THE EFFECTS OF A PERCEPTUAL-MOTOR DEVELOPMENT PROGRAM ON CHILDREN WITH DEVELOPMENTAL COORDINATION DISORDER

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Declaration

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

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Signature Date

Abstract

The purpose of this study was to determine the effectiveness of a perceptual-motor development programme for children with Developmental Coordination Disorder (DCD), as identified on the Movement Assessment Battery for Children (M-ABC). A pre- and post-test design was employed in the study and data were reported as case studies. The programme included a cognitive approach to perceptual-motor activities, with special attention to visual perception. The intervention programme was implemented over six consecutive weeks, with two 45-minute sessions each week.

The motor proficiency of nine of the 12 children who participated in this study improved to the point where they were no longer classified as having DCD. The reasons for this improvement could be attributed to the regular practise provided by the perceptual-motor activities that were the content of the program and to the method of presentation, i.e. the cognitive strategies that were child-centred, which could have helped develop self-confidence in the children. These results are in agreement with the research of Schoemaker and Kalverboer (1994) that many children with DCD may learn to overcome or cope with their movement problems.

The three children who performed most poorly on the M-ABC pre-test did not improve over the course of the intervention programme. A thorough examination of their perceptual-motor system could provide more information about the various factors that may contribute to their movement problems. It is also possible that the programme simply was not long enough for these children (they did not get enough practise) and/or they were not able to respond to the child-centred cognitive approach in such a short period of time.

Opsomming

Die doel van hierdie studie was om die effektiwiteit van ‘n perseptueel-motoriese ontwikkelingsprogram vir kinders met agterstande in die ontwikkeling van koördinasie (Developmental Coordination Disorder), soos geïdentifiseer deur die Bewegings asseserings Toetsbattery vir Kinders (Movement ABC Test Battery), na te gaan.   ‘n Pre- en post-toetsontwerp is gebruik en die inligting en resultate is as gevallestudies gerapporteer. Die program het ‘n kognitiewe benadering tot motoriese aktiwiteite ingesluit, met spesiale aandag aan visuele persepsie.   Die intervensieprogram het oor ses weke gestrek, met twee 45-minute sessies per week.

Die motoriese bedrewendheid van nege van die twaalf deelnemers aan hierdie studie, het in so mate verbeter dat hulle nie meer as kinders met agterstande in die ontwikkeling van koördinasie geklassifiseer kan word nie.   Hierdie verbetering kan toegeskryf word aan die gereelde oefenaktiwiteite wat deur middel van die program voorsien is, asook die metode van aanbieding.   Die metode, ‘n kognitiewe kind-gesentreerde benadering kon moontlik die selfvertroue van die deelnemers ontwikkel het. Hierdie resultate stem ooreen met die bevindinge van Schoemaker en Kalverboer (1994) wat aandui dat baie kinder met afterstand in die ontwikkeling van koördinasie geleer kan word om hul bewegingsprobleme te oorkom, of om daarby aan te pas.

Die drie deelnemers wat die swakste op die Bewegingsasseerings Toetsbattery vir Kinders presteer het, het geen verbetering met die intervensieprogram getoon nie. ‘n Deeglike ondersoek van hul perseptueel-motoriese sisteme sou meer inligting omtrent oorsake van hul bewegingsprobleme kon aandui.   Dit is ook moontlik dat die duur van die intervensieprogram nie lank genoeg was nie (hulle nie voldoende oefening gekry het nie) en/of dat hulle nie binne die beskikbare tyd positief daarop kon reageer nie.

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Dedication

To Reuben and Ronald Walters

Acknowledgements

Firstly, I would like to extend my gratitude to the headmasters of the schools who were so kind to grant me the opportunity to test the children at the schools.

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Chapter One

Setting the Problem

The incidence of motor disorders in school-aged children is estimated between 5%-8% (Dewey & Wilson, 2001; Pereira, Landgren, Gillberg & Forssberg, 2001). In the 1994 report of the American Psychiatric Association, it was estimated that 6%-10% of school-aged children had movement problem characteristics that could be classified as Developmental Coordination Disorder (DCD) (Dewey, Kaplan, Crawford & Wilson, 2002). Other authors have suggested that up to 28% of school-aged children may have characteristics of DCD (Watkinson, Causgrove-Dunn, Cavakuere, Calzonetti, Wilhelm & Dwyer, 2001)

Developmental Coordination Disorder

There are children who demonstrate a "marked impairment in the development of motor coordination" (Dewey & Wilson, 2001, p.7). If the degree of their motor impairment significantly hampers academic achievement and daily life activities, the term Developmental Coordination Disorder or "DCD" is used to describe the motor skill deficit (Poulsen & Ziviani, 2004). The World Health Organization also recognizes the term DCD to describe this condition (Dewey & Wilson, 2001).

Henderson and Henderson (2002) presented the four criteria for identifying children with DCD that had been adopted in 1994 by the American Psychiatric Association in the fourth edition of their Diagnostic and Statistical Manual for Mental Disorder (DSM-IV)

Criterion A:

> "Performance in daily activities that require motor coordination is substantially below the expected, given the person's chronological age and measured intelligence. This may be manifested by marked delays in achieving motor milestones (e.g., walking, crawling, sitting, dropping things, "clumsiness", poor performance in sports, or poor handwriting)" (p.19)

Criterion B:

> "The disruption in coordination significantly interferes with academic achievement or activities of daily living." (p. 20)

Criterion C:

> "The disturbance is not due to a general medical condition (e.g. cerebral palsy, hemiplegia, or muscular dystrophy) and does not meet the criteria for a Pervasive Developmental Disorder." (p. 20)

Criterion D:

> "If mental retardation is present the motor difficulties are in excess of those usually associated with it." (p. 20)

There is an inconsistency in the research with regard to the selection criteria when the term DCD is used (Geuze, Jongmans, Shoemaker & Smits-Engelsman, 2001; Hoare, 1994). Geuze et al. (2001) found that many studies refer to their subjects as DCD when in fact the four diagnostic criteria for DSM-IV were not applied. They advocated strict adherence to the diagnostic criteria of the DSM-IV.

Defining DCD

Perhaps the most important characteristic of DCD in terms of school-aged children is that it includes a distinct "impairment in the development of motor coordination…that significantly interferes with academic achievement or activities of daily living" (Miller, Polatajoko, Missiuna, Mandich & Macnab, 2001, p.184).

There is now international agreement among researchers and clinicians to use the term DCD in clinical observations and in research publications when reference is made to children with motor skill deficits (Henderson & Henderson 2002; Missiuna; 2001; Polatajko, Fox & Missiuna, 1995). However, in Scandinavian countries these children are diagnosed as having motor perceptual dysfunction (MPD). Polatajko et al. (1995) reported the following international consensus definition of DCD:

> "DCD is a chronic and usually permanent condition characterised by impairment of motor performance sufficient to produce functional performance deficits not explicable by the child's age or intellect, or by other diagnosable neurological or psychiatric disorders. DCD is expressed in movement and spatial-temporal organization problems. Persons with DCD display qualitative differences in

> movement from their peers. There is a high incidence of associated problems in a wide range of functions." (p.5)

The Cause of DCD

Missiuna (1994) highlighted the need to establish what the cause of the motor problem is in children with DCD. Several authors have attempted to find the cause of DCD, but it seems that a lot of research still needs to be done on this topic. For example, Dewey and Wilson (2001) reported on several studies that looked at the underlying origin(s) of DCD where it was suggested that deficits in visual perception or deficits in kinesthetic perception could be responsible for this condition. Murray, Cermak & O'Brien (1989) stated that DCD appears to be related to some aspects of visual perceptual skills. They cautioned, however, one should not assume that because a child is poorly coordinated, that he or she will automatically have visual perceptual problems. When a child experience difficulties in motor coordination and visual perception, one may not assume that DCD is the underlying cause of the visual perceptual difficulties and that the remediation of perceptual deficits will automatically improve coordination.

Schoemaker, Van der Wees, Flapper, Verheij-Jansen, Scholten-Jaegers and Geuze (2001) could not find evidence to suggest that there is a common problem among children with DCD in any one of the perceptual modalities they investigated. They acknowledged that it is clear that no consistent pattern of problems can be found among DCD children, hence its heterogeneity. They further suggested that some children with DCD may experience difficulties in visual, proprioceptive or tactile perception, but that no causal relation exists between motor and perceptual impairments. Dewey and Wilson (2001) questioned whether DCD is a single syndrome and if one can distinguish between existing subtypes.

The Impact of DCD

Children who have DCD encounter a wide range of difficulties. According to Henderson and Henderson (2002), there is a high degree of co-morbidity among children identified as DCD and other childhood conditions. Co-morbid factors are other childhood symptoms that might occur in conjunction with DCD, which they identified as dyslexia and attention deficit hyperactivity disorder (ADHD).

The study of O'Bierne, Larkin and Cable (1994) demonstrated that children who are poorly coordinated performed at a lower power output and could not sustain peak power output. They observed that the reduced power output and resultant increase in muscular fatigue becomes more evident as the poorly coordinated children gets older. This observation links with the Developmental Skill-Learning Gap Hypothesis that Wall (2004) proposed, in which clumsy children are not able to learn the gross motor skills enjoyed by their peers, and eventually experience a degree of social alienation from the peer group. Adults who were clumsy as children have reported that they are less physically active and as children, found ways to avoid doing physical activities primarily because they did not want to be humiliated or laughed at (Fitzpatrick & Watkinson, 2003).

Purpose of the Study

The purpose of this study was to investigate whether a perceptual-motor activity program could have a positive influence on the coordination of children identified with DCD. Because the investigator is particularly interested in the relationship between visual perception and DCD, this study will also attempt to gain insight into this dimension of DCD. The program itself will attempt to utilise some cognitive teaching strategies to involve the children in thinking about their movement.

Research Questions

The following research questions guided this study:

1. Will the motor coordination of children improve after an eight-week perceptual-motor intervention program, as assessed by the Movement Assessment Battery for Children (Henderson & Sugden, 1992)?

2. Will there be any changes in the visual perception of the children who participate in the intervention program, as assessed by the Developmental Test for Visual Perception-2nd edition (Hammill, Pearson & Voress, 1993)?

Significance of the Study

With the prevalence of coordination problems ranging from 6 to10% of all school-going children (Dewey et al. 2002) to 28% (Watkinson et al. 2001), we need to find practical ways to help these children. Early identification and intervention has been mentioned consistently as the best way to address children's movement problems and possibly help them improve (Lombard & Pienaar, 2003; Woodgard & Surburg, 1997).

Unfortunately, specialized assessment and intervention is financially out-of-reach for most children who live in low-income communities, and many times the school is left to "deal with their problem" (Miyahara & Wafer, 2004). Most teachers are unable to provide the necessary programs for children with DCD. It has been this investigator's experience that most children from historically disadvantaged communities go to schools that have inadequate equipment and facilities. If a low-cost practical intervention program can be developed that can assist these children at minimal costs, perhaps funding can be found to support this effort to provide these children with DCD a realistic chance of improving their condition. In a study completed by Bowman & Wallace (1990), it was documented that pre-school children in low socio-economic groups have serious problems and perform at a developmentally lower level in three of the four items they examined:

- Hand size and strength.
- Visiomotor integration.
- Praxis (the ability to plan movement).

In a sense this study is an investigation to determine whether an individualised perceptual-motor program, delivered by a qualified Physical Education teacher, can assist children with DCD.

Methodology

The Movement Assessment Battery Checklist (Henderson & Sugden, 1992) was used for the initial screening to identify the children with motor difficulties. The children were from the Cape Flats (Retreat, Heathfield, Grassy Park and West Lake) who attended three different schools. A total of 67 children were identified by their classroom teachers as exhibiting motor coordination difficulties. From this initial group of 67, 31 children were given permission by their parents to be assessed on the M-ABC Test (Henderson & Sugden, 1992). A total of 13 children were found to exhibit symptoms consistent with Developmental Coordination Disorder. The visual perception of three of these children was assessed with the DTVP-2 test as part of the exploration portion of this study.

A case study methodology was followed. The children (N=13) were involved in an intervention program that was run over eight weeks. Two sessions, one of one hour and one of 30 minutes respectively were presented at their schools and during school time. After the eight-week intervention program, a posttest of the M-ABC Test was completed with 12 children and compared to their pre-test scores

Delimitations

- Only children with normal intelligence, between the ages of six and nine were used for the purpose of this study.
- The study was restricted to children from low-income communities, from three different schools on the Cape Flats in Cape Town, South Africa.
- Only children who scored at the 15th percentile or lower on the M-ABC Test were included in the study.
- A sample size of 12 children was accepted as sufficient for this case study approach.
- The intervention program was run twice weekly. The total time per week was 90 minutes and the program continued for eight consecutive weeks in total.
- It was decided to explore only the visual system in relation to the intervention program for DCD. This limitation was for practical reasons (time required for assessment and the identification of vision in the literature as a problem with many children with DCD).

