motor impairments vs. matched controls (N=52) (Tan, Parker and Larkin 2001). • Typically developing children, children with learning or attention problems +/- MI (study 1 Dewey and Wilson 2001).	Continue? Y/N

	• Using data from previously unpublished studies 4 groups: Group 1 = 76 children referred to OT for motor difficulties +/- LD or attention problems. Group 2 = 61 children with DCD +/- reading disabilities and/or ADHD, not referred to Occupational Therapy. Group 3 = 20 children with DCD, no know co-morbidities and not referred for Occupational therapy. Group 4= 155 typical children (no DCD/ADHD/LD etc) (study 2 Dewey and Wilson 2001). • General UK school population (Croce, Hovart and McCarthy 2001). • Referred to occupational therapy as clumsy or having coordination difficulties (High et al 2000). • Poor motor performance suspected DCD (Co-morbidities included LD). 78% ≤15th percentile, 56% ≤5th percentile (Leemrijse et al 1999). • 2 groups of children- non-referred group randomly selected and a group of referred for observed motor delays (Smits-Engelsman et al 1998). • DCD and typical children for control all above the 35th percentile on motor tests (Smyth and Mason 1998). • Children with LD/attention disorders, DCD and general population (Kaplan et al 1998). * Note: These details and references for studies analysing normative data in other countries are detailed in the "Normative data/scores" row.	
Number of items:	There are 4 age bands each with 8 items grouped into 3 subscales, Manual dexterity (3 items), Ball skills (2 items), Balance (3 items). Age bands are 4-6, 7-8, 9-10, 11-12 years (thus 32 items across all age bands).	Cont YES
Score system:	Items are scored in seconds or number of correctly performed trials. These raw scores are converted into point scores between 0-5 on each item. Children within each age band perform the same tasks but point scores are given for children in12 month age intervals. These point scores are summed into an impairment score which is converted into a percentile via a table in the manual. A higher point score indicates a greater impairment.	Cont? YES
Equipment required:	All equipment supplied with the test except for a stopwatch and clip board, kit includes: Table top mat, bank box, 16 coins, 16 cube beads, Lace, Fine tipped red pen, 2 jumping stands, 2 wooden pins, Weight cord, Bean bag, Tennis ball, Tape measure, Coloured tape, Peg board,16 plastic pegs, Lacing board, Target box, Bolt with fixed nut, 3 loose nuts, Scissors, Wall target and 2 balance boards.	
Time required to perform:	20-40 minutes.	
Description:	YES- In manual.	Cont? YES
Normative	The M-ABC was normed on 1234 Children aged 4-12 year olds, using a representation of	Cont?

data/scores:	the demographics of America in rural and urban areas, children with disabilities were excluded (Henderson and Sugden 1992). <u>Studies comparing manual norms to norms in other populations:</u> Norms in manual require adjustment prior to use for Spanish children (N= 385) (Ruiz et al 2003), Chinese children (N=255 and N=799) (Chow, Henderson and Barnett 2001, Chow et al 2006) and Japanese children (N=133) (Miyahara et al 1998). The Japanese sample size was small and largely from higher socioeconomic families, thus may not have been a true representation of the entire population; making definitive and appropriate decisions about the use of the M-ABC in Japan not possible (Miyahara et al 1998). Norms in manual appear suitable for Australian children aged 4-5years (N=149) (Livesey, Coleman, Piek 2007) and for Netherlands children (N=208) (Smits-Engelsmanet al 1998). Norms in manual for 6 year olds Swedish children (N= 60) appear to require little adjustment, although the small sample size makes it difficult to generalise (Rosblad and Gard 1998).	YES
Validity:	**CRITERION VALIDITY:** **Concurrent validity:** (Deconinck et al 2008) M-ABC balance items did not correlate well with the indicators of balance on the modified version of the Clinical Test of Sensory Interaction on Balance (mCTSIB) (Deconinck et al 2008). **Concurrent validity:** (Van Waelvelde et al 2007a) *Spearman's* correlation coefficient between M-ABC and PDMS-2 (95% CI, coefficients significant at 0.01 level). Total scores were good to excellent (0.76, CI=0.51-0.90) and correlations between M-ABC and PDMS-2 gross motor tests were moderate to good (0.71, CI =0.44-0.87). Correlations between gross motor and total scores between the M-ABC and PDMS-2 varied from moderate to good (0.67 to 0.71). (Note: fine motor components were also correlated) (Van Waelvelde et al 2007a). Level of agreement between the total scores of the M-ABC and PDMS-2 when children were split into 2 groups of above or below the 15th percentile of each test was fair (K= 0.29 with 95% CI between 0.15-0.43, percentage of agreement was 68%) (Van Waelvelde et al 2007a). **Concurrent validity:** (Van Waelvelde et al 2004a) Spearman's rho Correlation coefficients between ball catching test and the ball catching item of the M-ABC were moderate to good for 7-8 year olds (rs=0.74) and 9 year olds (rs= -0.54), p= <.01 for both. (Note: the ball catching test measured very different aspects to catching to the M-ABC) (Van Waelvelde et al 2004a). Spearman's rho correlations for the Körper Koördinationstest für Kinder (KTK) jump and	Partial **1 ½** **/3**

the jumping tests on the M-ABC were fair for 7-8 and 9-10year olds (rs= -0.41, p<.01 and 0.33 respectively). (Van Waelvelde et al 2004a).

Spearman's rho correlation co-efficients for the M-ABC balance in walking and KTK beam were fair for 7-8 year olds (rs= -0.46, p<.01) and for 9 year olds (rs=-.38) (Note: the balance in walking component in the M-ABC for 9 year old is balancing a ball on a plate, thus a different construct, which may explain the lower correlations). The KTK beam and M-ABC static balance spearman's rho correlations were moderate to good (rs= -0.63, p<.01) for 7-8 year olds and 9 year olds (-0.66, p<.01) (Van Waelvelde et al 2004a).

Spearman's rho correlation co-efficients between:

Ball catching test and M-ABC total impairment score were moderate to good for 7-8 year olds (0.72, p=.01) and 9 year olds (-0.68, p=.01).

KTK jump and M-ABC total impairment score were good to excellent for 7-8 year olds

(-0.76) and moderate to good for 9 year olds (-0.69) with p<0.01.

KTK beam and M-ABC total impairment score were moderate to good for 7-8 year olds (-0.72) and for 9 year olds (-0.58) (both p<0.01) (Van Waelvelde et al 2004a).

Concurrent validity: (Van Waelvelde et al 2004b)

Pearson's correlation coefficients (p<0.01) between the M-ABC total score: and ball catching (-0.44), KTK jump (-0.28), a tracing task (-0.52), visual timing (-0.30), VMI copy task (0.49) were fair to moderate but there was no to little relationship between the M-ABC and visual discrimination (-0.20) (Note: all correlations between other measures were also low to moderate, varying between 0.04- to -0.54 the highest correlation being between visual timing and ball catching) (Van Waelvelde et al 2004b).

Concurrent validity: (Tan, Parker and Larkin 2001)

Spearman rank order correlation analyses between:

M-ABC, and BOT-MP-SF and between the M-ABC and MAND were good to excellent (0.79 and 0.86 respectively), for whole population (Tan, Parker and Larkin 2001).

For 54 matched cases of MI and control, Spearman rank correlations were also good to excellent between the M-ABC and BOT-MP and M-ABC and MAND (0.84 and 0.88 respectively) (Tan, Parker and Larkin 2001).

Concurrent validity: (Crawford, Wilson and Dewey 2001)

Level of agreement between BOT-MP and M-ABC impairment scores was 67% (Crawford, Wilson and Dewey 2001).

Agreement measured by Proportion of observed agreement (Po) and kappa (adjusted for chance) between M-ABC and BOT-MP total scores was fair (Po =0.722, kappa=0.416) between M-ABC and BOTMP gross motor composites was also fair (Po= 0.722, kappa= 0.430) (Crawford, Wilson and Dewey 2001) with whole sample.

Concurrent validity: (Croce, Hovart and McCarthy 2001)

Pearson's product moment correlation coefficients between the M-ABC and BOT-MP – Long Form (LF) was good to excellent (r = 0.76, p<0.001). Across age groups correlations varied from moderate to excellent for 9-10 year olds (r=0.70) and for 11-12 year olds

(r=0.90) (P<0.001 on both) (Croce, Hovart and McCarthy 2001).

Pearson's product moment correlation coefficients between the M-ABC and BOT-MP – Short form (SF) were moderate to good across age groups (r=0.71, p<0.001). Correlations in each age band were all good to excellent (r=0.76 -0.90 p<0.001) except for 9-10 year olds which was moderate to good (r=0.60, p<0.01) (Croce, Hovart and McCarthy 2001).

Concurrent validity: (Dewey and Wilson 2001) **– study 1**

Children tested on the M-ABC, BOT-MP, and VMI- level of agreement:

Typically developing children that failed to meet DCD criteria on all 3 tests = 85.9% and for LD or attention problems = 77.8%

Typical Children that met DCD criteria 1 of 3 tests= 14.1% and for LD or attention problems = 22.2%

Typical children that met DCD criteria for on 2 of the 3 tests = 8.5% and for LD or attention problems = 14.8%

Typical children that met DCD criteria on all 3 tests = 1.4% and for LD or attention problems = 3.7%

Concurrent validity: (Dewey and Wilson 2001) **– study 2**

Using data from previous studies – no ages

(4 groups)

Fair associations between the VMI and M-ABC or TOMI = (kappa =0.42. p< 0.001) with the overall agreement was found to be 71%.

Moderate to good associations were found between the BOT-MP and the M-ABC or TOMI (kappa = 0.62, p< .001) with an overall agreement of 82%.

Concurrent validity: (High et al 2000)

Spearman's rho correlation coefficients were used to assess the degree of linear association between the z-score from the Southern California Sensory Integration Test (SCSIT) and the M-ABC. Correlations between the M-ABC total scores and SCSIT tests varying from no or little relationship to moderate to good agreement as below (High et al 2000):

Correlations between:

- M-ABC and SCSIT motor accuracy right were moderate to good (r= 0.59).
- M-ABC manual dexterity subtest and SCSIT motor accuracy right were moderate to good (r= 0.59).
- M-ABC and SCSIT motor accuracy left were fair (r=0.46).
- M-ABC manual dexterity subtest and SCSIT motor accuracy left were fair (r=0.46).
- M-ABC and SCSIT imitation postures had little or no relationship: (r = 0.06).
- M-ABC and SCSIT Standing balance eyes open had little or no relationship; r= 0.06.
- M-ABC and SCSIT Bilateral Motor coordination were fair (n=12) (r= 0.26).

Concurrent validity: (Smits-Engelsman et al 1998)

Overall Pearson's correlation coefficients between the M-ABC and the KTK is moderate to good (r=0.62, p<0.0001 (Smits-Engelsman et al 1998)

Correlations between the KTK and M-ABC items were:

- KTK task walk backwards along a balance beam correlated with the M-ABC manual dexterity and balance items to a fair degree (r=0.47 and 0.48 respectively) (Smits-Engelsman et al 1998).
- Fair to little agreement between the balance items of the M-ABC and the KTK items of jumping sideways and moving sideways on boxes (r=0.30 and 0.23 respectively) (Smits-Engelsman et al 1998)

The analysis on the 74 referred children had similar results the overall correlation being moderate to good (r=0.65 p<0.0001). Correlations between KTK balance and manual dexterity and balance from the M-ABC were fair up to moderate to good (r=0.42 and 0.59 respectively) (Smits-Engelsman et al 1998).

Level of agreement between the M-ABC and KTK to identify DCD was 78%. Using Chi square tests to compare the proportion of children passing and failing the test, it was found the level of agreement was statistically significant (X2 = 64.4, p<0.001) (Smits-Engelsmanet al 1998).

Concurrent validity: (Smyth and Mason 1998)

Only 3 specific relations were found between proprioceptive tasks on the kinaesthetic sensitivity test (KST) and the subscales of the M-ABC: (1)posture matching KST and Balance M-ABC, (2) mean random error vision and Ball skills and (3)men standard error right hand proprioception and manual dexterity) out of 21 had correlations, of p<0.01 (Smyth and Mason 1998).

Concurrent validity: (Kaplan et al 1998)

Agreement between tests on all subjects (Po=portion of observed agreement) and

Kappa correlations between:

- M-ABC and BOT-MP battery composite were fair (kappa = 0.465, Po= 0.819).
- BOTMP-gross motor composite and M-ABC were fair (kappa = 0.479, Po= 0.813).
- BOT-MP-fine motor composite and M-ABC showed little to know relationship (kappa = 0.155, Po= 0.735).
- BOTMP-Short Form and M-ABC were fair (kappa = 0.327, Po = 0.800) (Kaplan et al 1998).

Percentage of agreement of subjects scoring below cut-offs between (Kaplan et al 1998):

- M-ABC & BOT-MP total= 44%
- M-ABC & BOT-MP FM = 18%
- M-ABC & BOT-MP GM = 51%
- M-ABC and BOT-MP SF = 26%

Average agreement between BOT-MP and M-ABC was fair = 34.75% (Kaplan et al 1998).

Concurrent validity: (Henderson and Sugden 1992)

Between M-ABC and BOT-MP the correlation coefficients between total scores levels were moderate to good (r=0.53) (Henderson and Sugden 1992).

	FACE VALIDITY: Not reported. **CONTENT VALIDITY:** Only on Predecessor. **CONSTRUCT VALIDITY:** (Henderson and Sugden 1992) Know groups method: Studies reported that children with MI and learning disabilities, LBW and children born pre-maturely all had scores lower than the standardised norms as would be expected for these groups (Henderson and Sugden 1992). **FACTOR ANALYSIS:** Not reported.	
Reliability:	**INTERNAL CONSISTENCY:** (Haga, Pedersen and Sigmundsson 2008) Correlations (Pearson's – 2 tailed) between 8 subtasks of the M-ABC, correlations were Poor to adequate,-0.005 (threading beads and rolling the ball) to 0.614 for (Rolling ball and walking heels raised). There were poor correlations for all subtests, indicating each individual item measures a separate construct. Correlations between subtests are listed below: <u>Manual dexterity</u> Posting coins and threading beads= 0.155 Posting coins and bicycle trail= -0.031 Threading beads and bicycle trail = 0.203 <u>Balls skills</u> Catching bean bag and rolling ball = 0.155 <u>Balance</u> SLS and jumping = 0.270 SLS and walking with heels raised = 0.177 Jumping and walking with heels raised = -0.034 **TEST – RETEST RELIABILITY:** **Test- retest:** (Van Waelvelde et al 2007b) Test-retest – (M-ABC administered 3 x with 3 week interval between each) ICC of 3 total impairment scores were excellent (0.88 with 95% CI between 0.79 and 0.93) (Van Waelvelde et al 2007b). ICC on the manual dexterity sub score over 3 tests and balance subscores over 3 tests were excellent (0.75, 95% CI 0.60-0.86 and 0.82, 95% CI 0.70-0.90 respectively) ICC Ball skills across the 3 test was fair (0.45, 95% CI 0.24-0.65) (Van Waelvelde et al 2007b). ICC on each item across testing were poor to excellent (0.14 to 0.81) (Van Waelvelde et al	YES **3/3**

2007b).