Conclusion

Children who show symptoms of DCD and those who exhibit co-morbid factors should be encouraged to participate in active movement activities. It is possible that they may experience a moderation in the effects of DCD if they can develop competence in a movement environment. This study will explore the benefits of a perceptual-motor program aimed at stimulating and encouraging the child with DCD to become more confident and capable in physical activities.

Chapter Two

Review of Literature

In the 1920's, children who experienced motor disabilities were said to have motor awkwardness. Physicians and therapists referred to the condition as "motor weakness" or "psychomotor syndrome" (Dewey & Wilson, 2001). These conditions, often referred to as clumsiness, were disregarded in early research into the movement disorders of children (Braun, 1997). Interest has developed over the past 30 years, and DCD is now regarded as a legitimate area for study in children's development (Henderson & Henderson, 2002). Current thinking on the nature of DCD will be reviewed in this chapter. Co-morbid factors have also been noted, and will be reviewed. For example, it has been documented that children who have DCD have lower fitness levels (Poulsen & Ziviani, 2004) and weaker muscular strength (O'Beirne et al. 1994) than their more physically active peers. This could lead to a sedentary lifestyle throughout childhood and adulthood with its associated health risks.

Because DCD does not appear to be one condition, the investigator was particularly interested in looking at what has been learned about vision in relation to DCD. Physical awkwardness among children, for example, has been attributed to inferior motor planning and inferior visuo-spatial recognition (Braun, 1997). The relationship between vision and DCD is also explored in the following chapter.

Finally, cognitive processes are discussed in relation to learning and DCD. The last section of the chapter presents guidelines for intervention programs that include an emphasis on cognitive processing.

Developmental Coordination Disorder

DCD is not easy to define. Many studies acknowledge its heterogeneity in terms of the kinds of problems that different children with DCD have (Miyahara & Wafer, 2004; Jongmans, Smits-Engelsman & Schoemaker (2003); Dewey & Wilson, 2001; Schoemaker et al. 2001; Hoare, 1994). Children with DCD show difficulties in the acquisition of new motor tasks (Missiuna, 1994). Throughout the literature, evidence is presented that there are various motor coordination difficulties within a group of children with DCD, and there is also huge variation in their proficiency over a wide range of motor activities (Przysucha & Taylor, 2004; Schoemaker et al. 2001; Missiuna, 1994).

Exner (1997) described the normal variation in the performance of new motor skills among young children in terms of irregularities that continue well past the age of six. He proposed that children continue to explore new ways of execution even though a skill has been accomplished with reasonable success. However, he noted that this exploration is accompanied by a reduction in the speed of execution. These findings compare favourably with those of Missiuna (1994), who completed research where children with DCD were able to learn novel movement tasks at the same rate as the children from a control group. However, the children with DCD were slower in their motor execution, apparently in an effort to be accurate.

Locomotion, Balance and Body Awareness

In a study completed by Woodruff, Bothwell-Meyers, Tingley and Albert (2002), irregularities were found in gait patterns in children with DCD. They suggested that directly teaching a walking pattern to children with DCD may assist them to execute running, hopping, jumping and kicking patterns more efficiently.

Children with DCD also exhibited distorted action in postural muscles (Johnston, Burns, Brauer & Richardson, 2002), specifically in terms of poor proximal stability and poor arm movement control in aiming at a specific target. They found that non-DCD children activated all their trunk muscles in the anticipatory period, compared to the children with DCD, who only activated two of the five trunk muscles. Shumway-Cook & Woolacott (1995) identified appropriate coordination of trunk stability as critical for the control of the body's position in space, for stability and for orientation to the environment.

Research about balance and DCD found that many boys with DCD exhibited balance control strategies that allowed their centre of gravity to come very close to the limits of their ability to be stable (Przysucha &Taylor, 2004.). This supports the position that DCD is not a single collection of problems for coordination. Not all boys with DCD have balance problems.

Bairstow and Laszlo (1981) proposed that children who were unable to process kinesthetic information sufficiently experienced motor performance impairments due to inaccurate feedback for motor control. Eight out of the 14 'clumsy' children they tested exhibited a lack of ability to process kinesthetic information. In order to execute accurate control of movement, a child must perceive where the moving limbs are at any given time, which is primarily dependent on kinesthetic information processing. It was their contention that kinesthesis provides information about movement performance earlier than vision, and that although vision also assists in the correction of motor errors, this is only after substantial error occurred. This observation challenged Corbin's (1980) classic position that the visual system was as crucial a source of information as the kinesthetic system in body awareness.

Timing

Johnston et al. (2002) identified exact completion timing as central to any definition of coordinated movement, especially when the movement is done in succession with other movements, for example, when writing or running. Other movements require exact completion timing to accomplish the interception of another object, for example, when catching or batting a ball. It was their finding that skilled movement requires exact execution and completion of the task and children with DCD have difficulty in achieving the required outcome on time, and so are prone to execute the movement poorly.

Co-morbid Factors

There is a high degree of co-morbidity among children identified as DCD with other childhood conditions (Henderson & Henderson 2002). Some children identified as DCD have exhibited symptoms of Learning Disabilities (LD) and Attention Deficit Hyperactivity Disorder (ADHD). The symptoms in these conditions frequently share co-morbidity (Jongmans et al. 2003; Dewey & Wilson, 2001). Kaplan, Wilson, Dewey and Crawford (1998) estimated that the degree of overlap could be quite high.

Involvement in school-related activities and tasks are vital to the development of physical, social and academic skills. Children who cannot cope with these every day situations may experience problems that exhibit itself in the form of poor handwriting, poor concentration and a pattern of organizational difficulties. These problems are typical of many children with LD, ADHD and DCD (Leew, 2001).

Learning Disabilities

O'Brien, Cermak and Murray (1988) proposed that there is an association between the motor problems and learning problems of children. They observed that the problems of children with learning disabilities (LD) are so diverse and those who display varied learning problems very often also display varied motor problems. In research completed by Kaplan et al. (1998), 56% of children that were DCD were also Learning Disabled and 41% of these Learning Disabled children were also ADHD. Sugden and Wann (1987) reported a 29-33% rate of co-morbidity with Learning Disabilities among children who had coordination difficulties. In the study done by Mc Fall, Dietz and Crowe (1993) 75% of the children identified with learning problems were boys. Several studies in reporting their subject samples consistently indicate that more boys are identified as DCD or motor 'incoordination' (Dewey et al. 2002; Miller et al. 2001; Polatajko et al. 2001; Schoemaker et al. 2001; Geuze & Kalverboer, 1994; Miyahara 1994; Armitage & Larkin, 1993; Wilson, Kaplan, Fellowes, Gruchy & Faris, 1992).

It seems as if there are various factors that are associated with DCD. Dewey et al. (2002) found that children with DCD found it harder to concentrate and pay attention to tasks. The group they studied showed a significantly poorer performance on measures of reading, writing and spelling, even when IQ discrepancies were controlled. Their results supported the argument that children with movement problems are at greater risk for developmental problems in other areas. Their findings suggested that children with DCD were likely to have learning problems in a number of different academic areas. They found that DCD children have difficulties in reading comprehension and in basic reading skills.

Cermak, Ward and Ward (1986) investigated the relationship between articulation disorders and motor coordination in children. Their results supported previous findings that indicated a relationship between articulation problems and motor difficulties, but it also indicated that the motor difficulties are not necessarily dyspraxia. Their results also revealed that children with articulation problems perform poorer on motor coordination tests than their peers without articulation problems.

Miyahara (1994) criticized the assumption that children who are identified as LD are usually 'clumsier' than the average child. The reality is in fact that within a group of children identified as 'clumsy', their level motor abilities may vary considerably. O'Brien et al. (1988) proposed that there were subtypes of LD and that classification could be made on the basis of motor ability, but an actual classification scheme was not suggested. Miyahara (1994) did propose four gross motor subtypes that were found among children with LD, although it must be noted that 43.6% of the LD children in his study had no gross motor problems:

- Subtype one: those children with LD, but with no gross motor problems.
- Subtype two: the children with LD and who are poor in all gross motor functions are also described as exhibiting ‘physical awkwardness’.
- Subtype three: children with LD and good balancing ability, despite poor performance on other gross motor skills.
- Subtype four: children with LD and very poor balancing skill and almost average or above average gross motor skills.

Miyahara (1994) stated that the advantage of identifying subtypes was in generating guidelines for the development of subtype-specific intervention programs.

Attention Deficit Hyperactivity Disorder

Weiss & Hechtman (1993) propose that ADHD is a lifelong condition because longitudinal studies show that people are affected into adulthood. Motor difficulties are often portrayed in connection with Attention Deficit Disorder (ADD) or ADHD, which includes a reduced ability to exercise good judgement and the individual may respond rapidly and impulsively, and with no thought spared about the outcome or consequences of that behaviour. It is estimated that about 50% of children with ADHD have some form of motor dysfunction (Pereira et al. 2001)

Harvey & Reid (2003) stated that there is more than one cause for ADHD and that co-morbidity is common. They cited research that demonstrated a link between ADHD and DCD. The research pointed to movement performance problems that are linked to ADHD. They also observed that ADHD is frequently present in conjunction with DCD, anxiety, depression, learning disabilities, conduct disorder and oppositional defiant disorder.

In a study done by Kaplan et al. (1998), 23 out of 162 children assessed met the criteria for ADHD, DCD and reading disability. They concluded that there is a correlation between ADHD and DCD.

Social Problems

Dewey et al. (2002) observed that children with DCD may have problems in social relationships with peers. Wall (2004) proposed a Developmental Skill-Learning Gap Hypothesis to explain why children who are less competent in terms of their motor proficiency may be at-risk for social problems. She suggested that the developmental skill-learning gap broadens for children with DCD when their peers advance to more competitive situations.

According to the Wall (2004) presentation, DCD children and other children with less physical skill have not acquired the typical level of skills expected of children in their peer group. This could be the situation even before the child goes to school. At school, when presented with a wide variety of movement experiences, the child may be less enthusiastic to participate. Wall (2004) proposed that their limited experience and knowledge base about gross motor activities would discourage them from participation and appreciation of the movement opportunities presented to them. This creates some isolation, which creates a 'gap' in terms of involvement between a child and his/her peers. Wilson et al. (1992) reported that children who have learning and motor problems fall behind their peers over time.

It is the Wall (2004) position that children who exhibit symptoms of DCD from an early age will gradually become less involved in physical activities. When one considers the Developmental Skill-Learning Gap Hypothesis, it could explain why children with DCD often decide to withdraw from sport opportunities with their peers (Fitzpatrick & Watkinson, 2003). Fitzpatrick & Watkinson (2003) interviewed adults who believed that they had displayed DCD symptoms as children. These adults expressed the emotional trauma they had to endure as children at school, especially on the sports field and in physical education lessons.

Schoemaker and Kalverboer (1994) found that DCD could be associated with different affective and social problems. Their results indicated that DCD children were more introverted and that they perceived themselves as less capable with regard to physical and social skills when compared to their peers. They also found that DCD children were more anxious when they were required to perform movement tasks.

Schoemaker and Kalverboer (1994) and Fitzpatrick and Watkinson (2003) both documented that children with DCD often find ways to hide their motor problems. Different methods would be employed to do this, including withdrawal from social situations (O'Beirne et al. 1994) and engaging in socially negative behaviour, such as acting foolish or aggressive (Schoemaker & Kalverboer, 1994). It was also discovered that DCD children had fewer play friends, and were less often asked to play with other children (Fitzpatrick & Watkinson, 2003; O'Beirne et al. 1994; Schoemaker & Kalverboer, 1994).

Human Immuno Virus

Potterton and Eales (2001) examined the occurrence of developmental delay in infants younger than 12 months, who were HIV positive. Motor development delays were associated with activities that required proximal muscle strength and movement coordination, for example, sitting prone, pull to sit and rolling over. They authors were careful to note that it is not possible to judge if the infants found the activities too strenuous due to muscle weakness (the result of a chronic health condition) or whether muscular coordination problems could be attributed to Central Nervous System delay. System input and further longitudinal neurological tests are suggested to obtain final results (Potterton & Eales, 2001).

In a study done by Parks and Danoff (1999), the motor performance changes in children testing positive for HIV over a 2-year period were investigated. They investigated changes in physical and motor performance during the course of the infection. Gross motor ability scores of the HIV-positive children were lower than those of age-matched norms, and fine motor ability was in standard range of age-matched norms. Agility and running speed seems to be negatively affected among these children. The authors recommended that these children be given the opportunity to acquire gross motor skills so that they could participate successfully in age-appropriate physical games and other activities. The performance of fine motor skills was not affected during the two years of this study.

Vision

The relationship between vision and motor performance is well-documented.

> "The motor behaviour of a small child adapts itself to resemble the stimulus perceived in the optic field." (Hammill et al. 1993, p.4)

Vision assists motor control in various ways (Shumway-Cook & Woolacott (1995). It is a source of initial information about the environment as well as feedback about performance. Rösblad and Von Hofsten (1994) did not find a significant difference between the role of vision in motor performance for children with DCD compared to those without. They did however observe that some individual children with DCD do seem to be more dependent on vision to control their performance. Hoare (1994) did notice that problems with visual perception did characterize a group of children with DCD, but also noted that it was not a problem with other groups of children, also with DCD.