The standard error of measure (SEM) to evaluate test-retest further was SEM= 2.4, 95% CI of 4.7 on the total MABC (where the impairment score ranges from 0-40), (Van Waelvelde et al 2007b).

To assess the stability of the diagnostic category which children can be assigned, the total impairment scores were dichotomized, using 15th percentile as cut off Coefficient of agreement between 3 separate testing times, was moderate to good (kappa = 0.72, 95% CI between .52 and .92) (Van Waelvelde et al 2007b).

To determine whether the effect of repeated testing was statistically significant the within subject effect of the general linear model of repeated measures was checked

Total M-ABC score was significant with $F(2,64) = 7.50$; $p=0.001$.

The within subject effect of the general linear model for repeated measures for the subscores was only significant for the 'ball skills' with $F(2,64) = 8.82$ and $p<0.001$, but not for the subscores of dexterity $F(2,64)= 0.50$, $p=0.95$ and balance $F(2,64) = 2.64$; $p=0.21$ (Van Waelvelde et al 2007b).

Test re-test: (Chow and Henderson 2003)

With 2 tests on each child by same assessor over 2-3 weeks, the average ICC overall items and ages was good to excellent (0.77, $p<0.001$) (Chow and Henderson 2003).

All ICC items were fair to excellent, with the lowest ICC on posting coins for 5 year olds and 6 year olds and the ball rolling for 6 year olds (0.55 significant at $p < 0.01$ and 0.48, $p <0.01$ respectively) and highest on bicycle trail for 6 year olds (1.00, significant at $p<0.001$) (Chow and Henderson 2003).

Test retest: (Chow et al 2002)

M-ABC scored 2 weeks apart:

Overall score test – retest correlations were moderate to good (0.72).

Other than 'lifting beads' and walking backwards' the remaining items reached $p= 0.01$ (Chow et al 2002).

ICC ranged from moderate to excellent with correlations of 0.60 (cutting out elephant) to 0.91 (Cross board balance) (Chow et al 2002).

The means for the 1st test for the whole sample were generally higher than for the 2nd test – indicating a learning effect (Chow et al 2002).

Test re-test: (Croce, Hovart and McCarthy 2001):

Children tested twice with M-ABC within 1 week of each other. Percentile scores were analysed.

ICC were excellent overall (0.95) and within each age band (5-6 year olds = 0.98, 7-8 year olds = 0.95, 9-10 =0.92, 11-12= 0.97 all $p <.001$) (Croce, Hovart and McCarthy 2001).

	Test retest: (Henderson and Sugden 1992): On each item – scores were dichotomised 0-1 (above the 15th percentile or "pass") and 1.5-5 (below the15th percentile or "fail): Percentage of agreement for each age band representative was moderate to excellent as follows: (Henderson and Sugden 1992): 5 year olds (N=30) varied from 77% (item 8) to 100% (item 7) , median agreement = 90% 7 year olds (N=32) varied from 62% (item 2) to 97% (item 1) median = 84% 9year olds (N=30) varied from 67% (item 2) to 93% (item 4), median = 80% Test- re-test of total impairment scores: Scores were assigned 2 categories above the 15th percentile or below the 15th percentile, then the % of agreement between tests was calculated, agreement was good to excellent, 5 year olds = 97% agreement, 7year olds = 91% agreement, 9year olds = 73% agreement (Henderson and Sugden 1992): **INTER-RATER RELIABILITY:** **Inter-rater reliability:** (Smits-Engelsman et al 2008) Inter-rater reliability for total impairment scores of the M-ABC was excellent with all Kappa scores very high varying from 0.95 for 7year olds to 1.00 for 4 year olds and 8 year olds, all significant at $p<0.01$ (Smits-Engelsman et al 2008). **Inter-rater reliability:** (Chow et al 2006) Inter-rater Reliability of the M-ABC items were good to excellent, ICC ranged from 0.93 to 0.99 with a mean of 0.96 (Chow et al 2006). **Inter-rater reliability:** (Chow and Henderson 2003) The inter-rater reliability ICC of total mean scores was excellent (0.96), between raters significance at $p <0.001$ (Chow and Henderson 2003). **Inter-rater reliability:** (Chow et al 2002) Inter-rater reliability ICC for total scores were excellent (0.94) between raters. Among individual items ICC were excellent ranging from 0.92 to 1.00 ($p<0.001$) except for jumping and clapping ICC which was moderate to good (0.52) (Chow et al 2002).	
Responsive ness:	**Sensitivity and Specificity:** (Van Waelvelde et al 2007a) The M-ABC scored more stringently than the PDMS-2 and the M-ABC's sensitivity was higher. (Van Waelvelde et al 2007a). **Least detectable difference (LLD) :** For total M-ABC was found to be 6.6 (Van Waelvelde et al 2007b).	YES **1/1**

	Sensitivity: (Van Waelvelde et al 2007a). The M-ABC has a different set of items for each of the 4 age groups which improves its sensitivity and age appropriateness (Van Waelvelde et al 2007a). **Sensitivity and Specificity:** (Crawford, Wilson and Dewey 2001) If BOT-MP used as gold standard for identifying DCD. Sensitivity for the M-ABC = 62% and specificity was 71% However, when children were also assessed with the DCDQ and VMI it appeared the BOT-MP identified less children with DCD than the M-ABC (Crawford, Wilson and Dewy 2001). **Least detectable difference and sensitivity:** (Leemrijse et al 1999) The LDD were calculated from the SEMs (cf. Statistical analysis) (Leemrijse et al 1999). LDD for items range from 2.19 to 4.27, for the clusters from 4.19 to 5.10. The LDD of the total score equalled 8.68. On the initial item scores 86% of items fell below 1 LDD, this also occurred in 46% of the initial cluster and in 13% of the initial total scores. Thus in these cases significant improvement would not be assessable (Leemrijse et al 1999). Expressed as a fraction of the whole score range, LDD of items scores range from 0.44 (item 1) to 0.85 (item 5), LDD of the cluster scores ranged from 0.28 (manual dexterity) to 0.48 (object control). The LDD of the total scores equalled 0.22 of the total score range (Leemrijse et al 1999). The SEM was calculated as the square root of the residual variance in the ANOVA repeated measures. For the item, scores SEM ranged from 0.79 to 1.34, for the cluster scores from 1.51 to 1.84. The SEM for the total score equalled 3.13 (scale range 0 to 40) (Leemrijse et al 1999). The conclusion was that the M-ABC total score is sufficiently sensitive to monitor individual change; cluster scores have moderately sensitivity and individual items have low sensitivity, thus are inappropriate to monitor individual change (Leemrijse et al 1999). However there did seem to be a learning effect on the M-ABC from the 1st to the 2nd assessment, the time between testing was only 2 weeks (Leemrijse et al 1999). **Sensitivity:** (Smits-Engelsmanet al 1998) The M-ABC scores were found to be accurately sensitive and fitting with the USA norms in Norwegian children. **Ceiling effects:** (Henderson and Sugden 1992) The M-ABC was designed to assess children with motor difficulties ability, thus ceiling effects would occur in the normal population. The M-ABC is not meant to be for assessing motor ability of typically developing children (Henderson and Sugden 1992).	
Precision:	YES- total score Ordinal measurement	YES 1/1

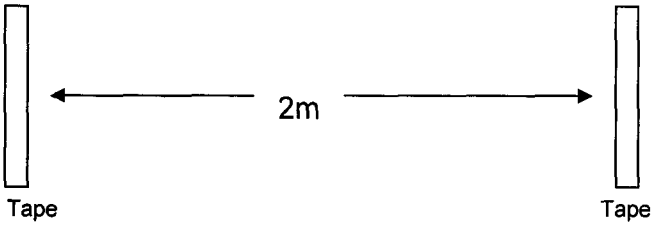
Client centred:	**Appropriateness:** • Common fundamental tasks performed: **Acceptability:** • Quick administration time. • Australian, Chinese, Japanese, Spanish children found the instructions easy to follow and responded positively to the tasks. (Miyahara et al 1998). • Score in percentile meaningful to the parent and easy to understand.	YES **2/2**
Tester centred:	**Feasibility:** • Short time to administer, requires minimal set up and most equipment is available in the kit. • The M-ABC was easier to use and required minimal training compared to the PDMS-2. Children were responsive and children's attention was kept (Van Waelvelde et al 2007a). • Inexperienced assessors with minimal training had good inter-rater reliability (Chow et al 2002). • Requires minimal training for quantitative part, but using the qualitative parts of the M-ABC requires more skill and experience in observing of children to recognise more subtle behavioural indices of emotional stress and poor motivation and awareness of strategies children develop to cope with their difficulties. **Utility:** • The M-ABC is easy to score and the system reduces mistakes, only 1 table is required to convert total impairment scores to a percentile score (Van Waelvelde, Peersman, Lenoir, Smits-Engelsman 2007a). • Scores as well as checklists on each item can be used to help determine intervention strategies and assess changes in the child's motor abilities over time and with different testers (Henderson and Sugden 1992). • Scoring very efficient and simple process (Henderson and Sugden 1992).	YES **2/2**
TOTAL SCORE		**10 ½ /12**

ADDENDUM D

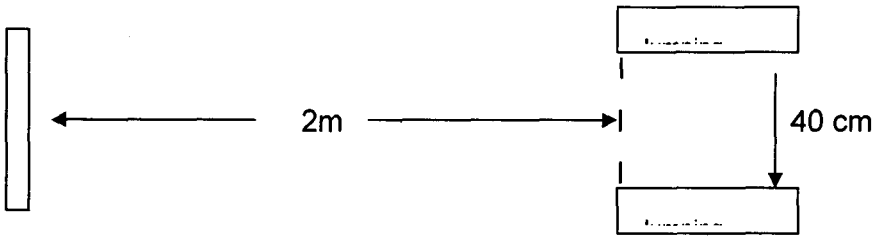
Full layout of the gymnasium setup as prescribed in the Movement ABC manual

For ages 4, 5 and 6:

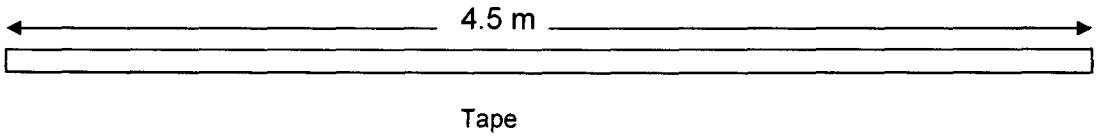
Catching Bean Bag



Rolling ball into Goal



Walking heels raised



Manual Dexterity: posting coins, threading beads, bicycle trail (at table)

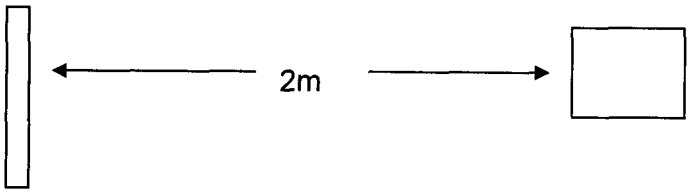
Ball Skills: catching a bean bag, rolling ball into a goal

Static balance: 1 leg standing balance

Dynamic Balance: jumping over the cord, walking heels raised

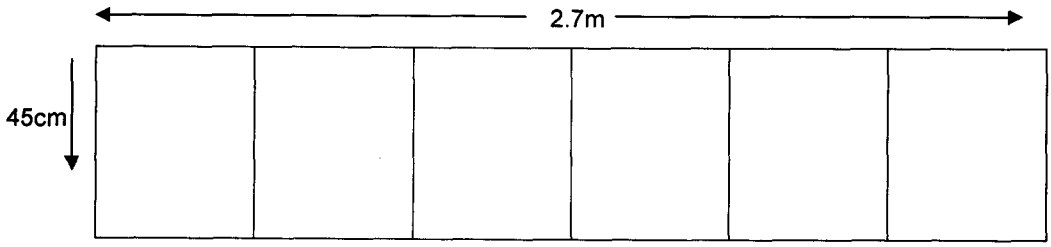
For ages 7 and 8 years:

Throwing bean Bag into the Box

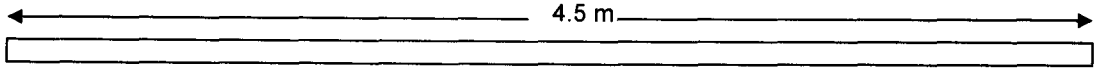


Tape Target Box

Jumping in squares



Heel-to-toe walking



Tape

Manual dexterity: placing pegs, threading lace, flower trail

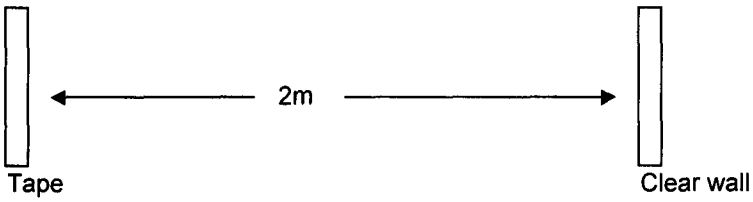
Ball Skills: one-hand bounce and catch, throwing bean bag into a box

Static Balance: stork balance

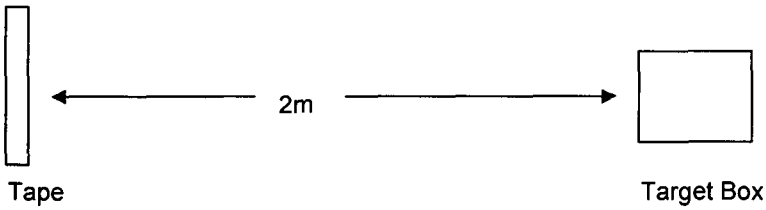
Dynamic Balance: jumping in squares, heel-to-toe walking

For ages 9 and 10 years:

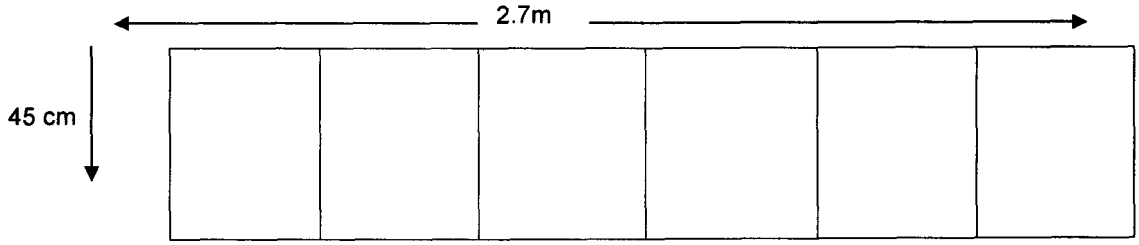
Two Hand Catch



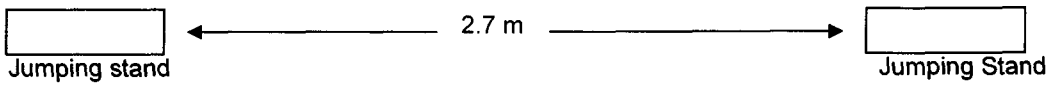
Throwing Bean bag into the Box



Hopping in Squares



Ball Balance



Manual Dexterity: shifting pegs, threading nuts on a bolt, flower trail

Ball Skills: two hand catch, throwing bean bag into the box

Static Balance: one board balance

Dynamic Balance: hopping in the squares, ball balance

ADDENDUM E

Movement ABC score sheets: Ages 4-6, 7-8 and 9-10

MOVEMENT

ABC

Movement Assessment Battery for Children

RECORD FORM

Complete by Sheila E. Henderson and Dave A. Sugden

AGE BAND 1 4–6 years

Name..... Gender .....