Coordination and perception may both mirror the integration of the central nervous system (Murray et al. 1990). Rösblad and Von Hofsten (1994) also noted that children with DCD were generally slower in their performance of tasks and that they did not seem able to anticipate what would happen as easily as children without DCD. In a study completed by Johnston et al. (2002), it was found that children with DCD took substantially longer to respond to visual signals and also longer to finish the goal-directed movement, when compared to children who were not identified as DCD. Lord and Hulme (1988) acknowledged that not all children with DCD experience visual-perceptual problems and that further research in this field is needed.

Visual Skills

Mon-Williams, Pascal and Wann (1994) found no significant deficiencies when ophthalmic tests were performed on children with DCD. They concluded that visual skills associated with the functioning of the eye were not responsible for the motor problems experienced by many children with DCD, but rather the problems were probably rooted in perception and/or visio-motor control. Dobler, Manly, Atkinson, Wilson, Ioannou and Robertson (2001) studied the interaction of hand use and spatial selective attention in children and suggest that development may result in a rising independence from action to the visual attention system.

Schoemaker et al. (2001) stated that the localisation of an object relies on intricate visual skills, in addition to the skill of distinguishing an object from its background (figure-ground perception), the perception of distance and the perception of form constancy.

From the studies reviewed by Wall (2004), children with DCD were found to be significantly less able to visually track the ball, when compared to the children without DCD. Tracking a ball includes the ability to anticipate its direction, height, speed, etc. Cheatum & Hammond (2000) described the impact on children who have visual-motor problems in terms of their withdrawal from play situations and low physical self-image. All of these situations may lead to anxiety and can be life-shaping traumatic experiences for young children (Fitzpatrick & Watkinson 2003; Cheatum & Hammond, 2000).

Vision and Feedback

Missiuna (1994) was convinced that many children with DCD rely significantly on vision to verify their performance. Not all studies agreed with this finding. Przysucha & Taylor (2004) investigated the control of stance and the role of visual information in children with DCD. They found no difference in balance ability between boys with DCD and the control boys, although some DCD children did rely heavily on visual input in order to maintain balance. They cautioned that this cannot be said of children with DCD in general.

Rösblad & Von Hofsten (1994) found that children with DCD took longer than children in a control group to complete a movement when visual feedback was provided. These results suggested to them that the children with DCD may use visual feedback very carefully when implementing some movement plan, in order to perform more accurately. Dwyer & McKenzie (1994) concluded that the poor performance of the subjects with DCD in their research could be due to inefficient visual rehearsal strategies.

Van der Meulen, Van der Gon, Gielan, Gooskens and Willemse (1991) cautioned that one should not use arm-tracking performance to judge the motor competence of an individual child. They found that there was no significant difference in the results of the subjects studied with regard to how they used visual feedback. These results show a minor variation and suggest that visual feedback information about the hand position contribute very little to the position-error and or velocity-error. It seems as if the poor writers used visual feedback as a movement strategy to compensate for their motor problem, therefore their greater reliance on visual feedback, compared to more proficient writers.

Vision, Drawing and Handwriting

Lord and Hulme (1988) investigated the role of visual perception in terms of drawing in ‘clumsy’ and normal children. They justified their study by stating that drawing is an essential skill because problems in handwriting and drawing could have an impact on other areas in education, which is frequently experienced by ‘clumsy’ children. They suggested that there is a variety of deficits in visuo-spatial perception in ‘clumsy’ children. Visual discrimination correlated negatively with the shape measure in the sighted condition and in tracing. This indicated to them a link between visual perceptual deficits and impaired motor performance in ‘clumsy’ children.

Weil and Amundson (1994) demonstrated the strong relationship between visual-motor skills and handwriting. Tseng and Cermak (1993) suggested that academic failure could be due to problems linked to poor handwriting. Letter formation is vital to the learning environment. It requires integration of the visual, motor, sensory and perceptual systems (Weil & Amundson, 1994).

Tseng and Chow (2000) investigated the relationship and differences in perceptual-motor measures and sustained attention between children with slow and normal handwriting speed. They found that the slow handwriting group were qualitatively different in the way they processed written information. The performance of the slow handwriters seemed to depend heavily on visual processing, compared to the normal speed handwriters, where performance was motor based. It is further suggested that an intervention program should focus on the improvement of visual processing, including memory and visual-motor integration as an alternative to the conventional intervention treatment of fine motor training. Cornhill and Case-Smith (1996) studied the factors that relate to good and poor handwriting. It was found that visual-motor integration and eye-hand coordination were significantly associated with a child’s handwriting skill.

The Cognitive Approach to Education

Ashman & Conway (1993) described learning as a collection of thought processes that occur inside our brains:

- Paying attention to the task at hand
- Understanding the association between the new information and what has already been learned.
- Understanding how learning takes place.
- Controlling the quality and pace of learning.
- Realizing that learning has occurred.

Ashman & Conway (1989) further stated that "the quality of one's learning is intimately bound to cognitive competence" (p. 29). They identified "learning to learn" as one of the major goals of education, and supported the cognitive approach to education, which includes learning how to solve problems, as an optimal approach to achieving this goal. They also associated learning with obtaining knowledge and skills, which takes education beyond process and includes product goals as well.

Problem Solving

The natural outcome of the planning process is the problem solving process (Mayer, 1988). Ashman & Conway (1993) described planning as an ongoing process that takes place in the brain. Mayer (1988) defined problem solving as the utilization of a set of actions to transform an initial situation into a target situation. Ashman & Conway (1997) claimed that problem-solving is a very complicated skill that includes intellectual skills, learning, cognitive strategies and meta-strategies that change attention, perception, the input and storage of information and the recall of knowledge from memory.

Ashman & Conway (1997) include the following abilities in problem solving:

- The ability to focus attention in order to extract maximum information from the learning or problem-solving situation.

- The ability to plan an appropriate strategy to accomplish the task.
- The ability to execute the strategy selected.
- The ability to monitor performance in terms of goal achievement.

Verbal Self-instruction

The writings of L.S. Vygotsky (1896-1934) form the basis of several theories about cognitive and educational psychology (Van der Veer & Valsiner, 1991). He spent time observing the problem solving strategies of young children. He found that children need to be able to ‘talk themselves through a problem’ and that this ‘talking’ assisted children in making plans in order to perform tasks (Missiuna et al. 2001). One of Vygotsky’s directives was that the educator should create suitable conditions in order for certain cognitive processes to develop (Van der Veer & Valsiner, 1991).

Meichenbaum & Goodman (1971) viewed problem solving as a three-stage process of comprehension, production and mediation. They concluded that poor performance could result from a deficit at any of these stages. They provided the foundation for the verbal self-instruction model. This model is based on the assumption that the educator gives the instructions and the child works through a series of self-instruction steps to facilitate learning and problem solving, which Ashman and Conway (1989) described in the following five-step sequence of learning processes:

1. Cognitive modelling.
2. Overt external guidance.
3. Overt self-guidance.
4. Faded overt guidance.
5. Covert self-instruction.

Ashman & Conway (1989) emphasised that adequate knowledge and training should be provided in order for educators to understand clearly how to implement cognitive strategies. These strategies should form an essential element of the learning process. Children and especially those with a learning problem need to master the basic skills before introduction and use of cognitive strategies.

'Zone of Proximal Development'

According to Vygotsky, circumstances can be created where optimal learning can take place, which he referred to as the 'Zone of Proximal Development' (Van der Veer & Valsiner, 1991). The Zone of Proximal Development (ZPD) is based on the principle that an adult or significant peer assists the child to learn. In order to create this ZPD and put a range of processes of internal development into action, teaching strategies must be implemented to facilitate this process. The ZPD of a child is defined as:

> "…the distance between his actual development, determined with the help of independently solved tasks, and the level of the potential development of the child, determined with the help of tasks solved by the child under the guidance of adults and in cooperation with his more intelligent partners" (Van der Veer & Valsiner, 1991, p.42).

Vygotsky suggested that by teaching a child one specific skill, a chain reaction occurs by which the child then has the potential to attempt and execute other related tasks Van der Veer & Valsiner, 1991). Vygotsky attempted to provide evidence for his views on the learning of a specific skill in one domain that transforms the intellectual functioning in other areas.

Leew (2001) and Lauchlan & Elliott (2001) advocated the assistance of an adult or a significant peer to help children improve their performance. They postulated that a child's cognitive processes can be adapted if a significant adult intervened in the child's thought processes, in effect place him or herself between the child and the activity (Leew, 2001; Lauchlan & Elliott, 2000).

Children's Cognitive Strategies

An infant's motor competencies are measured in terms of developmental milestones. These developmental milestones are measured in terms of growth rate and cognitive competency. All the motor milestones, from hitting at an overhead mobile at four to five months; pincer grasp with only the forefinger and thumb at +-12 months and lower trunk and leg muscles mature more so that crawling, walking and eventually running takes place at about 11-15 months, are associated with cognitive development (Honing, 1990).

Movement education programs emphasise motor skill acquisition in order for children to become competent and confident in the environment. Buschner (1990) argued the need to develop children's thinking skills as a goal in order to improve the value of the movement program. He further stated that teachers must realise that they should work with the child in a holistic way, i.e. attending to intellectual, social, physical and emotional development.

Buschner (1990) explained that children's cognitive development, which includes discovery, decision-making and problem solving, is often developed within the context of play. Children enjoy moving and often learn through discovery and, together with a child's ordinary need to play, forms the basis of an integrative and holistic approach to movement education. Bressan (1990) supported the position that participation in movement education should be playful and thoughtful. She stated that children must be involved cognitively to become skilful in the performance of motor tasks, and advocated educational processes that facilitate the children's involvement in the decision making process about their movement performance.

If play is associated with cognitive development, the nature of the play experience is important. Cross & Coster (1997) summarised the characteristics of play:

- The purpose of play is fun and enjoyment.
- The outcome or result is not important.
- Includes acting on an object or idea.
- Play necessitates active involvement from the player.

Lauchlan and Elliott (2001) found that the children learned cognitive skills that were encouraged throughout their intervention program. The content (tasks and activities) was not the main focus of the program. The basis of their intervention was in the method in which the materials were presented, how the activities were linked, mediation and the teaching of cognitive skills. They believed that this encouragement of cognitive skills is generalizable to domains such as addressing impulsive behaviour.

Leew (2001), Missiuna et al. (2001) and Polatajko et al. (2001) all advocated the effectiveness of strategy-based, problem-solving approach to improve movement skills. When indirect inquiry teaching styles are used, both convergent and divergent thinking occurs. During the flow of thinking, three fundamental processes occur: memory, discovery and creativity. Divergent thinking makes it possible for the child to discover more than one solution to the problem and Convergent thinking leads to only one solution to the problem (Mosston & Ashworth, 1990). This approach provides opportunities to accommodate individual needs of children. Children who experience movement problems or are DCD need time to explore movements. The successful implementation of questioning, problem solving and exploration may cultivate children's ability to think and enable them to execute value judgements about their movement and learning (Buschner, 1990).

Developmental Coordination Disorder

Candler & Meeuwsen (2002) suggest that children with DCD have the ability to learn when they receive implicit information. The children in their study performed a two-dimensional computer task. They acknowledge that when confronted with more complex tasks, the DCD children may show distinct discrepancies.

Transfer and generalization of learning are complicated issues (Ashman & Conway, 1989). It seems as if successful generalization relies on the criteria used to determine the extent of transfer that occurred and the framework within which the instruction occurred. It is further suggested that generalization depends on the adaptation and grouping of strategies in order to solve new problems (Ashman & Conway, 1989). It is clear that in order to be successful in these skills, the fundamental basics of the task to be transferred needs to be mastered (Ashman & Conway, 1989; Ashman & Conway, 1997).

Intervention Programs

Dewey et al. (2002) reviewed research demonstrating that children with attention, learning and language problems often exhibit difficulties in motor skills. They suggested that a motor intervention program combined with an academic intervention program would improve academic outcomes for these children (Dewey et al. 2002; Ashman & Conway, 1989).

Early intervention is critical if children with movement problems are to achieve significant improvements in performance of fundamental motor skills (Acronstam, 2003; Lane, Soares-Attanasio & Farmer-Huselid, 1993; O'Beirne et al. 1994 and Woodard & Surburg, 1997). It is interesting to note that all government schools in England are under legislative obligation to provide baseline assessments of children's abilities at school entry at four years of age (Gathercole & Pickering, 2000). This type of early screening is possibly what all children need if early intervention is to improve academic and motor outcomes for children.

Intervention treatments for children with DCD are varied and the efficiency of these interventions is controversial. There is an increase in interventions that concentrate directly on skill acquisition and enhanced performance (Mandich, Polatajko, Macnab & Miller, 2001). They grouped treatment approaches into two categories:

- "Bottom up" approaches, which focus on performance components of underlying processes.
- "Top down" approaches, that focus on skill achievement and the performance of functional tasks.

"Bottom up" Approaches to Intervention

This approach is a kind of building-block approach where sensory, sensory-motor or sensory integrative therapy is believed to address weaknesses in the performance of fundamental skills. Once fundamental skills are learned, more complex skills can be "built" from them. For many years, studies have shown that sensory-motor experiences will stimulate the development of these fundamental motor skills and therefore improve motor performance (Polatajko et al. 2001).

Sensory Integration

This is one of the most widely used intervention programs for children with DCD. Sensory Integration was implemented to treat children with learning disabilities who also had a sensory integrative dysfunction. This approach was intended to give the child suitable sensory stimulation in order to encourage motor modification and upper cortical learning (Mandich et al. 2001).

Sensory Integration treatment has included a central role for play as a means to accomplish intervention objectives (Cross & Coster, 1997). DeGangi, Wietlisbach, Goodin and Scheiner (1993) suggested that play as well as structured learning experiences can be beneficial for children with sensorimotor difficulties.

Dunkerley, Tickle-Degnen and Coster (1997) reported that two themes appeared during sensory integration treatment; i.e. playfulness and work. For the child, play represents enjoyment of the activity, being innovative, successful, confidence and trying hard. The child appeared to be enthusiastically involved in the task. For the tutor, play included being innovative with the activities and acting playfully. On the other hand, work meant trying hard, cooperating, and asking for help, for the tutor, work involved supporting and guiding the child. It was further suggested that the tasks should be stimulating enough to allow the child to experience success. If the tasks are too challenging, the child may experience failure and if the task is not challenging enough, the child may experience intervals and free time.

Ayres & Mailloux (1981) described the impact of sensory integration programs in terms of a generalized outcome on brain function that leads to an improved cognitive ability to coordinate focused interaction with the social, emotional and physical environment. All the subjects in their study displayed these gains. However, Wilson et al. (1992) stated that there is much debate over the success of sensory integration as treatment for children with motor difficulties and learning problems. Their research found no significant differences between sensory integration treatment and academic tutoring in terms of impact on cognitive function (Kaplan et al. 1993; Wilson et al. 1992). Hoehn and Baumeiter (1994) concluded that the current body of research does not provide sufficient evidence to confirm that sensory integration therapy is a successful primary or secondary remedial treatment for children with learning problems and other disorders.

Perceptual-motor Training

This approach suggests a fundamental relationship between motor behaviour and underlying perceptual processes. In perceptual motor treatments, the child is presented with a wide range of experiences with motor and sensory tasks. A general improvement of motor skills is expected as a result of increasing sensory and motor task exposure. It appears as if all approaches have similar outcomes (Mandich et al. 2001).

"Top down" Approaches to Intervention

Mandich et al. (2001) and Lauchlan and Elliott (2001) identified top down intervention approaches as either task-specific or based on the cognitive approach.

Task-specific Intervention

The main focus of this approach is on explicit instruction of the task to be learned (Mandich et al. 2001). It is based on the principle that performance is the consequence of learning and that learning is optimal when instruction is focused completely at the target activity. The task may be broken down into smaller units in order to teach the task. Each unit may be taught separately and then linked for a whole-task performance. Transfer and generalization of specific tasks must be taught.

Cognitive Approaches

CO-OP. CO-OP is the Cognitive Orientation to daily Occupational Performance program. This is a different approach from the traditional physical approach in that it is a verbal approach. During treatment sessions, the child is constantly and actively involved in solving performance problems and explore solutions (Polatajko et al. 2001). The assumption is that, through the use of cognitive strategies, the child will be able to improve performance (Missiuna et al. 2001; Polatajko et al. 2001). This approach is based on the role that cognition plays in the acquisition of skills needed for home, school and play activities. One of the central features of CO-OP is the assumption of the transfer of skills. CO-OP is developed to encourage children to learn new skills and to improve existing skills (Missiuna et al. 2001)

The primary focus of CO-OP is on cognition and strategy use in skill acquisition and the development of proficiency in daily life activities (Polatajko et al. 2001; Yerxa, 1994). CO-OP is based on three fundamentals:

- Skill acquisition (child centered): The child identifies three skills that she or he is expected to perform at home, school or play; or what she or he wants to learn.

- Cognitive strategy development: The child learns a global strategy that will enable him or her to solve performance problems and improve while promoting skill acquisition.

- Generalization and transfer: The child uses the newly acquired skills and strategies as a basis for learning related tasks and strategies, outside the intervention sessions.

Miller et al. (2001) found that the results of CO-OP were promising with regard to its success and point out that further research is justified. They further propose that the effectiveness of CO-OP in a school set-up and treatment in small groups be evaluated.

The Global Cognitive Strategy. The Global Cognitive Strategy provides a framework within which the child and or mediator can talk through problems that were encountered during execution of a task (Polatajko et al. 2001). The child is encouraged to use the following line of self-talk:

GOAL: What do I want to do?

PLAN: How am I going to do it?

DO: Do it! (Execute the plan!)

CHECK: How well did my plan work?

These four steps facilitate metacognitive thinking skills that are proposed by Feuerstein's theory of mediated learning experience (Lauchlan & Elliott, 2001; Polatajko, et al. 2001). The term metacognition was presented in the 1970's to describe the awareness of cognition. Metacognition involves competence in planning, monitoring, self questioning, and self directing activities (Ashman & Conway, 1993)

The core of this type of intervention is that the child is taught problem-solving strategies to solve motor problems and to use self-talk. This is a verbally-based approach of discovered strategies to guide performance and to encourage strategy learning. Bridging methods are used to encourage transfer: The tutor associates the child's acquired knowledge to situations that could occur, and guides the child to discover how cognitive tactics can be useful in new circumstances; i.e. a transfer of skills (Miller et al. 2001). The "Cognitive Bridges" as it was referred to in Cratty & Martin (1969) should be established between two tasks in order to acquire the greatest benefits form transfer. Cratty & Martin (1969) also suggested that children with motor problems could experience greater transfer between different activities when compared to children without movement problems.

The Contemporary Treatment Approach. The Contemporary Treatment Approach (CTA) included neuromuscular, multi-sensory and biomechanical methods with the emphasis on motor aspects of skill acquisition (Ashman & Conway, 1993). In line with Contemporary Approaches (CTAs), the tutor set the objectives and maintains the lead throughout the entire treatment program.

Heartland's Model. Clark & Miller (1996) developed the use of a problem solving approach known as the Heartland's Model. It is proposed that the point of reference changes, from finding the child's performance problem on discrepancies within the child, to finding the problem in the difference between the child's performance and the demands of the situation (e.g. the teacher expectations, difficulty and nature of the curriculum, structure of the physical environment). This model is based on four levels:

Level I problem solving occurs between teachers and parents.

Level II problem solving includes other resources. The teacher and parent consult with other people with regard to concerns about the child.

Level III problem solving occurs with the extended problem solving team. This team consists of the teacher, parents and specialists (e.g. school psychologist, educational consultant and relevant personnel). Level III takes place if intervention at the previous levels was not adequate in meeting the needs of the student, or the problem is severe enough to require the expertise of specialists. An analysis of all available data is done and all previous intervention is evaluated to determine if additional resources and services are needed to alleviate the child's problem.

Level IV problem solving involves the actual consideration of the child's right to special educational and occupational therapy services.

After an intervention plan is developed and implemented, the child's progress towards a goal is monitored so that performance can be evaluated (Clark & Miller, 1996). The effectiveness of the intervention is established and this is based on multiple data collection methods from various sources and settings on a continued basis. The process of evaluation is interactive and the child can monitor progress.

Cognitive-behavioural Therapy. Cognitive-behavioural therapy (CBT) is an approach used for children and adolescents (Kendall & Choudhury, 2003). The initial treatment was for children with Attention Deficit Disorder, impulsivity in the classroom and acting out behaviour problems. It appears as if CBT did not deliver on its promises to assist children identified as ADHD. There seemed to be increasing support for a medication to treat children with ADHD. CBT gained momentum again when treatment were focused on internalizing disorders i.e. anxiety and depression. However, Hinshaw, Whalen and Henker (1984) found that cognitive behavioural intervention was most effective when used in conjunction with behavioural rehearsal, in order to practice the newly learned social skills, explicit encouragement of appropriate social conduct and exact self-assessment and self-monitoring in hyperactive children. Their results suggested that hyperactive children should be participants in the evaluation of their behaviour and this improves the treatment effect (Hinshaw et al. 1984). Hinshaw et al. (1984) further reported on longitudinal studies that indicate no real benefit of stimulant medication, e.g. Ritalin, on social and educational outcomes.

Weiss & Hechtman (1993) stated that cognitive therapy was developed to encourage self-controlled behaviour, resulting in improved mediation and self-control strategies. They further report on controlled studies that investigated cognitive therapy. Some studies found that the main focus of cognitive therapy was on self-instruction. These studies found minor clinical improvement in academic performance and behaviour and also no evidence of generalization, nor a lasting effect of cognitive therapy (Weiss & Hechtman, 1993).

Link to DCD

Miller et al. (2001) discussed the Cognitive Orientation to Daily Occupational Performance (CO-OP) in the treatment of children with DCD. The study by Miller et al. (2001) was run over ten individualised sessions. The children were all identified as DCD and the CO-OP group learned the Goal-Plan-Do-Check strategy.

Leew (2001) conducted a ten-week intervention program which focused mainly on a strategy-based, problem-solving approach to learning. The children who participated in this study showed features that are characteristic of a DCD child. Participation of parents was not mandatory but was firmly encouraged. The program, called the Passport to Learning, included:

- Process Questioning- the tutor asks questions that help the child to concentrate on the thought process and not on the result;
- Bridging- the tutor encourages the child to think about different circumstances or activities where the technique that they have learned can be applied. This forms a "bridge" between the intervention session and other situations and assists in generalization.
- Challenging- the child is motivated to focus on why the answer is accurate and how he got to that answer in order for him to be able to repeat it successfully.
- Describing- the child is encouraged to use correct and precise language when describing the activities, complicated points and potential solutions.
- Modelling- the tutor thinks out loud, and illustrates the problem solving process, assessment strategies and revision processes.
- Reflection/Summarizing- the tutor use questions and goes into detail about the child's answers and performance and assists the child to review the things that helped or hindered his success.

From the literature it seems evident that cognitive intervention has a positive role to play in addressing the motor problems or DCD that some school-going children battle with. It appears as if Guided Discovery, Cognitive Intervention, Problem Solving Strategies, the Dynamic Performance Analysis and CO-OP are preferred methods for intervention. Lauchlan & Elliott (2001), Missiuna et al. (2001) and Polatajko et al. (2001) all recognised the infancy stage at which cognitive intervention and (Lauchlan & Elliott, 2001) dynamic assessment is. They suggest therefore that more research be done in these fields.

Learning Strategies

A learning strategy, according to Lidor (2004), is implemented in a self-paced task where children can devise a plan or course of action. It also refers to the thoughts and behaviour that a child displays during the learning process in an effort to improve information processing and the eventual success in performing the activities.

Lidor (2004) identified five steps that foster the development of learning strategies:

1. The child is asked to get ready in a mechanical, attitude and emotional way in order to execute a task.
2. The child is directed to imagine successful execution of the task.
3. The child is guided to direct attention on specific signals in order to block out irrelevant information.
4. The child is required to execute the movement without thinking about it or its result.
5. The child is guided to provide feedback on the task.

These steps are similar to other cognitive strategies proposed by Leew (2001), Missiuna et al. (2001) and Polatajko et al. (2001).

- A non-awareness strategy.

  This strategy guides the child to plan the course of action that is about to be executed. Attention is directed to one specific cue and they are encouraged to 'let the movement flow'.

- An awareness strategy.

  This strategy indicates the thought and behaviour processes of novice participants. The child is directed to focus on all details regarding body sensation while executing the movement.

Almost ten years later, it appears as if evidence are increasing in support of cognitive intervention (Leew, 2001; Polatajko et al. 2000; Mandich et al. (2001); Missiuna et al. 2001). Mandich et al. (2001) found that cognition plays an active role in the acquisition of new skills. They acknowledged that verbal self-guidance is only one strategy, rooted among many others.

Ashman & Conway (1989) stated that the focus of intervention should be to promote and develop independent learning ability by using material that is relevant to the teacher and the children involved. The intervention content should have "ecological validity." The children should understand that the skills taught are of value and that these skills can be applied to various situations.

Conclusion

Children who have DCD encounter a wide range of difficulties. Dewey and Wilson (2001) questioned whether DCD is a single syndrome and if one can distinguish between existing subtypes. In addition to motor coordination difficulties, it seems that many children with DCD also display co-morbid factors that have a negative effect in several areas of their daily lives. DCD, visual perception and co-morbid factors all have a huge impact on children when they need to perform their daily tasks at school, on the sports field and the play ground. In working with children who have DCD, we need to search for the best kinds of intervention programs. The fact that education, sport and play have such a huge impact on a child's life makes it compelling for research to explore the potential benefits of perceptual-motor intervention programs.