Home address ..... Date of test .....

..... Date of birth .....

..... Age .....

School ..... Grade/class .....

.....

Assessed by .....

Preferred hand (defined as the hand used to write with) .....

Other information .....

.....

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INFLUENCES ON PERFORMANCE

Complete the sections below by noting any physical factors or features of the child's behavior during testing which you suspect might have affected his or her motor performance. Headings (with examples) are given as guidelines only. Although negative aspects are given more emphasis, remember to note positive aspects of the child's behavior.

BEHAVIORAL FACTORS

- **Overactive** (squirms and fidgets; moves constantly when listening to instructions; fiddles with clothes) .....
- **Passive** (hard to interest; requires much encouragement to participate; seems to make little effort) .....
- **Timid** (fearful of activities like jumping and climbing; does not want to move fast; constantly asks for assistance) .....
- **Tense** (appears nervous, trembles; fumbles with small objects; becomes flustered in a stressful situation) .....
- **Impulsive** (starts before instructions/demonstrations are complete; impatient of detail) .....
- **Distractible** (looks around; responds to noises/movement outside the room) .....
- **Disorganized/confused** (has difficulty in planning a sequence of movements; forgets what to do next in the middle of a sequence) .....
- **Overestimates own ability** (tries to change tasks to make them more difficult; tries to do things too fast) .....
- **Underestimates own ability** (says tasks are too difficult; makes excuses for not doing well before beginning) .....
- **Lacks persistence** (gives up quickly; is easily frustrated; daydreams) .....
- **Upset by failure** (looks tearful; refuses to try task again) .....
- **Appears to get no pleasure from success** (makes no response to feedback; has a blank facial expression) .....
- **Other** .....

PHYSICAL FACTORS

- Weight/height/weight in relation to height .....
- Vision/hearing/speech .....
- Anatomical/postural defect .....
- Other .....

SUMMARY OF QUANTITATIVE DATA

MOVEMENT ABC CHECKLIST SCORE

Motor score

..... + ... + ... + ... = ...

MOVEMENT ABC TEST SCORE

Manual Dexterity ..... + ... + ... = ...

Ball Skills ..... + ... = ...

Static and Dynamic Balance ..... + ... + ... = ...

TOTAL IMPAIRMENT SCORE

SUMMARY OF QUALITATIVE OBSERVATIONS

MANUAL DEXTERITY (Body control/posture; functioning of limbs; spatial accuracy, control of force/effort, timing of actions; other observations including response to feedback during *informal* testing)

BALL SKILLS (Body control/posture; functioning of limbs; spatial accuracy, control of force/effort, timing of actions; other observations including response to feedback during *informal* testing)

STATIC AND DYNAMIC BALANCE (Body control/posture; functioning of limbs; spatial accuracy, control of force/effort, timing of actions; other observations including response to feedback during *informal* testing)

POSTING COINS — MANUAL DEXTERITY

Quantitative data

Record **time taken** (secs); **F** for failure; **R** for refusal; **I** for inappropriate

Preferred hand
Trial 1 .....
Trial 2 .....

Nonpreferred hand
Trial 1 .....
Trial 2 .....

age 4	age 5	age 6
0–23	0–20	0–17
24–25	21	18–19
26–27	22	20
28–32	23–24	21–24
33–49	25–29	25–28
50+	30+	29+

score
0 / 0
1 / 1
2 / 2
3 / 3
4 / 4
5 / 5

age 4	age 5	age 6
0–27	0–23	0–20
28–30	24–25	21–22
31–33	26	23
34–47	27	24–25
48–55	28–32	26–29
56+	33+	30+

* Item score

* Item score = (Preferred hand + Nonpreferred hand) ÷ 2

Qualitative observations

Body control/posture

- ☐ Does not look at slot while inserting coins
- ☐ Holds face too close to task
- ☐ Holds head at an odd angle
- ☐ Does not use pincer grip to pick up coins
- ☐ Exaggerates finger movements in releasing coins
- ☐ Does not use the supporting hand to hold box steady
- ☐ Does *extremely* poorly with one hand (asymmetry striking)
- ☐ Changes hands or uses both hands during a trial
- ☐ Hand movements are jerky
- ☐ Sitting posture is poor
- ☐ Moves constantly/fidgets

Adjustments to task requirements

- ☐ Misaligns coins with respect to slot
- ☐ Uses excessive force when inserting coins
- ☐ Is *exceptionally* slow/does not change speed from trial to trial
- ☐ Goes too fast for accuracy

Other

.....

.....

THREADING BEADS — MANUAL DEXTERITY

Quantitative data

Record **time taken** (secs); **F** for failure; **R** for refusal; **I** for inappropriate

Trial 1 .....
Trial 2 .....

score	age 4*	age 5	age 6
0	0–38	0–55	0–47
1	39–46	56–60	48–53
2	47–51	61–66	54–55
3	52–57	67–76	56–61
4	58–64	77–103	62–100
5	65+	104+	101+

Item score

* 4 year olds thread 6 beads only

Qualitative observations

Body control/posture

- ☐ Does not look at bead while inserting tip of lace
- ☐ Holds materials too close to face
- ☐ Holds head at an odd angle
- ☐ Does not use pincer grip when picking up beads
- ☐ Holds lace too far from tip
- ☐ Holds lace too near tip
- ☐ Finds it difficult to push tip with one hand and pull it through with the other
- ☐ Changes threading hand during a trial
- ☐ Hand movements are jerky
- ☐ Sitting posture is poor
- ☐ Moves constantly/fidgets

Adjustments to task requirements

- ☐ Sometimes misses hole with tip of lace
- ☐ Picks up beads the wrong way round
- ☐ Is *exceptionally* slow/does not change speed from trial to trial
- ☐ Goes too fast for accuracy

Other

.....

.....

BICYCLE TRAIL — MANUAL DEXTERITY

Quantitative data

Record **number of deviations**; **F** for failure; **R** for refusal; **I** for inappropriate

Trial 1 .....
Trial 2 .....
Hand used .....

score	age 4	age 5	age 6
0	0–4	0–1	0
1	5	2	1
2	6–7	3	–
3	8–9	4–5	2
4	10–11	6–7	3
5	12+	8+	4+

Item score

Qualitative observations

Body control/posture

- Does not look at trail ☐
- Holds face too near paper ☐
- Holds head at an odd angle ☐

- Holds pen with an odd/immature grip ☐
- Holds pen too far from point ☐
- Holds pen too close to point ☐
- Does not hold paper still ☐
- Changes hands during a trial ☐

- Sitting posture is poor ☐
- Moves constantly/fidgets ☐

Adjustments to task requirements

- Progresses in short jerky movements ☐
- Uses excessive force, presses very hard on paper ☐
- Is *exceptionally* slow ☐
- Goes too fast for accuracy ☐

Other

.....

.....

CATCHING BEAN BAG — BALL SKILLS

Quantitative data

Record **number of catches**; **R** for refusal; **I** for inappropriate

.....

score	age 4*	age 5	age 6
0	6–10	7–10	9–10
1	5	6	8
2	4	5	7
3	2–3	3–4	6
4	1	1–2	5
5	0	0	0–4

Item score

* 4 year olds may trap the bean bag against the body

Qualitative observations

Body control/posture

- Does not follow trajectory of bean bag with eyes ☐
- Turns away or closes eyes as bean bag approaches ☐

- Arms are not raised symmetrically for catching ☐
- Holds hands out flat with fingers stiff as the bean bag approaches ☐
- Hands and arms held wide apart, fingers extended ☐
- Arms and hands do not 'give' to meet impact of bean bag ☐
- Fingers close too early or too late ☐

- Does not move until bean bag strikes body ☐
- Body appears rigid/tense ☐

Adjustments to task requirements

- Does not adjust to height of throw ☐
- Does not adjust to direction of throw ☐
- Does not adjust to force of throw ☐
- Movements lack fluency ☐

Other

.....

.....

ROLLING BALL INTO GOAL — BALL SKILLS

Quantitative data

Record **number of goals**; R for refusal; I for inappropriate

.....
Hand used .....

score	age 4	age 5	age 6
0	5–10	6–10	8–10
1	4	5	7
2	3	4	6
3	2	3	5
4	1	2	4
5	0	0–1	0–3

Item score

Qualitative observations

Body control/posture

- ☐ Does not keep eyes on target
- ☐ Does not use a pendular swing of the arm
- ☐ Does not follow through with the rolling arm
- ☐ Releases ball too early or too late
- ☐ Changes hands from trial to trial
- ☐ Cannot maintain balance while rolling ball

Adjustments to task requirements

- ☐ Errors are consistently to one side of goal (asymmetry striking)
- ☐ Control of direction variable
- ☐ Judges force of roll poorly (too much or too little)
- ☐ Control of force is variable
- ☐ Movements lack fluency

Other

.....

.....

ONE-LEG BALANCE — STATIC BALANCE

Quantitative data

Record **time balanced** (secs); **R** for refusal; **I** for inappropriate

Preferred leg
Trial 1 .....
Trial 2 .....

Nonpreferred leg
Trial 1 .....
Trial 2 .....

age 4	age 5	age 6
5–20	11–20	15–20
4	8–10	11–14
3	7	9–10
2	5–6	7–8
1	3–4	5–6
0	0–2	0–4

score
0 / 0
1 / 1
2 / 2
3 / 3
4 / 4
5 / 5

age 4	age 5	age 6
5–20	9–20	15–20
4	6–8	11–14
3	5	8–10
2	4	6–7
1	3	4–5
0	0–2	0–3

* Item score

* Item score = (Preferred leg + Nonpreferred leg) ÷ 2

Qualitative observations

Body control/posture

- ☐ Does not hold head and eyes steady
- ☐ Looks down at feet
- ☐ Makes no or few compensatory arm movements to help maintain balance
- ☐ Exaggerated movements of arms and trunk disrupt balance
- ☐ Body is held rigid
- ☐ Sways wildly to try to maintain balance
- ☐ Does *extremely* poorly on one leg (asymmetry striking)

Other

.....

.....

JUMPING OVER CORD — DYNAMIC BALANCE

Quantitative data

Record P for success; F for failure; R for refusal; I for inappropriate

Trial 1 .....
Trial 2 .....
Trial 3 .....

score	age 4*	age 5	age 6
0	pass on Trial 1		
1	–	–	–
2	pass on Trial 2		
3	pass on Trial 3		
4	–	–	–
5	fails all 3 trials		

Item score

* 4 year olds need not land with feet together

Qualitative observations

Body control/posture

- Does not use arms to assist jump ☐
- Arms swing out of phase with legs ☐
- Arm movements are exaggerated ☐

- Body appears rigid/tense ☐
- Body appears limp/floppy ☐

- Makes no preparatory crouch ☐
- Lacks springiness/no push-off from feet ☐
- Uneven take-off and loss of symmetry in flight and landing ☐
- Lands with stiff legs/on flat feet ☐
- Stumbles on landing ☐

Adjustments to task requirements

- Does not combine upward and forward movements effectively ☐
- Uses too much effort ☐
- Movements are jerky ☐

Other

.....

.....

WALKING HEELS RAISED — DYNAMIC BALANCE

Quantitative data

Record **number of correct steps**; **F** for failure; **R** for refusal; **I** for inappropriate

Trial 1 .....
Trial 2 .....
Trial 3 .....

score	age 4	age 5	age 6
0	9–15	12–15	15
1	7–8	9–11	14
2	5–6	8	13
3	4	6–7	10–12
4	3	5	8–9
5	0–2	0–4	0–7

Item score

Qualitative observations

Body control/posture

- Does not look ahead ☐
- Does not keep head steady. ☐

- Does not compensate with arms to maintain balance ☐
- Exaggerated arm movements disrupt balance ☐

- Body appears rigid/tense ☐
- Body appears limp/floppy ☐

- Is very wobbly when placing feet on line ☐
- Sways wildly to try to maintain balance ☐

Adjustments to task requirements

- Goes too fast for accuracy ☐
- Individual movements lack smoothness and fluency ☐
- Sequencing of steps is not smooth/pauses frequently ☐

Other

.....

.....

MOVEMENT

ABC

Movement Assessment Battery for Children

RECORD FORM

Compiled by Sheila E. Henderson and David A. Sugden

AGE BAND 2 7–8 years

Name..... Gender .....

Home address ..... Date of test .....

..... Date of birth .....

..... Age .....

School ..... Grade/class .....

.....

Assessed by .....

Preferred hand (defined as the hand used to write with) .....

Other information .....

.....

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INFLUENCES ON PERFORMANCE

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BEHAVIORAL FACTORS

- **Overactive** (squirms and fidgets; moves constantly when listening to instructions; fiddles with clothes) .....
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- **Timid** (fearful of activities like jumping and climbing; does not want to move fast; constantly asks for assistance) .....
- **Tense** (appears nervous, trembles; fumbles with small objects; becomes flustered in a stressful situation) .....
- **Impulsive** (starts before instructions/demonstrations are complete; impatient of detail) .....
- **Distractible** (looks around; responds to noises/movement outside the room) .....
- **Disorganized/confused** (has difficulty in planning a sequence of movements; forgets what to do next in the middle of a sequence) .....
- **Overestimates own ability** (tries to change tasks to make them more difficult; tries to do things too fast) .....
- **Underestimates own ability** (says tasks are too difficult; makes excuses for not doing well before beginning) .....
- **Lacks persistence** (gives up quickly; is easily frustrated; daydreams) .....
- **Upset by failure** (looks tearful; refuses to try task again) .....
- **Appears to get no pleasure from success** (makes no response to feedback; has a blank facial expression) .....
- Other .....