It is well documented that educational practice is moving away from teacher oriented instructional methods to more child centred approaches, that is, from command to discovery (Cheatum & Hammond, 2000; Mosston & Ashworth, 1990). To date, it seems as if the cause of DCD cannot be isolated and the role of cognitive intervention seems to be a practical tool to assist children with this condition in order to ameliorate the challenges they face daily. Wright (1968) reviewed research on the relationship between perceptual-motor experiences motor performance. They found that a lack of visual, tactile and/or kinesthetic stimuli during infancy has a negative effect on motor functioning. Ashman & Conway (1997) acknowledged that there is a steady, growing shift from behavioural to cognitive approaches in education.

The present study attempts to determine the influence of a perceptual-motor development intervention program on the motor problems of children with DCD. This study builds upon existing studies and explores visual perception with selected children. The unique feature of the research is that it also attempts to implement cognitive intervention strategies within the perceptual-motor intervention program.

Chapter Three

Methodology

This chapter will describe the research method, the assessment instruments, the procedures and the approach to data analysis that were used in this study.

The Case Study Research Method

The case study research method was selected for this study. Thomas & Nelson (2001) described the advantages of the case study approach when the researcher wants to gain specific insight and knowledge in a situation where individual differences are the rule, not the exception. The case study is a type of descriptive research and the fundamental theory behind it is that the cases that are studied have similar characteristics to other similar cases. The purpose here is not to oversimplify the results of a case study, or to make assumptions about the sample of subjects studied. The results of several case studies may contribute towards inductive reasoning in the construction of a theory. There are three categories of case studies: Descriptive, interpretive and evaluative. The current study is an evaluative case study that is focussed on learning about the potential value of the intervention program.

In most case studies, random sampling is not applied because the intention is not to measure significant changes or differences within a population (Thomas & Nelson, 2001). The case study more often chooses a group of subjects from which the researcher should be able to gain the most information or knowledge. Thomas & Nelson (2001) labelled this approach to the recruitment of subjects 'criterion-based sampling'. In this approach, the researcher determines the criteria that will be used in the study and then obtain a sample that meets the criteria. The amount and type of data that is collected as well as the method of data collection in a case study differ from study to study (Thomas & Nelson, 2001).

The case study method is applied in different fields of study, including educational settings for children with reading problems for example. Thomas & Nelson (2001) emphasised that the case study can be used in a study where programs are evaluated, such as the current study.

Selection of Assessment Instruments

An instrument to assess DCD was central to completion of this research. Because the investigator was also interested in exploring the possible presence of visual perception problems in children with DCD, and instrument to assess visual abilities was also identified.

The Movement Assessment Battery for Children (M-ABC)

Various instruments of assessment for movement skills may classify different children as displaying motor impairment. In the current research studies, children identified with DCD may show different levels of movement problems (Dewey et al. 2002). It is therefore crucial to administer a test that actually measures the variables they intend to measure (Cermak et al. 1986). Crawford, Wilson and Dewey (2001) studied the consistency of test results in the classification of children with DCD. They used three measures of motor skills: The Bruininks-Oseretsky Test of Motor Proficiency (BOT), the Movement Assessment Battery for Children (M-ABC), and the Developmental Coordination Disorder Questionnaire (DCDQ).

The results of the study done by Crawford et al. (2001) reflect some uncertainty with regard to whether or not BOT may under-identify children with motor problems (Wilson, Kaplan, Crawford & Dewey, 2000 and Hattie & Edwards, 1987). The study of Crawford et al. (2001) indicated that the M-ABC identifies children with motor problems that the BOT does not identify. The Developmental Coordination Disorder Questionnaire (DCDQ) is a recently developed measure that assesses parents' perceptions of their children's motor proficiency. An early analysis of DCDQ showed internal consistency, however, to date, no other studies looked at its reliability (Crawford et al. 2001). Geuze et al. (2001) remarked that the use of a simple checklist (by teachers) on the basis of characteristics for the evaluation of developmental motor problems should be considered insufficient to meet the Criterion A of the DSM-IV criteria for DCD.

Crawford et al. (2001) suggested that an accurate portrayal of a child's actual fine motor skills lies in using a more universal measure, such as the M-ABC, and observations and reports on functional performance of the child in his or her environment. They also observed the possibility that M-ABC might be a more complex test for children with attention problems. They believe that it is vital that an instrument of motor skills constantly identify the same children.

The M-ABC Checklist

The initial step in the administration of the M-ABC is a kind of pre-assessment of movement abilities. The M-ABC checklist is a series of questions that could be completed by any adult who is accustomed to the motor and everyday task performance of a specific child. The Checklist is composed of 48 questions, grouped into five sections. Children who are identified to have certain levels of movement difficulty, are then referred for testing using the M-ABC test.

The Movement-ABC (M-ABC) Checklist was found to be of value to identify children with DCD in Singapore (Wright, Sugden, Ng & Tan 1994). This is in agreement to what Lombard and Pienaar (2003) found when they used the M-ABC Checklist on a group of children from the North-west Province in South Africa. Wright et al. (1994) suggested that there is room for the M-ABC Checklist to be modified in order to include activities that is relevant to children and teachers in Singapore. Lombard & Pienaar (2003), in conjunction with the teachers concerned, agreed to complete only sections one and five of the M-ABC Checklist. The teachers considered themselves capable to complete these sections. The first section predominantly examines a child's manual dexterity and the fifth section incorporates extensive behavioural aspects. Based on their findings, Lombard & Pienaar (2003) advocated that sections one and five of the M-ABC Checklist is an adequate screening method to identify children with DCD. They further propose that teachers should receive adequate information about vague questions.

The M-ABC Test

The M-ABC (Henderson & Sugden, 1992) has been recognised as the most valid and commonly used objective assessment to identify children with DCD (Miyahara & Wafer, 2004; Jongmans et al. 2003; Candler & Meeuwsen, 2002; Dewey et al. 2002; Johnston et al. 2002; Woodruff et al. 2002; Crawford et al. 2001; Dewey & Wilson 2001; Geuze et al. 2001; Schoemaker et al. 2001; Braun, 1997; Cantell, Smyth & Ahonen, 1994). To date, it is still considered one of the best tests to identify DCD and it comes the closest to the requirements of the selection Criterion A of the DSM-IV (Geuze et al. 2001). The M-ABC is a standardized age-appropriate motor test with norms. In order to make a decision about intervention, the M-ABC Total Motor Impairment (TMI) score is used. This score provides a summary of the child's motor performance on the test as a whole. The TMI score provides information about movement performance and this is interpreted in terms of age-related standards and percentile norms (Henderson & Sugden, 1992).

The M-ABC Test provides an indication of a child's motor performance across fine and gross motor tasks (Henderson & Sugden, 1992). The test battery is conducted on an individual basis and requires that the child execute a series of motor tasks in a standard manner. Performance is related to norms using categories for different age groups with standardized scores for the various groups.

- Age band 1: include ages four to six years.
- Age band 2: includes ages seven and eight years.
- Age band 3: includes ages nine and ten years.
- Age band 4: includes ages eleven and twelve years.

Every age band consists of eight items that measure different aspects of perceptual motor abilities: three items measure manual dexterity; two items measure ball skills and three items for measuring balance.

The activities are divided into three sub-sections:

<u>Manual Dexterity (three tasks)</u>

- First task: Posting coins, or placing pegs or placing pegs by rows.
- Second task: Threading beads, or threading lace or threading nuts on bolt.
- Third task: Bicycle trail or flower trail.

<u>Ball Skills (two tasks)</u>

- First task: Catch beanbag, or one hand bounce and catch or two hand catch.
- Second task: Rolling ball into goal or throw beanbag into box.

<u>Static and Dynamic Balance (three tasks)</u>

- First task (static balance): One leg balance, or stork balance or one-board balance.
- Second task (dynamic balance): Jumping over cord, or jumping in squares or hopping in squares.
- Third task (dynamic balance): Walking heels raised or heel-to-toe walking or ball balance.

Van Waelvelde, DeWeerdt, De Cook and Smits-Engelsman, 2004 investigated the validity of certain aspects of the M-ABC Test. They found that in age band three:

- The child's ball throwing ability was also assessed in the ball skills test item that was designed to assess only the ball catching skills and suggest that the tester throw the ball to the child.
- They found that the task of balancing the ball on the plate is considerably different from the 'walking on a line' task in age bands one and two and suggest that it should be replaced with a task that is a variation of the 'walking on a line' task.

Van Waevelde et al. (2004) concluded that a distinction cannot be made between a child who performed well at the first attempt and a child that needed several trials to achieve the same result.

The Developmental Test of Visual Perception – DTVP-2

Between 1964 and 1989 a wide variety of different visual-perceptual or visual-motor integration tests were developed. Hammill et al. 1993 reviewed reports on popular tests. These tests included the following:

- Purdue Perceptual-Motor Survey (1966).
- Motor-Free Visual Perception Test (1972).
- Bender Gestalt Test for Young Children (1975).
- Test of Visual-Perceptual Skills (1982).

- Test of Visual-Motor Skills (1986).
- Developmental Test of Visual-Motor Integration (1989).
- Sensory Integration and Praxis Tests (1989).

All of these tests were found to be inadequate and was not recommended. It was found that these tests were all badly assembled and their results are unreliable because they do not assess anything consistently (Hammill et al. 1993).

Hammill et al. (1993) proposed that a complete assessment of a child's visual perception must be made up of two types of measurement tasks: Tasks that are entirely visual-perceptual (these tasks should involve minor or no motor skills) and tasks that involve visual-motor integration or visually guided motor activities. The DTVP-2 was exclusively designed to assess a child's visual perceptive ability under motor-reduced and motor-enhanced situations so that a comparison can be made between the two (Hammill et al. 1993).

Prior to the development of the Developmental Test of Visual Perception (DTVP), there was no comprehensive norm-referenced assessment tool to evaluate various aspects of visual perception (Hammill et al. 1993). The first edition of the DTVP assessed the following visual perceptual skills:

- Form Constancy - the detection of the main characteristics of specific figures or shapes as it appears in various sizes, shadings, textures and positions.
- Figure-ground - the recognition of figures surrounded within a broad sensory background.
- Position in Space – the distinction of figures that are turned around or reversed.
- Spatial Relations – understanding of shapes and designs relative to one's body and space.

The Developmental Test of Visual Perception –Second Edition (DTVP-2) was a revised version intended to evaluate the visual-perceptual ability of a child under motor-reduced and motor-enhanced situations in order to make a comparison between the two (Hammill et al. 1993). The purpose of using of the DTVP-2 was to document the presence and level of visual-perceptual or visual-motor problems in children ages four to 12. The DTVP-2 consists of eight subtests. These subtests measure different, but interrelated visual-perceptual and visual-motor skills. These skills are:

- Subtest 1: Eye-hand Coordination

  The child should draw a line between two lines on the Examiner Record form, for example from the dog on the left to the bone on the right side of the page and not touch the black lines on the record form. The lines become narrower and include curves and angles as difficulty increases.

- Subtest 2: Position in Space

  This is a matching task and the child is required to match the stimulus figure with a precise figure presented in a series of similar but different figures.

- Subtest 3: Copying

  The child is required to copy a figure in the empty square next to the stimulus figure. The figures become increasingly complex as they proceed.

- Subtest 4: Figure-Ground

  The child is presented with a stimulus figure and is required to identify as many figures as possible from a complicated and puzzling background.

- Subtest 5: Spatial Relations

  The child is presented with two grids of evenly spaced dots. The dots on the first grid are connected to form a pattern and the child must duplicate the pattern on the second grid, to form the same pattern.

- Subtest 6: Visual Closure

  The child is presented with a stimulus figure and is required to match this exactly with a series of incomplete figures. The child is required to mentally/visually complete the figure in order to make a match.

- Subtest 7: Visual-Motor Speed

  The child is presented with four different geometric shapes, they are required to make as many lines or crosses in those shapes within a specific time frame.

- Subtest 8: Form Constancy

  The child is presented with a stimulus figure and is required to find it among a series of other figures that may be a different size or concealed in a distracting background or presented on its side or upside down.

The DTVP-2 may be used in four principal areas: to identify candidates for referral; to confirm the efficiency of these intervention programs; to serve as an investigative instrument; to record the prevalence and extent of visual perceptual or visual-motor problems in individual children (Hammill et al. 1993). In this research, the investigator used the DTVP-2 to explore the existence of visual-perceptual or visual-motor problems in the children identified as exhibiting symptoms of DCD.

Procedures

The procedures below were followed in order to complete this study.

Selection of Subjects

Children from low socio-economic backgrounds have been found to be at a disadvantage in terms of visual-motor integration, when compared to children in middle or higher socio-economic groups (Bowman & Wallace, 1990). The incidence of DCD among children from lower socio-economic backgrounds is not known, but even if the rate is not greater than among children from other backgrounds, it is likely that the financial resources to provide remedial programs are not available. The investigator decided to focus her study on children from lower income backgrounds in the belief that individual programs are not usually available to them.

The headmasters of twelve primary schools in lower socio-economic areas were contacted and kindly requested to read through the proposal and some background information on the proposed study. They were then asked to consider whether they would inform teachers and parents in their school about the opportunity to participate in the study.

It was made clear to the headmasters that the project would not be a school project, but rather a private project involving a private program run outside of the school program.

Six headmasters indicated that classroom teachers in their schools were interested in the M-ABC Checklist because they thought that some children in their classes had motor coordination problems. Checklists were distributed to the classroom teachers who requested them.

The teachers from two schools never returned the completed M-ABC Checklists. At two other schools only one child at each school was identified with motor coordination problems on the M-ABC Checklist. The investigator decided that there were not enough children in each of these schools to make the provision of an intervention program viable. These two potential subjects were therefore excluded from the program due to practical reasons.

Two headmasters indicated there were teachers and parents that were very interested in providing their children with access to such a private program. After several meetings with the headmasters and class teachers, 67 children were initially identified as potential subjects. The teachers completed checklists for these (N=67) children. On analysis and interpretation of the checklists, only 31 children scored 15 percent or below the 15th percentile on the M-ABC Checklist and these (N=31) children were then screened on the formal M-ABC Test. A total of thirteen children (N=13) scored below the 15th percentile on the M-ABC Test. The sample of thirteen (N=13) children was found to be sufficient for the purposes of the case study approach (Thomas & Nelson, 2001). The parents of these children were contacted. They were told that the free program was also serving as a research project for the M. thesis of the investigator. All the parents were eager to give their child the opportunity to gain extra movement experiences. All parents or guardians consented to allow their children to participate in the research project.

After three weeks of the intervention program, one of the children was dropped from the program due to absenteeism for consecutive sessions. This reduced the total number of subjects to twelve (N =12). The chronological age of these subjects was recorded at the initial M-ABC Test (see Table 1). The chronological age was calculated by subtracting the date of testing from the birth date of each subject (Hammill et al. 1993). The age group of the subjects ranged between six and nine years, males and females and all from previously disadvantaged communities on the Cape Flats in the Western Cape Province.

Table 1. Chronological age of the test subjects

Subjects	Gender	Age
Subject: 1	Male	7 years 3 months and 10 days
Subject: 2	Male	6 years 2 months and 0 days
Subject: 3	Female	7 years 1 month and 4 days
Subject: 4	Female	7 years 2 months and 21 days
Subject: 5	Male	6 years 4 months and 25 days
Subject: 6	Male	6 years 2 months and 19 days
Subject: 7	Male	6 years 2 months and 3 days
Subject: 8	Female	6 years 4 months and 25 days
Subject: 9	Male	7 years 5 months and 18 days
Subject: 10	Female	9 years 0 months and 6 days
Subject: 11	Male	6 years 5 months and 0 days
Subject: 12	Female	9 years 11 months and 23 days

Pre-test

The initial group of 13 subjects was selected for participation in the intervention program after the pre-test (the M-ABC) of the 31 children identified by the Checklist. The Pre-Test of the M-ABC was completed after school at the end of the second term at the different schools that the children attended, or, in the case of subject 12, in a familiar venue. She could not be tested during school time. The venue had to be in a venue that she was familiar with. This was done so that she would not have too many new and strange things around her that might distract her from the activities.

The children were dressed in their school uniform or sports clothes, or barefoot, which did not seem to hamper performance on the tasks required for the M-ABC test. The M-ABC pre-test was administered on an individual basis by the investigator. The pre-tests were conducted in a classroom frequently used by the learning support teacher or in the school hall. All test procedures was adhered to as it is described in the test manual. The author found it practical to improvise with regard to the dynamic balance activities (jumping and hopping in squares). A plastic mat which had the exact rectangles measured out was made and procedures to set up the equipment at three different venues were less time consuming.

As part of the exploratory nature of this research in terms of visual perception and DCD, six subjects were selected from the original 31 to complete the DTVP-2 test. This is a relatively long test so the administration to all 31 children was not practical. Three of the six children tested scored below average on the DTVP-2 test scored below the 15th percentile on the M-ABC Test. The other three children scored above average on the DTVP-2 and well above the 15th percentile on the M-ABC and were therefore excluded from the study.

The DTVP-2 tests were done at the same venues where the M-ABC Test was done. The author had exercised caution when it seemed that the children were showing signs of getting tired or restless.

The Intervention Program

Ashman & Conway (1989) stated that for an intervention program to be practical, it is recommended that provision should be made for individual differences in the affective and cognitive domains. Lauchlan & Elliott (2001) recognised the need to draw upon the important cognitive and meta-cognitive processes as well as the need to address the affective realm and build feelings of competence. Continuous assessment and modifications to an intervention program, consistent with the varied needs of the individuals involved, is essential in order to measure the success of the intervention program (Ashman & Conway, 1989).

Cratty & Martin (1969) specified that when working with children in comprehensive perceptual-motor development programs, activities should be included that encourage the development of gross motor skills and abilities, such as fundamental motor skills, balance, agility, and particular sports skills, as well as fine motor skills such as drawing and writing. This interpretation supported the decision to include pen and paper activities in the intervention program.

The perceptual-motor intervention program, with its emphasis on the cognitive approach, was conducted over a period of eight weeks. The program was divided into two sessions of 30-60 minutes each per week. The program was designed to incorporate fine and gross motor activities. These activities were then used to encourage the children to think about what they were doing and how they executed the activities.

The author drew mainly on the cognitive strategies used in the works of Leew's (2001) Passport to Learning and the CO-OP program as described in Chapter Two. Aspects of play and playfulness (Cross & Coster, 1997; Dunkerley et al. 1997) were also incorporated.

The activities were presented to the children in the form of games or tasks. See Appendix B for more details about the specific tasks. The program was run on an informal basis and the children were given ample time to engage in the activities. Points that were constantly emphasised were taken from the CO-OP approach. This seemed to help the children to talk themselves through the activity or problem that they needed to solve.

The Global Cognitive Strategy of Goal-Plan-Do-Check (G-P-D-C) program provided a structure for self talk.

- Goal: The child firstly had to identify what the **Goal** is that needs to be achieved and ask the question: What do I want to do?

- Plan: Once the child was clear about what needed to be done, then a **Plan** had to be devised. This was necessary because the child then got to think about the steps that should be followed in order to achieve the identified Goal. The question that was asked is: How am I going to do it? The child had to list (talking aloud so that we could all hear) a few steps that had to be followed as the Plan in order to be able to achieve the identified Goal.

- Do: The next step was to **DO** it, that is, to execute the Plan.

- Check: The child then had to **Check** the outcome of the performance. After execution, the child was encouraged to evaluate whether the Plan worked and if the Goal was achieved. The last question that the child had to ask was: How well did my Plan work? During this part of the program, the other subjects could provide their contribution on how well the Plan worked. At the end of the activity or task, the task or tasks were reviewed and we (that is, the author of the study and the subjects concerned) considered possible reasons for why the execution was successful or unsuccessful. Then we would either identify with all the steps in the initial Plan and the success it brought about or "fix the Plan" in order to achieve the desired outcome.

At the end of the sessions the children were encouraged to think about the use of the G-P-D-C strategy that could be used in other areas of their daily life, that is, at school, on the playground or at home.

The Passport to Learning approach was used essentially for:

- The accomplishment that comes about by the creation of a fun, supportive and a safe atmosphere.
- The mediator (author of the study) used questions to help the child to focus on the process of thinking and not on the product. The attention to visual details, a main feature of the Passport to Learning, was also emphasised.

There are several common features in the two programs (CO-OP and Passport to Learning) which was a main characteristic of the Cognitive Motor Intervention Program in the current study:

- Mediated learning
- Fun and non-threatening
- Talk or think aloud. (To talk yourself through the process.)
- The four strategies: G-P-D-C and asking the questions, as stated earlier or as in Passport to Learning: What is the problem? How am I going to do it? Do it (implement the plan) and How well did my plan work?

Lauchlan and Elliott (2001) emphasised that it is not the intervention materials or activities, but the method of presentation that is important. The method of presentation includes mediation and the cognitive skills that are taught. Dwyer and McKenzie (1994) came to the conclusion that children with DCD can duplicate geometric shapes as accurately as the control children, if there is no interval between presentation and recall of the shapes. They further suggest that ineffective visual strategies may be accountable for their inaccurate or poor performance, therefore the attention to visual detail that was emphasised during the intervention program.

Post-test

The M-ABC Post-test scores for each of the twelve (N =12) subjects were completed for at the end of the eight-week cognitive and motor intervention program. As it was stated earlier, one subject was excluded from the program after several days of absenteeism. Only twelve subjects were therefore tested on the M-ABC post-test. The post-tests were conducted at the same venues as the pre-tests.

As it was stated above, one subject was excluded from the study due to absenteeism. Therefore only two subjects who were initially assessed on the DTVP-2 were re-assessed after the cognitive and perceptual-motor intervention program. Post-test assessment on the DTVP-2 for subjects 10 and 12 was done at the same venues as for the pre-test.

Debriefing of Subjects

After the post-test, brief and informal feedback was provided to the teachers of the subjects involved. A more detailed description of the findings of the study was presented to the teachers and the headmasters of the schools concerned within one month after completion of the study. The parents or guardians of the children were informed telephonically or by means of a letter about the performance and progress of the subjects after the eight-week perceptual-motor intervention program. The parents or guardians of subjects that seem not to have benefited from perceptual-motor program were presented with possible reasons for the lack of impact of the intervention. Suggestions for further interventions were presented to them.

Treatment of Data

The data is presented in the form of a case study. The case study is used in qualitative research. Characteristic of a case study is the collection and analysis of information (Thomas & Nelson, 2001). In the current study, the M-ABC Checklist and Test and the DTVP-2 were used as the sources to gather information about the test subjects. Qualitative data was collected through observations by the author of this study and the class teachers of the subjects concerned as well quantitative data collection in the use of the M-ABC Checklist, Test and the DTVP-2 which is highly regarded as a test of great validity and reliability (Hammill et al. 1993). The results and observations are presented in the following chapter in terms of three clusters of subjects, which should not be surprising considering the heterogeneity of DCD.

Summary

The motivation for this study was to investigate the effect of a perceptual-motor intervention program taking a cognitive approach, on children with DCD. The program was highly individualised. When an attempt is made to work with children who are DCD, care should be taken to acknowledge the individual differences among these children. The fact that so many authors have referred to the heterogeneity of DCD makes it inevitable that an intervention program should cater for each child at his or her level of competence. If this is done in a group situation, the challenge is even greater for the teacher or researcher. Cognitive intervention can and should form part of the way in which we guide and teach children to become independent in movement and independent thinkers.

Ashman & Conway (1989) identified the focus of intervention as the promotion and development of independent learning ability by using material that is relevant to the teacher and the children involved. The intervention content should have ecological validity (Ashman & Conway 1989). The children should understand that the skills taught are of value and that these skills can be applied to various situations, in order to maximise the impact of the program.

Chapter Four

Results and Discussion

This chapter will first present a general overview of the performance of the 12 subjects on the Movement Assessment Battery for Children (M-ABC), and then the subjects will be discussed as case studies. An overview of the subject's performance on the different test items is provided. The results of the exploratory assessment of two subjects on the Developmental Test for Visual Perception –Second Edition (DTVP-2) then will be presented. The chapter will close with formal answers to the two research questions posed on page four.

Overview of the Results of the M-ABC

The score of most value on the M-ABC is the Total Motor Impairment score (TMI), which is a summary of performance on the test as a whole. It is the sum of scores from the eight subtests performed by the children. The Total Motor Impairment score is then also interpreted in terms of percentile norms and age-related standards, which are easily used and understood (Henderson & Sugden, 1992).

The M-ABC Test scores are calculated as follows: a good performance TMI score is 0 and a poor TMI score is 5. The Pre- and post-test percentile scores for all subjects are presented in Figure 1. Henderson and Sugden (1992) suggest that children who scored below the 5th percentile should be considered as suggestive of a definite motor problem. The subjects who scored between the 5th and 15th percentile are considered as borderline. Intervention for these children should be considered, depending on the impact their poor motor skills have on their overall development and the resources available. For this study, it was decided to include children who scored below the 16th percentile in the pre-test for the purposes of this study.

The TMI pre- and post-test scores for these subjects are presented in Figure 2. Most of the children's post-tests indicate improvement in terms of percentile scores. Some of these children as we will see performed weaker in certain individual subtests, but their TMI scores indicate improved performance. Then there are children who divert from this pattern and their test results did not show an improvement.