PHYSICAL FACTORS

- Weight/height/weight in relation to height .....
- Vision/hearing/speech .....
- Anatomical/postural defect .....
- Other .....

GUIDELINES FOR INTERVENTION

SUMMARY OF QUANTITATIVE DATA

MOVEMENT ABC CHECKLIST SCORE

Motor score

..... + ... + ... + ... = ...

MOVEMENT ABC TEST SCORE

Manual Dexterity ..... + ... + ... = ...

Ball Skills ..... + ... = ...

Static and Dynamic Balance ..... + ... + ... = ...

TOTAL IMPAIRMENT SCORE

SUMMARY OF QUALITATIVE OBSERVATIONS

MANUAL DEXTERITY (Body control/posture; functioning of limbs; spatial accuracy, control of force/effort, timing of actions; other observations including response to feedback during *informal* testing)

BALL SKILLS (Body control/posture; functioning of limbs; spatial accuracy, control of force/effort, timing of actions; other observations including response to feedback during *informal* testing)

STATIC AND DYNAMIC BALANCE (Body control/posture; functioning of limbs; spatial accuracy, control of force/effort, timing of actions; other observations including response to feedback during *informal* testing)

PLACING PEGS — MANUAL DEXTERITY

Quantitative data

Record time taken (secs); F for failure; R for refusal; I for inappropriate

Preferred hand
Trial 1 .....
Trial 2 .....

Nonpreferred hand
Trial 1 .....
Trial 2 .....

age 7	age 8
0–24	0–21
25–27	22–23
28–29	24
30–33	25–27
34–39	28–29
40+	30+

score
0 / 0
1 / 1
2 / 2
3 / 3
4 / 4
5 / 5

age 7	age 8
0–29	0–25
30–31	26–28
32–33	29–30
34–37	31–32
38–47	33–34
48+	35+

Item score

* Item score = (Preferred hand + Nonpreferred hand) ÷ 2

Qualitative observations

Body control/posture

- Does not look at board while inserting pegs ☐
- Holds face too close to task ☐
- Holds head at an odd angle ☐
- Does not use pincer grip to pick up pegs ☐
- Exaggerates finger movements in releasing pegs ☐
- Does not use the supporting hand to hold board steady ☐
- Does *extremely* poorly with one hand (asymmetry striking) ☐
- Changes hands or uses both hands during a trial ☐
- Hand movements are jerky ☐
- Sitting posture is poor ☐
- Moves constantly/fidgets ☐

Adjustments to task requirements

- Misaligns pegs with respect to holes ☐
- Uses excessive force when inserting pegs ☐
- Is *exceptionally* slow/does not change speed from trial to trial ☐
- Goes too fast for accuracy ☐

Other

.....

.....

THREADING LACE — MANUAL DEXTERITY

Quantitative data

Record time taken (secs); F for failure; R for refusal; I for inappropriate

Trial 1 .....
Trial 2 .....

score	age 7	age 8
0	0–20	0–20
1	21–22	21–22
2	23–24	23–24
3	25–28	25–28
4	29–43	29–39
5	44+	40+

Item score

Qualitative observations

Body control/posture

- Does not look at holes while inserting tip of lace ☐
- Holds materials too close to face ☐
- Holds head at an odd angle ☐
- Does not use pincer grip to hold lace ☐
- Holds lace too far from tip ☐
- Holds lace too near tip ☐
- Finds it difficult to push tip with one hand and pull it through with the other ☐
- Changes threading hand during a trial ☐
- Hand movements are jerky ☐
- Sitting posture is poor ☐
- Moves constantly/fidgets ☐

Adjustments to task requirements

- Sometimes misses hole with tip of lace ☐
- Is *exceptionally* slow/does not change speed from trial to trial ☐
- Gets muddled in the threading sequence ☐
- Goes too fast for accuracy ☐

Other

.....

.....

JUMPING IN SQUARES — DYNAMIC BALANCE

Quantitative data

Record **number of correct jumps**; **F** for failure; **R** for refusal; **I** for inappropriate.

Trial 1 .....
Trial 2 .....
Trial 3 .....

score	age 7	age 8
0	5	5
1	–	–
2	4	4
3	3	3
4	2	2
5	0–1	0–1

Item score

Qualitative observations

Body control/posture

- ☐ Does not use arms to assist jump
- ☐ Arms swing out of phase with legs
- ☐ Arm movements are exaggerated

- ☐ Body appears rigid/tense
- ☐ Body appears limp/floppy

- ☐ Makes no preparatory crouch
- ☐ Lacks springiness/no push-off from feet
- ☐ Uneven take-off and loss of symmetry in flight and landing
- ☐ Jumps with stiff legs/on flat feet
- ☐ Stumbles on landing

Adjustments to task requirements

- ☐ Does not combine upward and forward movements effectively
- ☐ Uses too much effort
- ☐ Movements are jerky

Other

.....

.....

HEEL-TO-TOE WALKING — DYNAMIC BALANCE

Quantitative data

Record **number of correct steps**; **R** for refusal; **I** for inappropriate

Trial 1 .....
Trial 2 .....
Trial 3 .....

score	age 7	age 8
0	13–15	15
1	8–12	14
2	7	13
3	5–6	10–12
4	3–4	7–9
5	0–2	0–6

Item score

Qualitative observations

Body control/posture

- ☐ Does not look ahead
- ☐ Does not keep head and eyes steady

- ☐ Does not compensate with arms to maintain balance
- ☐ Exaggerated arm movements disrupt balance

- ☐ Body appears rigid/tense
- ☐ Body appears limp/floppy

- ☐ Is very wobbly when placing feet on line
- ☐ Sways wildly to try to maintain balance

Adjustments to task requirements

- ☐ Goes too fast for accuracy
- ☐ Individual movements lack smoothness and fluency
- ☐ Sequencing of steps is not smooth/pauses frequently

Other

.....

.....

HOPPING IN SQUARES — DYNAMIC BALANCE

Quantitative data

Record **number of correct hops**; **F** for failure; **R** for refusal; **I** for inappropriate.

Preferred leg
Trial 1 .....
Trial 2 .....
Trial 3 .....

Nonpreferred leg
Trial 1 .....
Trial 2 .....
Trial 3 .....

age 9	age 10
5	5
–	–
–	–
4	4
1–3	3
0	0–2

score
0 / 0
1 / 1
2 / 2
3 / 3
4 / 4
5 / 5

age 9	age 10
5	5
–	–
4	4
3	3
1–2	2
0	0–1

* Item score

* Item score = (Preferred leg + Nonpreferred leg) ÷ 2

Qualitative observations

Body control/posture

- ☐ Does not use arms to assist hop
- ☐ Arms swing out of phase with legs
- ☐ Arm movements are exaggerated

- ☐ Body appears rigid/tense
- ☐ Body appears limp/floppy

- ☐ Nonsupporting leg held up in front of body
- ☐ Lacks springiness/no push-off from feet
- ☐ Noticeably poorer on one foot than the other
- ☐ Hops with stiff legs/on flat feet
- ☐ Stumbles on landing

Adjustments to task requirements

- ☐ Does not combine upward and forward movements effectively
- ☐ Uses too much effort
- ☐ Movements are jerky

Other

.....

.....

BALL BALANCE — DYNAMIC BALANCE

Quantitative data

Record **number of drops**; **F** for failure; **R** for refusal; **I** for inappropriate

Trial 1 .....
Trial 2 .....
Trial 3 .....

Hand used .....

score
0
1
2
3
4
5

age 9	age 10
0	0
–	–
1	1
2	2
3–4	3–4
5+	5+

Item score

Qualitative observations

Body control/posture

- ☐ Does not look ahead
- ☐ Does not keep head steady

- ☐ Does not compensate with free arm to maintain balance
- ☐ Exaggerated arm movements disrupt balance

- ☐ Body appears rigid/tense
- ☐ Body appears limp/floppy
- ☐ Shuffles forward, does not lift feet off floor

Adjustments to task requirements

- ☐ Goes too fast to control ball
- ☐ Individual movements lack smoothness and fluency
- ☐ Sequencing of steps is not smooth/pauses frequently

Other

.....

.....

ABC Movement Assessment Battery for Children

Completed by sheath the Henderson and Sugden

RECORD FORM

AGE BAND 3 9-10 years

Name..... Gender .....

Home address ..... Date of test .....

..... Date of birth .....

..... Age .....

School ..... Grade/class .....

.....

Assessed by .....

Preferred hand (defined as the hand used to write with) .....

Other information .....

.....

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NFLUENCES ON PERFORMANCE

Complete the sections below by noting any physical factors or features of the child's behavior during testing which you suspect might ve affected his or her motor performance. Headings (with examples) are given as guidelines only. Although negative aspects are given ore emphasis, remember to note positive aspects of the child's behavior.

BEHAVIORAL FACTORS

- **Overactive** (squirms and fidgets; moves constantly when listening to instructions; fiddles with clothes) .....
- **Passive** (hard to interest; requires much encouragement to participate; seems to make little effort) .....
- **Timid** (fearful of activities like jumping and climbing; does not want to move fast; constantly asks for assistance) .....
- **Tense** (appears nervous, trembles; fumbles with small objects; becomes flustered in a stressful situation) .....
- **Impulsive** (starts before instructions/demonstrations are complete; impatient of detail) .....
- **Distractible** (looks around; responds to noises/movement outside the room) .....
- **Disorganized/confused** (has difficulty in planning a sequence of movements; forgets what to do next in the middle of a sequence) .....
- **Overestimates own ability** (tries to change tasks to make them more difficult; tries to do things too fast) .....
- **Underestimates own ability** (says tasks are too difficult; makes excuses for not doing well before beginning) .....
- **Lacks persistence** (gives up quickly; is easily frustrated; daydreams) .....
- **Upset by failure** (looks tearful; refuses to try task again) .....
- **Appears to get no pleasure from success** (makes no response to feedback; has a blank facial expression) .....
- **Other** .....

PHYSICAL FACTORS

- Weight/height/weight in relation to height .....
- Vision/hearing/speech .....
- Anatomical/postural defect .....
- Other .....

GUIDELINES FOR INTERVENTION

SUMMARY OF QUANTITATIVE DATA

MOVEMENT ABC CHECKLIST SCORE

Motor score

..... + ... + ... + ... = ...

MOVEMENT ABC TEST SCORE

Manual Dexterity ..... + ... + ... = ...

Ball Skills ..... + ... = ...

Static and Dynamic Balance ..... + ... + ... = ...

TOTAL IMPAIRMENT SCORE [ ]

SUMMARY OF QUALITATIVE OBSERVATIONS

MANUAL DEXTERITY (Body control/posture; functioning of limbs; spatial accuracy, control of force/effort, timing of actions; other observations including response to feedback during *informal* testing)

BALL SKILLS (Body control/posture; functioning of limbs; spatial accuracy, control of force/effort, timing of actions; other observations including response to feedback during *informal* testing)

STATIC AND DYNAMIC BALANCE (Body control/posture; functioning of limbs; spatial accuracy, control of force/effort, timing of actions; other observations including response to feedback during *informal* testing)

SHIFTING PEGS BY ROWS — MANUAL DEXTERITY

Quantitative data

Record **time taken** (secs); **F** for failure; **R** for refusal; **I** for inappropriate

Preferred hand	Nonpreferred hand
Trial 1	Trial 1 .....
Trial 2	Trial 2 .....

age 9	age 10
0–12	0–12
13	13
14	–
15	14
16–17	15–16
18+	17+

score
0 / 0
1 / 1
2 / 2
3 / 3
4 / 4
5 / 5

age 9	age 10
0–14	0–13
15	14
16	15
17	16
18–19	17
20+	18+

Item score*

* Item score = (Preferred hand + Nonpreferred hand) ÷ 2

Qualitative observations

Body control/posture

- ☐ Does not look at board while inserting pegs
- ☐ Holds face too close to task
- ☐ Holds head at an odd angle
- ☐ Does not use pincer grip to pick up pegs
- ☐ Exaggerates finger movements in releasing pegs
- ☐ Does not use the supporting hand to hold board steady
- ☐ Does *extremely* poorly with one hand (asymmetry striking)
- ☐ Changes hands or uses both hands during a trial
- ☐ Hand movements are jerky
- ☐ Sitting posture is poor
- ☐ Moves constantly/fidgets

Adjustments to task requirements

- ☐ Misaligns pegs with respect to holes
- ☐ Uses excessive force when inserting pegs
- ☐ Is *exceptionally* slow/does not change speed from trial to trial
- ☐ Goes too fast for accuracy

Other

.....

.....

THREADING NUTS ON BOLT — MANUAL DEXTERITY

Quantitative data

Record **time taken** (secs); **F** for failure; **R** for refusal; **I** for inappropriate

Trial 1 .....
Trial 2 .....

score	age 9	age 10
0	0–20	0–17
1	21–23	18–19
2	24	20–21
3	25–28	22
4	29–33	23–24
5	34+	25+

Item score

Qualitative observations

Body control/posture

- ☐ Does not look at nuts and bolt while threading
- ☐ Holds materials too close to face
- ☐ Holds head at an odd angle
- ☐ Does not use pincer grip to pick up nuts
- ☐ Does not hold the bolt steady to receive nuts
- ☐ Finds it difficult to coordinate hand movements
- ☐ Changes threading hand during a trial
- ☐ Hand movements are jerky
- ☐ Sitting posture is poor
- ☐ Moves constantly/ fidgets

Adjustments to task requirements

- ☐ Does not align the nuts correctly on bolt
- ☐ Tries to force nut when misaligned
- ☐ Is *exceptionally* slow/does not change speed from trial to trial
- ☐ Goes too fast for accuracy

Other

.....

.....

FLOWER TRAIL — MANUAL DEXTERITY

Quantitative data

Record **number of deviations**; **F** for failure; **R** for refusal; **I** for inappropriate

Trial 1 .....
Trial 2 .....
Hand used .....

score	age 9	age 10
0	0	0
1	1	1
2	–	–
3	2	2
4	3	–
5	4+	3+

Item score

Qualitative observations

Body control/posture

- ☐ Does not look at trail
- ☐ Holds face too near paper
- ☐ Holds head at an odd angle

- ☐ Holds pen with an odd/immature grip
- ☐ Holds pen too far from point
- ☐ Holds pen too close to point
- ☐ Does not hold paper still
- ☐ Changes hands during a trial

- ☐ Sitting posture is poor
- ☐ Moves constantly/fidgets

Adjustments to task requirements

- ☐ Progresses in short jerky movements
- ☐ Uses excessive force, presses very hard on paper
- ☐ Is *exceptionally* slow
- ☐ Goes too fast for accuracy

Other

.....

.....

TWO-HAND CATCH — BALL SKILLS

Quantitative data

Record **number of correct catches**; **R** for refusal; **I** for inappropriate

.....

score	age 9	age 10
0	6–10	8–10
1	5	7
2	4	6
3	3	4–5
4	1–2	1–3
5	0	0

Item score

Qualitative observations

Body control/posture

- ☐ Does not follow trajectory of ball with eyes
- ☐ Turns away or closes eyes as ball approaches

- ☐ Arms are not raised symmetrically for catching
- ☐ Holds hands out flat with fingers stiff as the ball approaches
- ☐ Arms and hands do not 'give' to meet impact of ball
- ☐ Fingers close too early or too late

- ☐ Body appears rigid/tense throughout

Adjustments to task requirements

- ☐ Does not adjust body position for catching
- ☐ Does not adjust position of feet as necessary
- ☐ Judges force of throw poorly (too much or too little)
- ☐ Movements lack fluency

Other

.....

.....

THROWING BEAN BAG INTO BOX — BALL SKILLS

Quantitative data

Record number of goals; R for refusal; I for inappropriate

.....
Hand used .....

score	age 9	age 10
0	5–10	6–10
1	4	5
2	3	–
3	2	4
4	–	3
5	0–1	0–2

Item score

Qualitative observations

Body control/posture

Does not keep eyes on target ☐

Does not use a pendular swing of the arm ☐
Does not follow through with throwing arm ☐
Releases bean bag too early or too late ☐
Changes hands from trial to trial ☐

Trunk and hips do not rotate as throwing arm comes forward ☐
Over-rotates and loses balance ☐

Adjustments to task requirements

Errors are consistently to one side of the box (asymmetry striking) ☐
Judges force of throw poorly (too much or too little) ☐
Control of force is variable ☐
Movements lack fluency ☐

Other

.....

.....

ONE-BOARD BALANCE — STATIC BALANCE

Quantitative data

Record time balanced (secs); R for refusal; I for inappropriate

Preferred leg	Nonpreferred leg
Trial 1	Trial 1 .....
Trial 2	Trial 2 .....

age 9	age 10	score	age 9	age 10
6–20	9–20	0/0	6–20	8–20
5	6–8	1/1	5	6–7
4	5	2/2	4	5
3	4	3/3	3	4
2	3	4/4	2	3
0–1	0–2	5/5	0–1	0–2

* Item score

* Item score = (Preferred leg + Nonpreferred leg) ÷ 2

Qualitative observations

Body control/posture

Does not hold head and eyes steady ☐
Looks down at feet ☐

Makes no or few compensatory arm movements to help maintain balance ☐
Exaggerated movements of arms and trunk disrupt balance ☐

Body is held rigid ☐
Sways wildly to try to maintain balance ☐

Does *extremely* poorly on one leg (asymmetry striking) ☐

Other

.....

.....

HOPPING IN SQUARES — DYNAMIC BALANCE

Quantitative data

Record **number of correct hops**; **F** for failure; **R** for refusal; **I** for inappropriate.

Preferred leg	Nonpreferred leg
Trial 1	Trial 1 .....
Trial 2	Trial 2 .....
Trial 3	Trial 3 .....

age 9	age 10	score	age 9	age 10
5	5	0/0	5	5
–	–	1/1	–	–
–	–	2/2	4	4
4	4	3/3	3	3
1–3	3	4/4	1–2	2
0	0–2	5/5	0	0–1

* Item score

* Item score = (Preferred leg + Nonpreferred leg) ÷ 2

Qualitative observations

Body control/posture

- Does not use arms to assist hop ☐
- Arms swing out of phase with legs ☐
- Arm movements are exaggerated ☐

- Body appears rigid/tense ☐
- Body appears limp/floppy ☐

- Nonsupporting leg held up in front of body ☐
- Lacks springiness/no push-off from feet ☐
- Noticeably poorer on one foot than the other ☐
- Hops with stiff legs/on flat feet ☐
- Stumbles on landing ☐

Adjustments to task requirements

- Does not combine upward and forward movements effectively ☐
- Uses too much effort ☐
- Movements are jerky ☐

Other

.....

.....

BALL BALANCE — DYNAMIC BALANCE

Quantitative data

Record **number of drops**; **F** for failure; **R** for refusal; **I** for inappropriate

Trial 1	Hand used .....
Trial 2	
Trial 3	

score	age 9	age 10
0	0	0
1	–	–
2	1	1
3	2	2
4	3–4	3–4
5	5+	5+

Item score

Qualitative observations

Body control/posture

- Does not look ahead ☐
- Does not keep head steady ☐

- Does not compensate with free arm to maintain balance ☐
- Exaggerated arm movements disrupt balance ☐

- Body appears rigid/tense ☐
- Body appears limp/floppy ☐
- Shuffles forward, does not lift feet off floor ☐

Adjustments to task requirements

- Goes too fast to control ball ☐
- Individual movements lack smoothness and fluency ☐
- Sequencing of steps is not smooth/pauses frequently ☐

Other

.....

.....

ADDENDUM F

Full description of the test items assessed on the Movement ABC (as determined by the manual)

The procedure for all the items tested and scored as prescribed in the Movement ABC Manual:

For ages 4, 5 and 6

Manual Dexterity 1: Posting Coins

The bank box is placed on the table top mat with its short side facing the child. On the side of the box corresponding to the dominant hand the coins are placed in 4 horizontal rows of 3 with approximately 1 inch between the columns and rows. The positions are reversed to test the other hand.

The child holds the box steady in 1 hand and grasps the coin with the other. The edge of the coin must touch the mat until the child is told to begin. At a signal, the child drops the coins through the slot in the bank box, 1 at a time, as quickly as he can. Timing is stopped when the last coin strikes the bottom of the box. Both hands are tested.

A practice trial is given with 6 coins and thereafter 2 formal trials for each hand. A second trial is only given if needed to achieve the pass criterion. The preferred hand is tested first; the number of seconds to complete the trial is recorded. If more than1 coin is picked up or if the child changes hands or uses 2 hands during the trial – this constitutes a fail.

Manual dexterity 2: Threading beads

For 4 year olds, six beads and lace are placed on the table top mat, for 5 and 6 year olds twelve beads are used. Place the beads in a row with the holes facing upwards. The child is allowed to choose the hand which holds the lace.

The child holds the lace in 1 hand and the bead in the other. The bead in the hand must touch the mat until a signal is given. The child then has to thread the beads, 1 at a time as quickly as possible. The examiner stops timing as soon as the child has moved the last bead past the tip of the lace and released it. 1 practice trial is given

followed by 2 formal trials. A second trial is only given if needed to achieve the pass criterion.

The time taken to thread all the beads is recorded. A trial is failed if the child threads more than1 bead at a time or drops a bead out of reach.

Manual dexterity 3: Bicycle trail

The child is seated at a table with both feet on the floor and arms resting comfortably on the table. The bicycle trail is place din front of him with a red felt tip pen alongside. He is expected to draw a single, continuous line without crossing the boundaries. The child is not penalised if he lifts the pen provided that he starts at the same point again. He is allowed to make small adjustments to the angle of the paper (up to 45 degrees) so it is easier to perform the task. Only the preferred hand is tested.

The record sheet can be used for the practice trial and the formal trial. The hand used for the trial should be recorded and the number of times that the boundary was crossed. An additional error point is added for every half inch that the line continues outside the boundary. A failed trial is when the direction of the line is reversed while drawing or if the pen is picked up and a line is restarted somewhere else.

Ball Skills 1: Catching a bean bag

A distance of 2m is marked onto the floor with 2 short strips of tape. The examiner and the child stand facing each other at either end of the tape. The examiner tosses a bean bag so that it reaches the level of the child's hands and the child catches the bean bag with both hands. At this age the child mat gather the bean bag to the body as part of the catch. At ages 5 and 6, the bean bag must be caught cleanly in the hands.

Five practice attempts are given, followed by 10 trials. A toss that is above the child's shoulders, below the waist or out of reach is not considered as an attempt. The number of correctly executed catches out of 10 is recorded. A trial is failed when the child steps over the line or gathers the bean bag to the body if 5 / 6 years old.

Ball Skills 2: Rolling ball into Goal

The child has to kneel behind the starting line which is 2m from the jumping stands. The jumping stands are placed 40cm apart with the long sides parallel to each other. When the child is ready, the ball is placed in front of him so he can choose which hand to use to perform the task. The child has to roll the ball across the floor between the jumping stands to score a "goal". Only 1 hand is tested.

Five practice attempts are given, the child mat change hands if he so wishes. Ten formal trials are given. The hand which was used is recorded as well as the number of "goals' scored. If the ball strikes 1 of the bases as it rolls between the jumping stands, it is still counted as a "goal'. A trial is only failed if the child releases the ball beyond the line or if the ball is bounced or thrown through the posts instead of rolling it.

Static balance: 1 Leg standing Balance

The child stands on 1 leg, with the arms held freely at the sides, for up to 20s. The free leg should be held backwards at the knee so the foot is behind the standing leg. The bent leg does not have to be maintained at a right angle, but must be kept off the floor and away from the supporting leg. Swaying is allowed and the arms may move from the sides. Once the child has achieved the balance position, timing is started. Both legs are tested and the child is allowed to choose which leg to balance on first.

One practice attempt for a maximum of 10 seconds is allowed, followed by 2 trials per leg. The examiner is allowed to help the child achieve the balance position. The number of seconds that the position can be held is recorded. If the child moves the standing foot, lets the free foot touch the floor or lifts the free knee up so that the foot is in front of the standing leg, a fail is recorded.

Dynamic Balance 1: Jumping over the cord

The child stands next to the jumping stand posts and the pins are inserted in the holes closest to the lower border of the knee cap. The jumping posts should be about shoulder width apart. The child has to jump over the cord from a stationary position

with the feet held together. At 4 years the child may land in any position but 5 and 6 year olds must land with feet together.

One practice attempt is given and 3 formal attempts. Only a pass or fail is recorded. A failed jump is when the child jumps without having had the feet together or if the pins are knocked out of the holes. If a 5 / 6 year old doesn't land with the feet together, it is also a failed attempt.

Dynamic balance 2: Walking heels raised

The child has to walk along a 4.5m line that has been taped onto the floor with his heels raised, without stepping off the line. Fifteen steps are required.
A practice attempt is given, followed by 3 formal trials.

The number of correct consecutive steps the child takes (up to 15) is recorded. If the heels touch the floor or a step is off the line, a fail is recorded.

For ages 7 and 8 years

Manual dexterity 1: Placing Pegs

The child is seated at the table with the peg board placed in front of him on the table – top mat. 12 pegs are lined up on the side of the board corresponding to the dominant hand. The pegs are placed in 4 horizontal rows of 3, with approximately 1 inch between columns and rows. To test the other hand, the position of the board and pegs are reversed.

The child holds the board steady with 1 hand and grasps the peg with the other. The grasped mat must remain in contact with the mat until the child is told to begin. At a signal the child has to place the pegs into any holes in the board. Tell the child that 4 holes will remain unfilled. The examiner should stop timing when the last peg is released. Both hands are tested.

One practice attempt and two formal trials is given per hand. A second trial is only given if needed to achieve the pass criterion. The number of seconds taken to complete each correct trial is recorded. A failed trial is recorded if the child picks up more than one peg at a time, if the child changes hands or uses both hands during a trial.

Manual Dexterity 2: Threading Lace

The task components are placed in a central position in front of the child with the lacing board broadside to the child. The child is allowed to choose the hand which holds the lace. The child picks up the lace and board before timing starts. At a signal, the lace is threaded back and forth through the holes in the lacing board. Timing is stopped when the lace is through the last hole and the child pulls up the slack in the free end of the lace.

One practice and 2 formal trials is given. A second trial is only given if needed to achieve the pass criterion. The number of seconds taken for a correct lacing is recorded. A failed trial is recorded if the child laces around the edge of the board or misses a hole in the board.

Manual Dexterity 3: Flower Trail

The child is seated at a table with both feet on the floor and arms resting comfortably on the table. The flower trail is placed in front of him with a red felt tip pen alongside. He is expected to draw a single, continuous line without crossing the boundaries. The child is not penalised if he lifts the pen provided that he starts at the same point again. He is allowed to make small adjustments to the angle of the paper (up to 45 degrees) so it is easier to perform the task. Only the preferred hand is tested.

The record sheet can be used for the practice trial and the formal trial. The hand used for the trial should be recorded and the number of times that the boundary was crossed. An additional error point is added for every half inch that the line continues outside the boundary. A failed trial is when the direction of the line is reversed while drawing or if the pen is picked up and a line is restarted somewhere else.

Ball Skills 1: One-hand Bounce and Catch

The child stands in a clear space away from walls and furniture. The floor surface should be smooth and even. The child has to bounce the tennis ball on the floor and catch it with the same hand. Both hands are tested.

Five practice attempts with each hand is allowed followed by ten formal trials for each hand. The number of correctly executed catches out of 10 attempts is recorded. A procedural fault like catching the ball with 2 hands or trapping it against the body or clothing constitutes a fail.

Ball Skills 2: Throwing Bean bag into Box

The target box is placed on the floor with the short side facing the child 2m in front of the child. The child has to throw the bean bag into the box with one hand. Only one hand is tested. The child is given 5 practice attempts followed by ten formal trials.

The hand used has to be recorded and the number of successful throws out of ten attempts. As long as part of the bean bag is in the box, a successful throw is

counted. Stepping over the line while throwing the bean bag or throwing it with two hands is considered a failed attempt.

Static Balance 1: Stork Balance

The child stands in a clear space away from walls and furniture. The child stands on one foot with the sole of the other foot held against the side of the supporting knee for 20 seconds. The hands are placed on the hips with the fingers facing forward. Timing is started when the child has achieved the balance position. The child is allowed to choose the leg on which to balance first. Both legs are tested.

The child is given one practice attempt for a maximum of 10 seconds. Two formal trials are given per leg. A second trial is only given if needed to achieve the pass criterion. The number of seconds (up to 20) the child maintains the balance is recorded without committing a procedural fault, i.e. moving the standing foot, moving the non-standing foot from the knee or taking the hands off the hips.

Dynamic Balance 1: Jumping in Squares

Six adjacent squares are taped onto the floor. Each square is 45cmX45cm, measured on the inside, which gives an overall length of 2.7m. The child must make 5 continuous jumps forward from square to square, stopping in the last square. The feet may be slightly apart on landing as long as the balance is maintained. The last jump is not counted if the child does not stop in a balanced, controlled position.