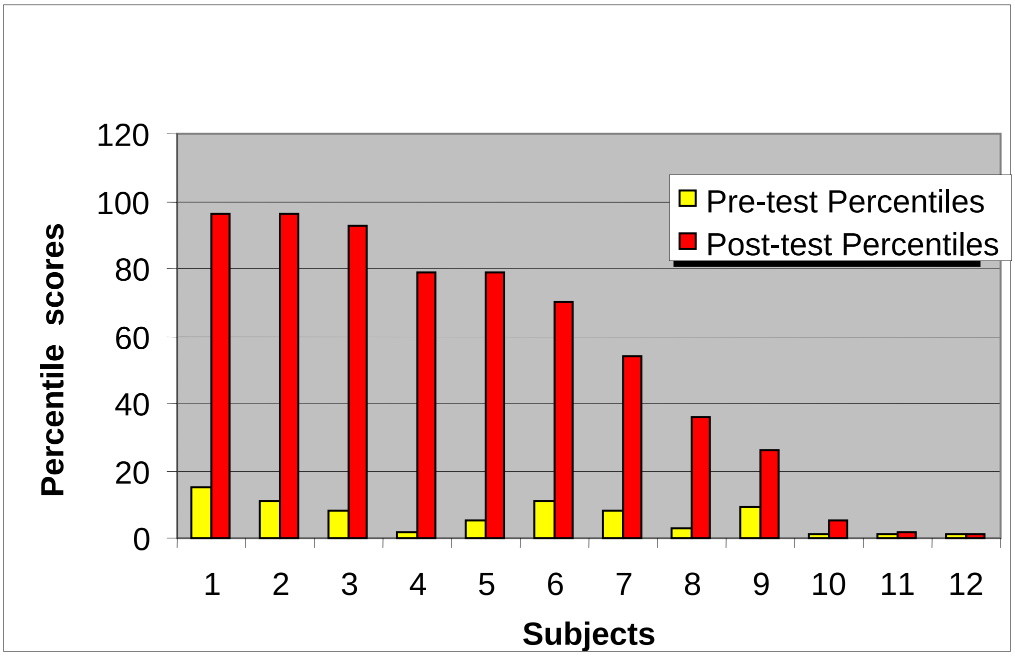


Figure 1

Pre- and Post-test Percentile Scores on the M-ABC.

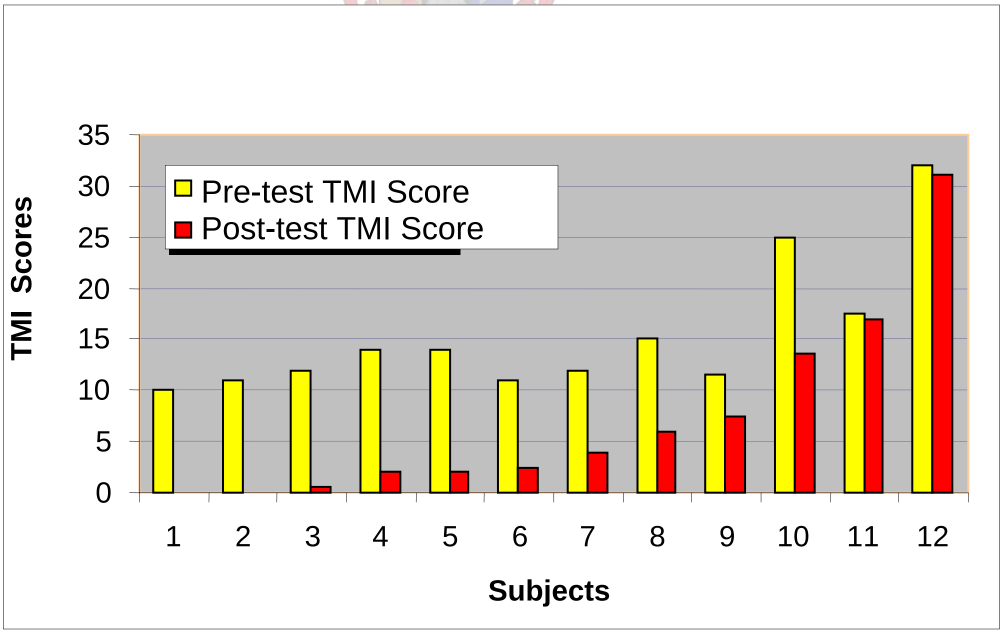


Figure 2

Pre- and Post-test TMI Scores based on the M-ABC.

Clusters of Results on the M-ABC

Based on an observation of the patterns in the pre- and post-test scores, the results of the subjects can be organized into one of three clusters. The case study style will be used within these clusters in order to facilitate a discussion of the results.

- The first category of children includes those who improved from very poor performance on the M-ABC pre-test (from the 8-15th percentile to the 93-96th percentile). This improvement in performance score on the M-ABC Test is consistent for three of the subjects tested.

- The second category has two sub-groups:

  Group One: Three children who performed very poorly on the pre-test (5th to the 11th percentile) and improved their performance on the post-test. Their post-test percentile scores were between 70 and 79.

  Group Two: Three children who performed very poorly on the pre-test (3rd to the 9th percentile) and improved their performance on the post-test. The post-test percentile scores for these children were between 26 and 54.

- The third category of children performed very poorly in the pre-test (the 1st percentile), and the post-test scores indicated a very slight improvement. The three children in this category made very little improvement in the TMI post-test scores of the M-ABC.

Category One: Subject 1, Subject 2 and Subject 3

The children in this category performed at the 15th, 11th and 8th percentile on the pre-test and were therefore classified as borderline cases. On this basis they were included in the intervention program (see Table 2).

Table 2. Pre- and Post-test TMI Scores of Subjects 1, 2 and 3

Subtests	Subject 1		Subject 2		Subject 3	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Subtest 1: Manual dexterity	1.5	0	0	0	1	0.5
Subtest 2: Manual dexterity	4	0	1	0	3	0
Subtest 3: Manual dexterity	0	0	0	0	0	0
Subtest 4: Ball skills	4.5	0	5	0	4	0
Subtest 5: Ball skills	0	0	0	0	4	0
Subtest 6: Static balance	0	0	0	0	0	0
Subtest 7: Dynamic balance	0	0	5	0	0	0
Subtest 8: Dynamic balance	0	0	0	0	0	0
Total (TMI)	10	0	11	0	12	0.5
Percentiles	15	96	11	96	8	93

Subject 1 Pre-test

Subject 1 experienced problems with manual dexterity tasks of peg placing and threading of beads and the ball skills catching task. Performance was varied on the manual dexterity tasks. Poor performance on the first two manual dexterity tasks and excellent performance on the third task, i.e. the bicycle trail, was recorded. On the ball skills tasks, performance was also varied with very poor performance on the first task, i.e. one hand bounce and catch and excellent performance on the second task, i.e. throwing the beanbag into a box. He performed very well on all three balance tasks, i.e. stork balance, jumping in squares and heel-to-toe walking. The TMI pre-test score of Subject 1 was 10 points which placed him on the 15th percentile.

Subject 2 Pre-test

The areas of poor performance for Subject 2 were threading beads, a manual dexterity task, beanbag catch, a ball skills task and jump over cord, a dynamic balance task. He performed very well on the manual dexterity tasks and varied performance on the ball skills and balance tasks. One ball skills task, rolling a ball into a goal, was performed with proficiency and the other task, catching a beanbag, was done very poorly. The same can be said of the balance tasks, excellent performance on two tasks, i.e. walking heels raised and one leg balance, and very poor performance on one dynamic balance task, i.e. jumping over cord. The TMI pre-test score of Subject 2 was 11 points which put him in the 11th percentile on the M-ABC Test.

Subject 3 Pre-test

Performance of Subject 3 on the manual dexterity tasks were varied with excellent score in one task, the bicycle trail and difficulties were experienced in the other manual dexterity tasks, that is, in peg placing and the threading of beads. Both ball skills tasks were performed poorly, i.e. ball catch activities and throwing the beanbag into the box. The three balance tasks, i.e. stork balance, jumping in squares and heel-to-toe walking were performed with excellence. Her TMI score for the pre-test was 12 points which puts her in the 8th percentile on the M-ABC Test.

Discussion of the Post-test Results for Subjects in Category One

In the post-test, these subjects performed much better with only Subject 3 exhibiting minor difficulties in the manual dexterity peg placing task. A possible reason for this could be that she has not yet established the use of the pincer grip to pick up the pegs. She had a very odd way of holding the pegs, i.e. using the middle finger at times and the index finger is not involved in the movement. This pattern of not using the index finger is also evident when she does pen-and-paper activities. The TMI scores for these subjects were 0.5 for subject 3 and 0 for Subjects 1 and 2. The post-test percentile scores for these children are excellent, at the 93rd, 93rd and 96th percentiles respectively. A few questions come to mind when the results are viewed:

- Did the intervention program improve these children's performance to such a degree that they are no longer considered as DCD?
- Is the improved performance as a result of true improvement in motor skills and can it be assigned to the cognitive skills learned?

Background of the Subjects in Category One

Subject 1 was a full-term baby weighing 3.6kg. It seems as if this subject enjoyed all the activities in the intervention program. Subject 1 particularly enjoyed the ball skills and more gross motor skill activities and always wanted to spend more time on it. The author noticed improvement in his performance a few weeks before post-test measurements were taken.

The gestation period of Subject 2 is unknown to the investigator because contact with his biological mother was not possible and the note that went home, requesting this information, was never returned. Subject 2 lives with the parents of his father for most of the time, but his mother's parents also have him in their care at irregular intervals. He does not have contact with his mother. His father works at sea and he does not see him regularly. His teacher expressed her concern about negative influences that he might be exposed to when with his regular caregivers. This, she suggested, could be related to some degree of behavioural problems he experiences.

Subject 3 was a premature baby, born at 36 weeks and weighed 3.05kg. Subject 3 is a very lively and talkative child. She was always an active participant in all activities throughout the intervention program. Subject 3 did not find talking aloud difficult and it seemed to help her think about the movement before execution, which seemed to result in improved performance.

Category Two Sub-Group One: Subject 4, Subject 5 and Subject 6

The children in this group performed at the 5th, 5th and 11th percentile on the pre-test of the M-ABC Test.

Table 3. Pre- and Post-test TMI Scores of Subjects 4, 5 and 6

Subtests	Subject 4		Subject 5		Subject 6	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Subtest 1: Manual dexterity	3.5	1.5	0	0.5	1	1.5
Subtest 2: Manual dexterity	2	0	4	0	0	1
Subtest 3: Manual dexterity	0	0	0	0	0	0
Subtest 4: Ball skills	5	0.5	4	1	3	0
Subtest 5: Ball skills	3	0	1	0	1	0
Subtest 6: Static balance	0.5	0	0	0.5	0	0
Subtest 7: Dynamic balance	0	0	0	0	3	0
Subtest 8: Dynamic balance	0	0	5	0	3	0
Total (TMI)	14	2	14	2	11	2.5
Percentiles	5	79	5	79	11	70

Subject 4 Pre-test

The performance of Subject 4 on the manual dexterity tasks was varied with very poor score in the first task, placing pegs and excellent score in the third task, the flower trail. Both ball skills tasks, i.e. one hand bounce and catch and the throwing a beanbag into a box task were performed poorly. Balance tasks were performed much better with excellent scores in the two dynamic balance tasks, i.e. jumping in squares and heel-to-toe walking and performance on the static balance, the stork balance was slightly poorer. Her TMI score was 14 points and this puts her in the 5th percentile of the M-ABC Test.

Subject 5 Pre-test

Subject 5 performed poorly on one manual dexterity task, i.e. threading beads and well on the other two manual dexterity tasks, i.e. the posting of coins and the bicycle trail tasks. Performance was very poor on one of the ball skills tasks, i.e. the catching beanbag task and performance on the other ball skills task, rolling a ball into a goal was much better. Performance on the static balance, the balance on one leg task and one dynamic balance task, the jumping over cord was very good. However, performance on the other dynamic balance task, the walking heels raised, was very poor. The TMI score for Subject 5 was 14 points, which placed him in the 5th percentile.

Subject 6 Pre-test

Subject 6 performed well on the manual dexterity tasks, i.e. the posting of coins, threading beads and the bicycle trail tasks and poorly on the ball skills tasks, catching a beanbag and the rolling the ball into a goal. The balance tasks, one leg balance, jumping over cord and the walking heels raised was performed poorly on the pre-test. Subject 6 had a pre-test TMI score of 11 points, which placed him in the 11th percentile.

Discussion of the Post-test Results for Subjects in Category 2 Sub-group One

The post-test performances of these children showed great improvements in scores. They improved on most of the test items, with Subject 4 improving on all the test items. Subjects 5 and 6, in fact, performed more poorly on two subtests. Subject 5 had a lower post-test score on subtest one, posting coins (manual dexterity) and sub-test six, one leg static balance activity. Subject 6 performed poorer in both manual dexterity tasks: subtests one and two, posting coins and the threading beads. The TMI post-test scores were 2 points for Subject 4, 2 points for Subject 5 and 2.5 points for Subject 6. The post-test percentile scores were 79 for subjects 4 and 5; and 70 for subject 6, which is very good.

The author proposes possible reasons for deterioration in selected post-test scores:

- The child was not as focussed on the task at hand as in the pre-test, which could suggest an attention problem, possibly associated with the movement problem.

- The poorer performance on manual dexterity tasks could be linked to the fact that the pincer grip has not yet been established and using their middle instead of the index finger could lead to increased time it takes them to perform the manual dexterity tasks.