One practice attempt is given, then three formal trials. Present the second and third trial only if needed to achieve the pass criterion. The number of correct and consecutive jumps (maximum of 5) completed without landing on or outside the lines, jumping more than once in a square or landing with the feet far apart.

Dynamic Balance 2: Heel-to-toe Walking

The child has to walk along a 4.5m line that has been taped onto the floor. The examiner should stand in a position that allows for a clear view of the sides of the

feet throughout task performance. The child has to place the heel of 1 foot against the toe of the other as he walks the line. 15 steps are required.

The child is given 1 practice attempt and 3 formal trials. The second and third trial is presented only if needed to achieve the pass criterion. The number of correct consecutive steps is recorded. Leaving a space between the heel and toe or stepping off the line is a fail.

For ages 9 and 10 years

Manual Dexterity 1: Shifting Pegs by Rows

The peg board is place din front of the child with 12 pegs placed in the second, third and fourth rows from the top, leaving the first row empty. The child holds the board steady with one hand and has to move the pegs one row up so that the fourth row is left empty. The pegs are only moved at the examiners signal and timing is stopped when the last peg is released. Both hands are tested. The preferred hand is tested first.

One practice is given by moving 1 row of pegs and 2 formal trials. The second is given only if needed to pass. The number of seconds taken to complete each correct trial is recorded. Moving more than 1 peg at a time or if the child changes hands or uses both hands during a trial is considered a fail.

Manual Dexterity 2: Threading Nuts on a Bolt

The bolt with a fixed nut is placed in front of the child with the head facing towards the child. Three loose nuts must be placed in a horizontal row at right angles to the bolt. The child is allowed to choose which hand to use.

At a signal the child screws the nuts, one at a time, down the bolt until it touches the fixed nut. Timing is stopped when the last nut is fully screwed on. All strategies are accepted provided that the nuts are screwed on one at a time.

One practice is given by letting the child screw on 1 nut until it touches the fixed nut. Two formal attempts are allowed but the second is only given if needed to pass. The number of seconds taken to screw on all 3 nuts correctly is recorded. Screwing on more than 1 nut at a time or failing to screw the nuts on all the way to the bottom constitutes a fail.

Manual Dexterity 3: Flower trail

The child is seated at a table with both feet on the floor and arms resting comfortably on the table. The flower trail is placed in front of him with a red felt tip pen alongside. He is expected to draw a single, continuous line without crossing the boundaries. The child is not penalised if he lifts the pen provided that he starts at the same point again. He is allowed to make small adjustments to the angle of the paper (up to 45 degrees) so it is easier to perform the task. Only the preferred hand is tested.

The record sheet can be used for the practice trial and the formal trial. The hand used for the trial should be recorded and the number of times that the boundary was crossed. An additional error point is added for every half inch that the line continues outside the boundary. A failed trial is when the direction of the line is reversed while drawing or if the pen is picked up and a line is restarted somewhere else.

Ball Skills 1: Two hand Catch

A distance of 2m is measured from a smooth wall with a short strip of tape. The child throws the ball against the wall from behind the tape, and catches the ball on return with both hands. Five practice attempts with each hand are allowed followed by ten formal trials.

The number of correctly executed catches out of 10 is recorded. A procedural fault is when the child steps over the line to throw or catching the ball by trapping it against the body or clothing.

Ball Skills 2: Throwing Bean Bag into the Box

The target box is placed on the floor with the short side facing the child 2.5m in front of the child. The child has to throw the bean bag into the box with one hand. Only one hand is tested. The child is given 5 practice attempts followed by ten formal trials.

The hand used has to be recorded and the number of successful throws out of ten attempts. As long as part of the bean bag is in the box, a successful throw is

counted. Stepping over the line while throwing the bean bag or throwing it with two hands is considered a fail.

Static Balance: One Board Balance

The child should be in a clear space, away from walls and furniture. The balance board is placed on a non-skid surface with the narrow strip (keel) on the ground. The examiner must be able to see whether or not the sides of the board touch the floor while the child is performing the task.

The child is given 1 practice attempt on each leg for a maximum of 10 seconds. Two formal trials is given, the second trial is only given if needed to achieve the pass criterion. The number of seconds (maximum of 20) the child maintains the balance - without tilting the board so the sides touch the floor, or touching the floor with the free foot, or touching either the board or the supporting leg with the free foot – is recorded.

Dynamic Balance 1: Hopping in the Squares

Six adjacent squares are taped onto the floor. Each square is 45cmX45cm, measured on the inside, which gives an overall length of 2.7m. The child stands on 1 leg in the first square and must make 5 continuous hops forward from square to square, stopping in the last square. The last jump is not counted if the child does not stop in a balanced, controlled position.

One practice attempt is given, then three formal trials. Present the second and third trial only if needed to achieve the pass criterion. The number of correct and consecutive jumps (maximum of 5) completed without landing on or outside the lines, hopping more than once in a square or letting the free foot touch the floor.

Dynamic Balance 2: Ball Balance

Place the jumping posts on the floor with a gap of 2.7m between them. The peg board and tennis ball are placed on the table so the child may pick them up with either hand. The child stands halfway between the stands. The board is held upside

down in the palm of 1 hand and the tennis ball is placed in the middle of the board. The child must steady the board so that the ball remains stationary without being held while he walks around the two stands to return to the starting point. If the ball falls, the examiner picks it up and returns it to the child, who replaces it on the board and continues from where the ball fell. Only 1 hand is tested.

One practice attempt is given, then two formal trials. Present the second trial only if needed to achieve the pass criterion. Record the hand used to hold the board. The number of times that the ball drops is recorded, up to 10 times. The trial is failed if the board is held improperly (e.g. with thumb on the upper surface), the ball is dropped and walking was not resumed from the point of drop or if the free hand is used to catch or steady the ball while walking.

ADDENDUM G

Child Score Sheet of the PEGS assessment tool

The Perceived Efficacy and Goal Setting System™

Child Score Sheet

Child's Name _____ Age _____

Completed By _____ Date _____

Part 1 **Directions:** Using the PEGS cards and placemats, administer each item to the child and record the child's responses on this score sheet.

Item	A Lot	A Little	A Little	A Lot
1. ☐ Catching balls – good			3	4
☐ Catching balls – not good	1	2		
2. ☐ Cutting food – not good	1	2		
☐ Cutting food – good			3	4
3. ☐ Sports – good			3	4
☐ Sports – not good	1	2		
4. ☐ Video games – not good	1	2		
☐ Video games – good			3	4
5. ☐ Finishing schoolwork on time – has trouble	1	2		
☐ Finishing schoolwork on time – good			3	4
6. ☐ Making things – not good	1	2		
☐ Making things – good			3	4
7. ☐ Games and sports – usually plays			3	4
☐ Games and sports – usually watches	1	2		
8. ☐ Tying shoes – difficult	1	2		
☐ Tying shoes – easy			3	4
9. ☐ Scissors – good			3	4
☐ Scissors – not good	1	2		
10. ☐ Playground – does not like to try new things	1	2		
☐ Playground – likes to try new things			3	4
11. ☐ Buttoning – good			3	4
☐ Buttoning – not good	1	2		
12. ☐ Computer – good			3	4
☐ Computer – not good	1	2		
13. ☐ Organizing numbers – good			3	4
☐ Organizing numbers – not good	1	2		
14. ☐ Bicycle – good			3	4
☐ Bicycle – not good	1	2		
15. ☐ Dressing – takes longer	1	2		
☐ Dressing – quickly			3	4

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2 3 4 5 6 7 8 9 10 11 12 A B C D E

tem	A Lot	A Little	A Little	A Lot
16. ☐ Ball games – not good	1	2		
☐ Ball games – good			3	4
17. ☐ Printing – neat			3	4
☐ Printing – not neat	1	2		
18. ☐ Zipping – good			3	4
☐ Zipping – not good	1	2		
19. ☐ Desk – tidy			3	4
☐ Desk – messy	1	2		
20. ☐ Painting – not good	1	2		
☐ Painting – good			3	4
21. ☐ Drawing – not neat	1	2		
☐ Drawing – neat and clear			3	4
If the child does not typically use a wheelchair, walker, or crutches for mobility, complete items 22–24, then SKIP to item 28 and Part 2.				
If the child does typically use a wheelchair, walker, or crutches for mobility, SKIP to items 25–28 and Part 2.				
22. ☐ Skipping – not good	1	2		
☐ Skipping – good			3	4
23. ☐ Kicking – not good	1	2		
☐ Kicking – good			3	4
24. ☐ Running – good			3	4
☐ Running – not good	1	2		
If the child does typically use a wheelchair, walker, or crutches for mobility, complete items 25–28 and Part 2.				
25. ☐ Skipping – not able to take part	1	2		
☐ Skipping – able to take part			3	4
26. ☐ Bathroom – needs help	1	2		
☐ Bathroom – independent			3	4
27. ☐ Keeping up – able			3	4
☐ Keeping up – not able	1	2		

28. Using the blank cards, ask the child if there are any other activities he or she would like to discuss. Record the child's responses.

Other things – good	Other things – tricky
1. _____	1. _____
2. _____	2. _____
3. _____	3. _____
4. _____	4. _____

art 2

Directions: Review with the child each card on which he or she scored 1 ("a lot less competent"). Include cards with scores of 2 if less than 4 cards with scores of 1 were selected. Record the child's goals and the rationale for each goal.

oals	Rationale
_____	1. _____
_____	2. _____
_____	3. _____
_____	4. _____

Summary Score Sheet

Part 1 Item Ratings

Directions: For each of the items, specify the rating reported by the child, caregiver, and teacher by writing the rating on this Summary Sheet. Add the ratings for each column and record the total in the appropriate PEGS Summary Score box.

The value of the ratings for each item is as follows:

1 = a lot less competent when participating in this activity
2 = a little less competent when participating in this activity
3 = a little more competent when participating in this activity
4 = a lot more competent when participating in this activity

Item	Child's Rating	Caregiver's Rating	Teacher's Rating
1. Catching a ball			
2. Cutting food			NOT APPLICABLE
3. Sports			
4. Playing video games			NOT APPLICABLE
5. Finishing schoolwork			
6. Making things			
7. Playing/watching games and sports			
8. Tying shoes			
9. Cutting with scissors			
10. Trying new things on the playground			
11. Buttoning			NOT APPLICABLE
12. Working on the computer			
13. Organizing numbers on a page			
14. Riding a bicycle			NOT APPLICABLE
15. Dressing			
16. Playing ball games			
17. Printing			
18. Zipping			
19. Keeping desk neat			
20. Painting			
21. Drawing			
Items 22–24 should only be completed if the child does not use a wheelchair, walker, or crutches for mobility			
22. Skipping rope			
23. Kicking a ball			
24. Running			
Items 25–27 should only be completed if the child does use a wheelchair, walker, or crutches for mobility			
25. Skipping rope			
26. Using the bathroom			
27. Keeping up with others			
PEGS Summary Scores*	/96*	/96*	/80*

*The PEGS Summary Scores **do not** represent standard score measures of the child's competency. The PEGS Summary Scores merely allow the therapist to get an overall impression of how the child's own overall rating compares to that of the caregiver and teacher.

Part 2 Goal Setting

Directions: Write the goals selected by the child, caregiver, and teacher in the space provided below.

Child's Goals:

1. _____
2. _____
3. _____
4. _____

Caregiver's Goals for the Child:

1. _____
2. _____
3. _____
4. _____

Teacher's Goals for the Child:

1. _____
2. _____
3. _____
4. _____

Comments and Interpretations:

_____

ADDENDUM H

Parent / caregiver questionnaire of the PEGS assessment tool

The Perceived Efficacy and Goal Setting System™

Caregiver Questionnaire

Child's Name _____ Age _____

Completed By _____ Date _____

Part 1 **Directions:** For each item, read both statements, identify the statement that best describes your child, and place a check in the corresponding box. Then, indicate whether the description in the statement you selected is **A Lot** or **A Little** like your child by checking the appropriate shape. A **square** always represents **A Lot**, and a **circle** always represents **A Little**.

Item	A Lot	A Little	A Little	A Lot
1. ☐ My child is able to catch balls accurately.				✓
☐ My child finds it difficult to catch balls.	✓			
2. ☐ My child needs help to cut his/her food (e.g., meat).	✓			
☐ My child can cut up his/her food (e.g., meat).				✓
3. ☐ My child is good at sports.			✓	
☐ My child is not good at sports.		✓		
4. ☐ My child has difficulty playing video games.	✓			
☐ My child is good at playing video games.				✓
5. ☐ My child often has trouble finishing his/her schoolwork on time.		✓		
☐ My child usually finishes his/her schoolwork on time.			✓	
6. ☐ My child finds making things with his/her hands difficult.		✓		
☐ My child is good at making things with his/her hands.			✓	
7. ☐ My child usually takes part actively in games and sports.				✓
☐ My child usually watches games and sports instead of playing them.	✓			
8. ☐ My child has problems tying shoes.	✓			
☐ My child can tie shoes easily.			✓	
9. ☐ My child is able to cut out shapes accurately and neatly.				✓
☐ My child finds it difficult to cut with scissors.	✓			
10. ☐ My child does not like to try new playground activities.	✓			
☐ My child likes to try new playground activities.			✓	
11. ☐ My child is good at buttoning pants and shirts.				✓
☐ My child is not able to manage buttons.		✓		
12. ☐ My child is good at working on the computer.				✓
☐ My child usually needs help using the computer.	✓			
13. ☐ My child is good at organizing numbers on the page when doing math problems.				✓
☐ My child finds it difficult to organize numbers on the page when doing math problems.	✓			
14. ☐ My child can ride a bike well.			✓	
☐ My child had/is having difficulty learning to ride a bike.		✓		
15. ☐ My child takes a long time to get dressed and finds some clothes hard to put on.	✓			
☐ My child gets dressed in a reasonable amount of time and can manage most clothes.			✓	

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3 4 5 6 7 8 9 10 11 12 A B C D E

Item	A Lot	A Little	A Little	A Lot
16. ☐ My child finds playing ball games difficult. ☐ My child is good at playing ball games.				X
17. ☐ My child's printing is neat and legible. ☐ My child's printing is not very neat and is often hard to read.				X
18. ☐ My child is able to manage zippers and fasteners. ☐ My child cannot manage zippers and fasteners.				X
19. ☐ My child's desk is reasonably neat and organized. ☐ My child's desk is messy and he/she has a hard time finding things in it.		X		
20. ☐ My child is not very good at painting. ☐ My child is able to paint well.			X	
21. ☐ My child is not able to draw well. ☐ My child is able to draw well.			X	
If your child **does not** typically use a wheelchair, walker, or crutches for mobility, **complete** Items 22–24, then **SKIP** to Part 2. If your child **does** typically use a wheelchair, walker, or crutches for mobility, **SKIP** to Items 25–27 and Part 2.				
22. ☐ My child finds skipping rope difficult. ☐ My child is good at skipping rope.				
23. ☐ My child usually cannot kick a ball with direction. ☐ My child is able to kick a ball with direction.				
24. ☐ My child is good at running. ☐ My child is slow and/or not very good at running.				
If your child **does** typically use a wheelchair, walker, or crutches for mobility, **complete** Items 25–27 and Part 2.				
25. ☐ My child is not able to participate in skipping rope. ☐ My child is able to participate in skipping rope.				
26. ☐ My child needs help to use the bathroom. ☐ My child is able to use the bathroom by himself/herself.				
27. ☐ My child is able to keep up with other kids. ☐ My child is not able to keep up with other kids.				

Part 2 **Directions:** Answer the questions below.

Are there any additional items with which your child has difficulty? If so, please list them.

Think about all of the activities listed in this questionnaire and any additional activities you listed above. If you were to select just a few, which activities would you most like to see your child perform better?

1. _____
2. _____
3. _____
4. _____

ADDENDUM I

Teacher questionnaire of the PEGS assessment tool

The Perceived Efficacy and Goal Setting System™

Teacher Questionnaire

Child's Name _____ Date ____ . ____ . ____

Completed By _____

Part 1 **Directions:** For each item, read both statements, identify the statement that best describes the child, and place a check in the corresponding box. Then, indicate whether the description in the statement you selected is **A Lot** or **A Little** like the child by checking the appropriate shape. A **square** always represents **A Lot**, and a **circle** always represents **A Little**. Do not answer Items 2, 4, 11, or 14.

Item	A Lot	A Little	A Little	A Lot
1. ☑ This child is able to catch balls accurately.				✓
☐ This child finds it difficult to catch balls.	■	●		
2. ■ This child can ride a bike well. ■ This child has difficulty learning to ride a bike.	NOT APPLICABLE			
3. ☑ This child is good at sports.				✓
☐ This child is not good at sports.	■	●		
4. ■ This child can play a musical instrument well. ■ This child has difficulty learning to play a musical instrument.	NOT APPLICABLE			
5. ☐ This child often has trouble finishing his/her schoolwork on time.	■	●		
☑ This child usually finishes his/her schoolwork on time.				✓
6. ☐ This child finds making things with his/her hands difficult.	■	●		
☑ This child is good at making things with his/her hands.				✓
7. ☑ This child usually takes part actively in games and sports.				✓
☐ This child usually watches games and sports instead of playing them.	■	●		
8. ☐ This child has problems tying shoes.	■	●		
☑ This child can tie shoes easily.				✓
9. ☑ This child is able to cut out shapes accurately and neatly.				✓
☐ This child finds it difficult to cut with scissors.	■	●		
10. ☐ This child does not like to try new playground activities.	■	●		
☑ This child likes to try new playground activities.				✓
11. ■ This child is good at working on the computer. ■ This child is not able to manage the computer.	NOT APPLICABLE			
12. ☑ This child is good at working on the computer.				✓
☐ This child usually needs help using the computer.	■	●		
13. ☑ This child is good at organizing numbers on the page when doing math problems.				✓
☐ This child finds it difficult to organize numbers on the page when doing math problems.	■	●		
14. ■ This child can play a musical instrument well. ■ This child has difficulty learning to play a musical instrument.	NOT APPLICABLE			
15. ☐ This child takes a long time to get dressed and finds some clothes hard to put on.	■	●		
☑ This child gets dressed in a reasonable amount of time and can manage most clothes.				✓

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3 4 5 6 7 8 9 10 11 12 A B C D E

Item	A Lot	A Little	A Little	A Lo
16. ☐ This child finds playing ball games difficult.				
☑ This child is good at playing ball games.				✓
17. ☑ This child's printing is neat and legible.				✓
☐ This child's printing is not very neat and is often hard to read.				
18. ☑ This child is able to manage zippers and fasteners.				✓
☐ This child cannot manage zippers and fasteners.				
19. ☑ This child's desk is reasonably neat and organized.				✓
☐ This child's desk is messy and he/she has a hard time finding things in it.				
20. ☐ This child is not very good at painting.				
☑ This child is able to paint well.				✓
21. ☐ This child is not able to draw well.				
☑ This child is able to draw well.				✓
[redacted]				
22. ☐ This child finds skipping rope difficult.				
☑ This child is good at skipping rope.			✓	
23. ☐ This child usually cannot kick a ball with direction.				
☑ This child is able to kick a ball with direction.				✓
24. ☑ This child is good at running.				✓
☐ This child is slow and/or not very good at running.				
[redacted]				
25. ☐ This child is not able to participate in skipping rope.				
☐ This child is able to participate in skipping rope.				
26. ☐ This child needs help to use the bathroom.				
☐ This child is able to use the bathroom by himself/herself.				
27. ☐ This child is able to keep up with other kids.				
☐ This child is not able to keep up with other kids.				

Part 2 **Directions:** Answer the questions below.

Are there any additional items with which this child has difficulty? If so, please list them.

Think about all of the activities listed in this questionnaire and any additional activities you listed above. If you we to select just a few, which activities would you most like to see this child perform better?

1. _____
2. _____
3. _____
4. _____

ADDENDUM J

Training Program

WEEK ONE

DAY 1

Warm-up: 2 minutes running on the spot – start off with jogging and gradually pick up the pace to running. Vary intensity, alternate running with jogging.
2 minutes star jumps
2 minutes stride jumps –stickers were used on the limbs when learners struggled. A white sticker was placed on the right arm and left leg. The therapist would then coax correct alternation by shouting "stickers" and "no stickers" to encourage contralateral coordination
3 minutes cross crawls – children had to touch elbows to opposite knees. Variations were implemented by touching fingertips to feet, elbows to feet and fingertips to feet behind the back.

Category 1: Mat activities

The subjects were crook lying on an exercise mat. Small breaks were given if subjects were tired.

1. Simple crunches by lifting the head and shoulders – each child was encouraged to feel the muscle contraction. Hold for 3 counts. Those who were able to control for 3 counts were requested to hold for longer. 4 minutes
2. Crunches lifting to side – lift and touch right knee with left hand and hold for 3 counts. "Feel" the muscle work. 3 minutes
3. Repeat to the other side. 3 minutes

Category 2: Big ball activities. These were chosen to follow the mat activities so that they would've practiced abdominal contractions before attempting the ball. A circle is made with subjects sitting on a therapy ball with the hips and knees at right angles.

Subjects sit upright and bounce on the spot while maintaining their balance, the therapist encouraging abdominal contractions throughout. 3 minutes

1. They would then reach to the side and touch the person to the right 2 minutes
2. Reach out and touch the person on the left- 2 minutes

3. Widen the circle and pass the beanbag around the circle (both directions) while maintaining your balance on the ball. 2 minutes

Cool Down – deep breathing exercises and stretches of the abdominals over the balls.

DAY 2

Warm-up: same as before

Category 3: Hoop Activities

Each child is given a hoop that is big enough to swing around the hips

1. The subjects are asked to Hula, and encouraged to stay on 1 spot as they tend to walk around the room and bump into each other. 2 minutes
2. The hoop is put down into the floor and we jump into and out of the hoop in different directions. Forward, back, right, left – one direction at a time and then combinations.5 minutes
3. Subjects are introduced to try and skip with the hoop. Those who struggle are allowed to "walk through" as the hoop comes around. This is done by hopping through on 1 leg at a time. 3 minutes

Category 4: Throw and Catch Activities

1. The hoops were then put in a line and subjects stood about 4 strides behind the line. They were then given 3 bean bags each to throw into their hoop, at the end we would see who got any bean bags into their hoop and fetch it for another round. 3 minutes
2. Children were partnered (the therapist filled any gaps) and 1child would throw the beanbag through the hoop while the other held the hoop. Swap around, 5 minutes.
3. Throw bean bags to each other, using different ways of throwing – underarm, over-arm etc.

Cool down – deep breathing and stretches. (Arms to the opposite sides in star jump stance, stretch triceps behind the head, twist body to reach behind. Stretch hamstrings in long sitting with legs apart and 1 leg bent at the knee)

DAY 3

Warm-up – same as before

Category 5: Balance Activities

For the balance activities, a small circuit was devised because the wait is too long if they have to wait turns. One station was the balance beam, one station was the trampoline and one station was the wobble board/ balance mat. 10 minutes per station

- 2 children on the balance beam were required to walk the beam forward and backwards without falling into the sea of sharks (sides). If this was relatively easy, the narrow side of the beam was used. This station was eliminated if only 4 children in the group.
- 2 children on the trampoline were required to jump as high as they could while continuing to jump on the same spot on landing. If this was achieved, every third jump had to be a star jump.
- 2 children on the balance mat and wobble board had to throw a ball to each other. If there were only 5 in the group, the child would bounce the ball against a wall. We had to start with a fairly large ball to increase the chances of success to catch.

Category 6: Combination / Games

The first week a combination of exercises was done. The researcher felt that the star jumps and stride jumps needed lots more practice, so the warm up time was doubled to 20 minutes. Also, the hoop jumping was difficult for most, so a hoop game was played for 20 minutes. The hoops were placed in various patterns and subjects had to jumps in the hoops in different orders.

Cool down – deep breathing and stretches of the week.

WEEK 2

DAY 1

Warm up as before

Category 1: Mat activities

1. Simple crunches by lifting the head and shoulders – Hold for 3 counts. Those who were able to control for 3 counts were requested to hold for longer. 3 minutes
2. Crunches lifting to side – lift and touch right knee with left hand and hold for 3 counts. "Feel" the muscle work. Repeat to other side. 4 minutes
3. Throw ball at wall when lifting head. 3 minutes

Category 2: Big ball activities

1. They would sit upright and bounce on 1 spot while maintaining their balance, the therapist encouraging abdominal contractions throughout. 3 minutes
2. They would then reach to the side and touch the person to the right 2 minutes Repeat other side. 4 minutes.
3. "Juggle" two balls while maintaining balance on the ball. For those who cannot manage the balls, beanbags were given. 3 minutes

Cool Down – deep breathing exercises and stretches of the abdominals over the balls.

DAY 2

Warm-up: same as before

Category 3: Hoop Activities

Each child is given a hoop that is big enough to swing around the hips

1. The subjects are asked to Hula. They thoroughly enjoy this! And are encouraged to stay on 1 spot as they tend to walk around the room and bump into each other. 1 minutes
2. The hoop is put down into the floor and we jump into and out of the hoop in different directions. Forward, back, right, left – one direction at a time and then combinations. This is difficult for some who cannot stop themselves after a jump and want to continue hopping. It is even more difficult to change direction when hopping. 5 minutes

3. Subjects skip using the hoop. Those who struggle are allowed to "walk through" as the hoop comes around. This is tried with hopping through on 1 leg at a time. 3 minutes

Category 4: Throw and Catch Activities

1. Children were partnered (the therapist filled any gaps) and 1child would throw the beanbag through the hoop while the other held the hoop. Swap around, 5 minutes.
2. Throw 20cm balls to each other, using different ways of throwing – underarm, over arm etc. 3 minutes
3. Throw 20 cm ball to touch a target on the wall and catch it again. 2 minutes

Cool down – deep breathing and stretches.

Arms to the opposite sides in star jump stance, stretch triceps behind the head, twist body to reach behind.

Stretch hamstrings in long sitting with legs apart and 1 leg bent at the knee

DAY 3

Warm-up – same as before

Category 5: Balance Activities

For the balance activities, a small circuit was devised because the wait is too long if they have to wait turns. One station was the balance beam, one station was the trampoline (the favourite!) and one station was the wobble board/ balance mat. 10 minutes per station

- 2 children on the balance beam were required to walk the beam forward and backwards without falling into the sea of sharks (sides). If this was relatively easy, the narrow side of the beam was used. They now have to balance with a beanbag on the head. This station was eliminated if only 4 children in the group.
- 2 children on the trampoline jump, every third jump a star jump. Alternate star jumps with lifting knees to chest.

- 2 children on the balance mat and wobble board had to throw a tennis ball to each other. If there were only 5 in the group, the child would bounce the ball against a wall.

Category 6: Combination / Games

Warm up: as before

Activity: The time was spent navigating a slalom course made with soccer cones. The children were required to find the way around the course without touching the cones. This was then followed by them doing different ways of following the course e.g. bunny hops, frog jumps etc

Cool down – deep breathing and stretches of the week.

WEEK 3

DAY 1

Warm up as before

Category 1: Mat activities

1. Crunches lifting to side – lift and touch right knee with left hand and hold for 5 counts. Repeat to other side. 4 minutes
2. Throw ball at wall when lifting head. 3 minutes
3. Three minutes of cycling in the air

Category 2: Big ball activities

1. Sitting on the ball they would then reach to the side and touch the person to the right. Repeat other side. 4 minutes.
2. "Juggle" two balls while maintaining balance on the ball. For those who cannot manage the balls, beanbags were given. 3 minutes
3. Straighten one knee while maintaining balance on the ball. Repeat with other knee.3 minutes

Cool Down – deep breathing exercises and stretches of the abdominals over the balls.

DAY 2

Warm-up – same as before

Category 3: Hoop Activities

Each child is given a hoop that is big enough to swing around the hips

1. The subjects are asked to Hula and are encouraged to stay on 1 spot as they tend to walk around the room and bump into each other. They also now hula with the arms. 3 minutes
2. A pattern is made with the hoops and each subject gets a chance to decide how the course should be followed, e.g. hopping 2 legs, right leg only, etc and the others have to follow. 7 minutes

Category 4: Throw and Catch Activities

1. Throw 20cm balls to each other, using different ways of throwing – underarm, over arm etc. 3 minutes
2. Throw 20 cm ball to touch a target on the wall and catch it again. 2 minutes
3. Throw tennis ball onto floor and catch it – try to use hands only, no body involvement.

Cool down – deep breathing and stretches.

Arms to the opposite sides in star jump stance, stretch triceps behind the head, twist body to reach behind.

Stretch hamstrings in long sitting with legs apart and 1 leg bent at the knee

DAY 3

Warm-up – same as before

Category 5: Balance Activities

For the balance activities, a small circuit was devised because the wait is too long if they have to wait turns. One station was the balance beam, one station was the trampoline and one station was the wobble board/ balance mat. 10 minutes per station.

- 2 children on the balance beam were required to walk the beam forward and backwards without falling into the sea of sharks (sides) with a beanbag on the head. They now have to pick up a beanbag at the end of the beam without losing balance or the beanbag from their heads.
- 2 children on the trampoline jump, every third jump a star jump. Alternate star jumps with lifting knees to chest.
- 2 children on the balance mat and wobble board had to throw a tennis ball to each other. Alternate throwing with bouncing tennis ball to each other

Category 6: Combination / Games

Activity: Combination of abdominal activities on the mat.

Lift the head when doing a "crunch" to throw a ball at a target which is placed on either side of them, or partnering and throwing a ball to the partner. 1 subject stands at the head of the other who is lying on the mat. The one lying down has to lift legs with extended knees for the one standing to catch. Swap partners. Those who are able to do this activity are then encouraged to lift legs and buttocks into the air to lift buttocks 1cm from the floor.

Cool down – deep breathing and stretches of the week.

WEEK 4

DAY 1

Warm up: as before. Stickers now not needed!

Category 1: Mat activities

1. Throw ball at wall when lifting head. 3 minutes
2. Four minutes of cycling in the air with head down.
3. Lift head and shoulders when cycling for 3 minutes

Category 2: Big ball activities

1. Straighten one knee while maintaining balance on the ball. Repeat with other knee. 2 minutes
2. Move forward so that shoulders are on the ball and hold as long as you can before coming back up to sit. 5 minutes
3. From sitting, turn the body until the ball is under the tummy. 3 minutes

Cool Down – deep breathing exercises and stretches of the abdominals over the balls.

DAY 2

Warm-up: same as before

Category 3: Hoop Activities

Each child is given a hoop that is big enough to swing around the hips

1. Hula with the waist and arms. 2 minutes
2. Hoop on the floor and hopping in and out in various combinations. 2 minutes
3. Skipping with the hops reintroduced and hopping through with both legs encouraged. 6 minutes. Very difficult to go through with both legs – allowed to go trough one at a time but must stay on 1 spot

Category 4: Throw and Catch Activities

1. Throw 20 cm ball to touch a target on the wall and catch it again. 2 minutes.
2. Bounce tennis ball onto floor and catch it – try to use only 1 hand, no body involvement. 3 minutes
3. Bounce tennis ball onto wall and catch it again. 5 minutes

Cool down – deep breathing and stretches.

Arms to the opposite sides in star jump stance, stretch triceps behind the head, twist body to reach behind.

Stretch hamstrings in long sitting with legs apart and 1 leg bent at the knee

DAY 3

Warm-up: same as before

Category 5: Balance Activities

For the balance activities, a small circuit was devised because the wait is too long if they have to wait turns. One station was the balance beam, one station was the trampoline, and one station was the wobble board/ balance mat. 10 minutes per station

- 2 children on the balance beam were required to walk the narrow beam forward and backwards without falling into the sea of sharks (sides) with a beanbag on the head and bounce a large ball on alternate sides and catch.
- 2 children on the trampoline throw 20 cm ball onto a target while jumping
- 2 children on the balance mat and wobble board had to throw a tennis ball to bounce against the wall and the other has to catch and throw back.

Category 6: Combination / Games

Activity: Hand Ball. Subjects were partnered and each pair was given an area to play.

Cool down – deep breathing and stretches of the week.

WEEK 5

DAY 1

Warm up: as before.

Category 1: Mat activities

1. Four minutes of cycling in the air with head down.
2. Lift head and shoulders when cycling for 3 minute
3. With head down, lift legs and buttocks into the air and cycle. 3 minutes

Category 2: Big ball activities

1. Move forward on the ball so that shoulders are on the ball and hold as long as you can before coming back up to sitting on the ball. 5 minutes
2. From sitting, turn the body until the ball is under the tummy. 3 minutes
3. Walk your hands forward till ball is under the knees (body is held in an horizontal position) and hold as long as you can before returning to the starting position.3 minutes

Cool Down – deep breathing exercises and stretches of the abdominals over the balls.

DAY 2

Warm-up: same as before

Category 3: Hoop Activities

Each child is given a hoop that is big enough to swing around the hips

1. Hoop on the floor with a combination of ways to get in and out e.g. frog jumps, bunny hops, cartwheels. 4 minutes
2. Skipping with the hoops and hopping through with both legs encouraged. 6 minutes. Very difficult to go through with both legs – allowed to go trough one at a time but must stay on 1 spot. Still difficult

Category 4: Throw and Catch Activities

1. Bounce tennis ball onto floor and catch it using only 1 hand. 2 minutes
2. Bounce tennis ball onto wall and catch it again. 3 minutes
3. Step and catch activity. A beanbag is placed at the top end of a board which has a little cylinder underneath it. The subject is required to step onto the bottom end and catch the beanbag. (Turns are taken as only 2 step and catch apparatus) 5 minutes

Cool down – deep breathing and stretches.

Arms to the opposite sides in star jump stance, stretch triceps behind the head, twist body to reach behind.

Stretch hamstrings in long sitting with legs apart and 1 leg bent at the knee.

DAY 3

Warm-up: same as before

Category 5: Balance Activities

For the balance activities, a small circuit was devised because the wait is too long if they have to wait turns. One station was the balance beam, one station was the trampoline, and one station was the wobble board/ balance mat.

- 2 children on the balance beam were required to walk the narrow beam forward and backwards without falling into the sea of sharks (sides) with a beanbag on the head and bounce a 20cm ball on alternate sides and catch.
- 2 children on the trampoline throw 20 cm ball onto a target while jumping. They turn around in 4 jumps so that they end up looking in front again (north, east. south, west) and then throw and catch the ball.
- 2 children on the balance mat and wobble board had to throw a tennis ball to bounce against the wall and the other has to catch and throw back. Stand in half kneeling and swap to other leg in front.

Category 6: Combination / Games

Activity: Crab soccer with 2 /3 on a side. Therapist fills in if one subject absent.

Cool down – deep breathing and stretches of the week.

WEEK 6

DAY 1

Warm up: as before.

Category 1: Mat activities

1. Lift head and shoulders when cycling for 3 minute
2. With head down, lift legs and buttocks into the air and cycle. 3 minutes
3. In four-point kneeling, lift one arm while maintaining abdominal contraction. Swap arms. 4 minutes

Category 2: Big ball activities

1. From sitting, turn the body until the ball is under the tummy. 3 minutes
2. Walk hands forward until the ball is under the knees and the body is horizontal. 3 minutes
3. Slowly pull the ball nearer to your hands until the ball is under the tibia and the buttocks are in the air. Hold 3 counts before resuming starting position. 4 minutes

Cool Down – deep breathing exercises and stretches of the abdominals over the balls.

DAY 2

Warm-up: same as before

Category 3: Hoop Activities

Each child is given a hoop that is big enough to swing around the hips

1. Hula with the waist and arms using two hoops. 2 minutes
2. Skipping with the hoops with both legs encouraged. Very difficult to go through with both legs – allowed to go through one leg at a time but must stay on 1 spot. 5 minutes
3. Hoop patterns again with each getting turn to choose the way to jump. 3 minutes

Category 4: Throw and Catch Activities

1. Bounce tennis ball onto floor and catch it using only 1 hand. Alternate hands. 2 minutes
2. Step and catch activity. A beanbag is placed at the top end of a board which has a little cylinder underneath it. The subject is required to step onto the bottom end and catch the beanbag. (Turns are taken as only 2 step and catch apparatus) 5 minutes
3. Two balls per pair – large ball is bounced and the smaller one thrown over arm.

Cool down – deep breathing and stretches.

Arms to the opposite sides in star jump stance, stretch triceps behind the head, twist body to reach behind.

Stretch hamstrings in long sitting with legs apart and 1 leg bent at the knee

DAY 3

Warm-up: same as before

Category 5: Balance Activities

For the balance activities, a small circuit was devised because the wait is too long if they have to wait turns. One station was the balance beam, one station was the trampoline, and one station was the wobble board/ balance mat. 10 minutes per station

- 2 children on the balance beam were required to walk the narrow beam forward and backwards without falling into the sea of sharks (sides) with a beanbag on the head and bounce a 20cm ball on alternate sides and catch. Balance bean is now elevated on to blocks – must be very stable!
- 2 children on the trampoline throw 20 cm ball onto a target while jumping. They turn around in 4 jumps so that they end up looking in front again (north, east. south, west) and then throw and catch the ball.
- 2 children on the balance mat and wobble board had to throw a tennis ball to bounce against the wall and the other has to catch and throw back. Stand on 1 leg and swap legs.

Category 6: Combination / Games

Activity: Trampoline activities combined with ball activities. Subjects are jumping on the trampolines, taking small turns (east, south, west, and north) to turn back to the front. When they reach front, a ball is thrown at a target and caught again. Each child gets three throws and jumps off to give the others a turn. Two groups hold competition to see how many throws on target they scored. If a ball is not caught on the rebound, the group loses a point.

Cool down – deep breathing and stretches of the week.

WEEK 7

DAY 1

Warm up: as before.

Category 1: Mat activities

1. Hold head up, lift legs and buttocks into the air and cycle. 4 minutes
2. In four point kneeling, lift one arm and opposite leg while maintaining abdominal contraction. Alternate sides ,6 minutes

Category 2: Big ball activities

1. From sitting, turn the body until the ball is under the tummy. Then move forward on the tummy till ball is under the knees and body is held in a horizontal position. Hold 5 counts before returning to the starting position. 3 minutes
2. With knees on the ball, hands on the floor in front of the ball, carefully pull up the buttocks until it is in the air and shins balance on the ball. 3 minutes
3. Gently lower the buttocks to each side and hold for 3 counts. Very difficult!

Cool Down – deep breathing exercises and stretches of the abdominals over the balls.

DAY 2

Warm-up: same as before

Category 3: Hoop Activities

Each child is given a hoop that is big enough to swing around the hips

1. Hoop on the floor, subjects choose how to get in and out and others follow.5 minutes
2. Skipping with the hoop with both legs. Still quite difficult to go through with both legs – allowed to go through one leg at a time but must stay on 1 spot. 5 minutes

Category 4: Throw and Catch Activities

1. Throw tennis ball at a target on the wall and catch it using only 1 hand. Alternate hands. 2 minutes
2. Step and catch activity. A beanbag is placed at the top end of a board which has a little cylinder underneath it. The subject is required to step onto the bottom end and move away so the next one can catch the beanbag. (Turns are taken as only 2 step and catch apparatus) 5 minutes
3. Two tennis balls per pair – one is bounced and the other one thrown over arm.

Cool down – deep breathing and stretches.

Arms to the opposite sides in star jump stance, stretch triceps behind the head, twist body to reach behind.

Stretch hamstrings in long sitting with legs apart and 1 leg bent at the knee

DAY 3

Warm-up: same as before

Category 5: Balance Activities

For the balance activities, a small circuit was devised because the wait is too long if they have to wait turns. One station was the balance beam, one station was the trampoline, and one station was the wobble board/ balance mat. 10 minutes per station.

- 2 children on the balance beam were required to walk the narrow beam forward and backwards without falling into the sea of sharks (sides) with a beanbag on the head and bounce a 20cm ball on alternate sides and catch. Balance bean is now lifted only on one end to make an incline – must be very stable!
- 2 children on the trampoline throw tennis ball onto a target while jumping. They turn around in 4 jumps so that they end up looking in front again (north, east. south, west) and then throw and catch the ball.

- 2 children on the balance mat and wobble board had to throw a tennis ball to bounce against the wall and the other has to catch and throw back. Stand on 1 leg and swap legs.

Category 6: Combination / Games

Activity: Driving our cars.

Subjects sit on the therapy balls and move forward so their lower backs are just resting on the ball and the head and shoulders are lifted so as to get an abdominal contraction. Each child has a hula hoop steering wheel and directs the way to a destination of choice. Each child has a turn to direct his route and all turns are enacted by twisting the body in that direction, while holding the steering wheel in front. For those that master the "driving" one leg is extended at the knee.

Cool down – deep breathing and stretches of the week.

WEEK 8

DAY 1

Warm up: same as before.

Category 1: Mat activities

1. Hold head up, lift legs and buttocks into the air and cycle. 2 minutes without stopping. See who can cycle the longest.
2. In four point kneeling, lift one arm and opposite leg while maintaining abdominal contraction. Alternate sides , 3 minutes
3. Lying in prone, lift alternate arm and leg from the mat. 3 minutes
4. Still in prone, lift both arms and both legs from the mat and hold 10 counts. 2 minutes

Category 2: Big ball activities

1. From sitting, turn the body until the ball is under the tummy and walk hands forward till ball is under the knees. With knees on the ball, hands on the floor

in front of the ball, carefully pull up the ball nearer until the buttocks are in the air and shins balance on the ball. 3 minutes

2. Gently lower the buttocks to each side and hold for 3 counts. Very difficult! 4 minutes
3. If this can be done, hold the ball under the tibia and try to lift one leg up behind you. Very difficult! 3 minutes

Cool Down – deep breathing exercises and stretches of the abdominals over the balls.

DAY 2

Warm-up: same as before

Category 3: Hoop Activities

Each child is given a hoop that is big enough to swing around the hips

1. Skipping with the hoops hopping through with both legs. 3 minutes.
2. Hopscotch game. 7 minutes

Category 4: Throw and Catch Activities

4. Throw tennis ball at a target on the wall and catch it using only 1 hand. Alternate hands. 2 minutes
5. Step and catch activity. A beanbag is placed at the top end of a board which has a little cylinder underneath it. The subject is required to step onto the bottom end and move away so the next one can catch the beanbag. (Turns are taken as only 2 step and catch apparatus) 5 minutes
6. Two tennis balls per pair – one is bounced and the other one thrown over arm.

Cool down – deep breathing and stretches.

Arms to the opposite sides in star jump stance, stretch triceps behind the head, twist body to reach behind.

Stretch hamstrings in long sitting with legs apart and 1 leg bent at the knee

DAY 3

Warm-up: same as before

Category 5: Balance Activities

For the balance activities, a small circuit was devised because the wait is too long if they have to wait turns. One station was the balance beam, one station was the trampoline, and one station was the wobble board/ balance mat. 10 minutes per station.

- 2 children on the balance beam were required to walk the narrow beam forward and backwards without falling into the sea of sharks (sides) with a beanbag on the head and bounce a 20cm ball on alternate sides and catch. Balance bean is now lifted only on one end to make an incline – must be very stable!
- 2 children on the trampoline now face each other and throw tennis ball while jumping. They turn around in 4 jumps so that they end up facing each other again (north, east. south, west) and then throw to each other
- 2 children on the balance mat and wobble board on 1 leg. They throw a tennis ball to bounce against the wall and the other has to catch and throw back. Swap legs.

Category 6: Combination / Games

Activity: An obstacle course devised from all the activities performed in the program. 10 jumps on the trampoline, followed by 10 target throws, then a walk on the balance beam with a beanbag on your head, a slalom course to be navigated by kicking a ball around the cones and then a hoop pattern to be jumped through.

Cool down – deep breathing and stretches of the wrists