There were numerous occasions during the intervention program when the children had to be reminded to *look* at where they wanted the ball or beanbag to go to, and that they needed to have their body in line with the target as well as positioning their feet properly. They were reminded during the program about:

During the intervention sessions the children were carefully observed. The children constantly had to be reminded to use the pincer grip for the pen and paper activities as well as for how they pick up the dizzy discs and for threading the discs. Cheatum and Hammond (2000) stated that children who need to correct a skill would need a lot of practise in this new way because new neurological pathways need to be established. The neurological pathways of the old (incorrect) way of holding the pencil should weaken in order for the child to fully adopt the new way of holding the pencil.

Category Two Sub-Group Two: Subject 7, Subject 8 and Subject 9

This group of children were among the weakest ones as the pre-test scores on the M-ABC Test shows (see Table 4). Their performance percentile scores were between the 3rd and 9th percentile. Very low pre-test scores were obtained on subtests two, four and seven.

Table 4. Pre- and Post-test TMI Scores of Subjects 7, 8 and 9

Subtests	Subject 7		Subject 8		Subject 9	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Subtest 1: Manual dexterity	0	1	1	0	1.5	1.5
Subtest 2: Manual dexterity	4	0	4	3	4	3
Subtest 3: Manual dexterity	0	0	0	0	0	0
Subtest 4: Ball skills	5	1	3	1	3	0
Subtest 5: Ball skills	3	2	2	0	2	3
Subtest 6: Static balance	0	0	2	0	1	0
Subtest 7: Dynamic balance	0	0	3	2	0	0
Subtest 8: Dynamic balance	0	0	0	0	0	0
Total (TMI)	12	4	15	6	11.5	7.5
Percentiles	8	54	3	36	9	26

Subject 7 Pre-test

Subject 7 performed with varied ability on the manual dexterity tasks, very poorly on one task, threading beads and excellent on the other two tasks, the posting of coins and the bicycle trail. Performance on the ball skills tasks, catching a beanbag and rolling the ball into goals were very poor. All three balance tasks were performed with proficiency, i.e. one leg balance, jumping over cord and walking with the heels raised. A TMI score of 12 points were obtained which indicate that performance was at the 8th percentile.

Subject 8 Pre-test

Performance on the manual dexterity tasks for Subject 8 were varied with a very poor score in one task, i.e. threading beads and better performance in the other task, i.e. posting coins and excellent performance in the third task, i.e. the bicycle trail. Her performance in both ball skills tasks, i.e. catching a beanbag and rolling the ball into a goal, was also poor. Performance on the balance tasks was also varied with poor performance on two tasks, the one leg balance and jumping over cord. She performed very well on the last balance task, i.e. the walking heels raised task. Subject 8 performed very poorly on the pre-test of the M-ABC Test. Her TMI pre-test score was 15 points which was in the 3rd percentile.

She experienced difficulty in several test items in the pre-test. For test item two, a manual dexterity task, she obtained a score of 4 points; and for test items four, a ball skills task, and seven, a dynamic balance task a score of 3 points were obtained for each test item. She scored 2 points for each of the activities in test item five, a ball skills task, and test item six, the static balance task. In test item one, a manual dexterity task, she scored 1 point and performed well, with a score of 0 in the remaining two test items, i.e. a manual dexterity task and the dynamic balance task of walking heels raised.

Subject 9 Pre-test

Performance of Subject 9 in the manual dexterity task scores was varied. Performance was poor and very poor performance on two tasks, i.e. the threading lace and the placing pegs tasks, and excellent performance on the third manual dexterity task, i.e. the flower trail. Both ball skills tasks were performed poorly, i.e. the one hand bounce and catch and throwing a beanbag into a box. Performance on the dynamic balance tasks was very good, i.e. heel-to-toe walking and jumping in squares. He performed slightly poorer on the static balance task, i.e. stork balance.

Subject 9 performed very well on three pre-test items, scoring 0 on subtests three (flower trail), seven (jumping in squares) and eight (heel-to-toe walking). His TMI score on the pre-test was 11.5, which indicates that performance was at the 9th percentile.

Discussion of the Post-test Results for Subjects in Category 2 Sub-group Two

The post-test scores for Subject 7 showed overall improved performance, with one exception. The score for subtest one, a manual dexterity task, i.e. posting coins was weaker by one point. His final TMI score in the post-test was 4 points and this indicates that performance was at the 54th percentile.

The post-test scores for Subject 8 showed relative improvement on all test items. On subtests one, five and six she scored 0, thus increasing her final score. Performance in subtests two, four and seven did not improve much. The manual dexterity task, of threading beads and the dynamic balance task, jumping over the cord, improved only by 1 point for each test item (see Table 4). Subtest four, the ball skills task to catch the beanbag, improved by 2 points. Her TMI post-test score on the M-ABC Test was 6 points which indicated an increase in performance to the 36th percentile.

The TMI post-test score for Subject 9 showed moderate increases in performance with a total of 7.5 points on the M-ABC Test. Test items that indicate huge improvements are the ball skills task of one hand bounce and catch and the static balance, stork balance task. In subtest two, manual dexterity (threading lace task) there was very little improvement, see table 4. Test item one remained unchanged, i.e. the manual dexterity task of placing pegs and test item 5, i.e. the ball skills task throwing beanbag into box, showed a decline in performance from 2 to 3 points. The overall performance of subject 9 improved to the 26th percentile on the M-ABC post-test.

The children in this group performed well below the post-test scores of the previous six subjects. It is noteworthy to mention here that Subjects 7 and 8 were very quiet and would happily work on their own. Subject 7 needed additional encouragement and affirmation to have several attempts at tasks during the intervention. During many sessions, Subject 7 would blatantly refuse guidance and assistance with most tasks.

Subjects 7, 8 and 9 were focussed and truly tried their best at all the activities during the intervention and the pre- and post-tests.

In addition to the possible reasons for poor performance presented in the sections above, the investigator noted another possible explanation: all three of their subjects were prematurely born at 28 and 36 weeks. Cheatum and Hammond (2000) noted that some children born prematurely may have coordination problems.

Background of Category Two Subjects

Subject 4 was a full-term baby, weighing 3.2kg. It seems as if she enjoyed all the activities in the intervention program. Subject 4 seemed a bit 'nervous' performing certain activities, however with enough encouragement she managed to perform to the best of her ability.

Two children, Subjects 5 and 8 are part of triplets. All three triplets were initially identified on the M-ABC Checklist, but only Subjects 5 and 8 showed movement problems on the M-ABC Test. They were born prematurely at 28 weeks and weighed 1.27kg and 700g respectively. Their class teacher has indicated her concern about their movement and academic achievement and the difficulty they have in changing into sport clothes for Physical Education and other skills normally performed by a Grade 1 child. At the end of the third term, she suggested that they might have to repeat Grade 1.

Subject 6 was adopted and lives with his adopted grandparents. The gestation period of Subject 6 is unknown to the investigator because contact with his biological mother was not possible and the note that went home, requesting this information never reached the author.

Subjects 7 and 9 were prematurely born at 36 weeks, Subject 7 weighed 2.24kg and this information is not known about subject 9 (The mother did not complete the information sheet). Subject 9 is a very lively and talkative child. He was always an active participant in all activities throughout the intervention program.

Subject 7 often seemed to be in his own world. He did not easily accept assistance with a task and would continue to do the task in an inappropriate manner. He particularly enjoyed using play dough, clay, “Where’s Wally” books and the "dizzy discs". He would very quietly get so involved in one activity and continue throughout the session. It was wonderful to see how he drew Subject 11 into the activity, creating models of birds and other animals with play dough and clay.

Category Three: Subject 10, Subject 11 and Subject 12

The children in this category performed very weakly in the pre-test and obtained percentiles that are at the bottom of the group. They obtained TMI scores of 25, 17.5 and 32 points respectively. These TMI scores fall in the 1st percentile for performance on the M-ABC Test.

Table 5. Pre- and Post-test TMI Scores of Subjects 10, 11 and 12

Subtests	Subject 10		Subject 11		Subject 12	
	Pre-test	Posttest	Pre-test	Posttest	Pre-test	Posttest
Subtest 1: Manual dexterity	5	5	0.5	3.5	5	5
Subtest 2: Manual dexterity	5	5	4	3	5	5
Subtest 3: Manual dexterity	0	0	0	0	0	0
Subtest 4: Ball skills	4	2	3	2	5	5
Subtest 5: Ball skills	2	0	5	5	5	5
Subtest 6 Static balance	3.5	1.5	0	0.5	3.5	4
Subtest 7: Dynamic balance	1.5	0	5	3	4.5	3
Subtest 8: Dynamic balance	4	0	0	0	4	4
Total (TMI)	25	13.5	17.5	17	32	31
Percentiles	1	5	1	2	1	1

Subject 10

The performance of Subject 10 in two manual dexterity tasks, i.e. placing pegs by rows and threading nuts on bolt, was extremely poor, but the third task, the flower trail, was executed very well. The ball skills tasks, i.e. two hand catch and throw a beanbag into a box, were also performed poorly. Performance on the balance tasks were also poor with the lowest score obtained on the first dynamic balance task, i.e. hopping in squares.

Subject 10 obtained a TMI score of 25 points and performed poorly on all the test items, except on subtest three, the manual dexterity task of the flower trail, where 0 points were scored. It seems as if the manual dexterity tasks, one and two, were very challenging because 5 points were scored on each of these subtests, i.e. the placing pegs by rows and threading nuts on bolt. Subtest four, a ball skills task, i.e. two hand catch and subtest eight, a dynamic balance task, i.e. ball balance, were also poorly executed whereby scores of 4 points were obtained on each of these subtests.

Performance on the static balance activity, one board balance was also very weak and 3.5 points were obtained in this subtest. Subtests five and seven, throwing the beanbag into the box and hopping in squares, also seemed difficult to perform for Subject 10. Scores of 2 and 1.5 points were obtained respectively.

Subject 11 Pre-test

The manual dexterity tasks of Subject 11 were executed with varied levels of competence: very poor performance on the second task, threading beads, and much better performance on the first, posting coins, and excellent performance on the third task, the bicycle trail. The ball skills tasks, catching a beanbag and rolling the ball into a goal, were executed very poorly. The balance tasks also showed very poor performance on the first dynamic balance task, i.e. jumping over cord, and excellent performance on the static balance task, the one leg balance and last dynamic balance task, i.e. the walking heels raised.

Subject 11 performed well on subtest three, the manual dexterity task, bicycle trail, subtest six the one leg balance task and subtest eight, the dynamic balance task of walking heels raised, scoring 0 on these pre-test items of the M-ABC Test. Performance on the remaining five pre-test items was weak. The total score on the M-ABC pre-test was 17.5 points and this indicates performance was at the 1st percentile for the pre-test.

Subject 12 Pre-test

Pre-test scores for Subject 12 showed very poor performance on two manual dexterity tasks, i.e. the placing pegs by rows and threading nuts on bolt and very good performance on the third manual dexterity task, i.e. the flower trail. There seems to be a similar pattern in the performance on the manual dexterity tasks of subject 10 and 12.

The ball skills tasks for Subject 12, i.e. the two-hand catch and the throwing a beanbag into a box, were performed very poorly. All the balance skills were performed poorly with the static balance task, the one board balance, slightly better performed when compared with the dynamic balance scores, i.e. the hopping in squares and the ball balance tasks. Subject 12 performed poorly on the pre-test in subtests one, two, four and five, obtaining scores of 5 points in each of these subtests. Subtests seven and eight, the dynamic balance tasks, were also performed with difficulty. Scores of 4.5 and 4 points were obtained in these subtests respectively. A score of 3.5 points were obtained in subtest six for the static balance, the one board balance task. Subject 12 performed the best in subtest three, the manual dexterity task of the flower trail and a score of 0 was obtained. Her total points on the M-ABC pre-test were 32, which placed her in the 1st percentile.

Discussion of the Post-test Results for Subjects in Category 3

The post-test TMI score for Subject 10 did not show much improvement. There was an improvement on subtests four, five, six, seven and eight. Scores on subtests one and two, the manual dexterity tasks of placing pegs by rows and threading nuts on the bolt, remained very poor at 5 points each. Her final TMI score on the M-ABC post-test was 13.5 points. An improvement from the 1st to the 5th percentile does not imply improvement

For Subject 11, performance on the post-test of the M-ABC test showed there was a slight improvement in performance on subtests two, four and seven (manual dexterity threading beads, ball skills catching a beanbag and dynamic balance of jumping over cord) to scores of 3, 2 and 3 points respectively. Subject 11 performed well on subtests three and eight, a manual dexterity task the flower trail and a balance task, the walking heels raised in the post-test where a score of 0 was obtained in both test items.

Subject 11's score on subtest five, the ball skills task, i.e. rolling the ball into a goal, remained unchanged and weak at 5 points. Results of subtests one, posting coins a manual dexterity task and six, the static balance task of one leg balance, shows a decline in performance with test item scores of 3.5 points up from 0.5 point for subtest one and 0.5 up from 0 for subtest six on the post-test for the M-ABC Test. The TMI post-test score for subject 11 was 17 points. Subject 11 did not make any real improvement in post-test scores and remains in the bottom three of the group (N=12) tested and at the 2nd percentile.

The TMI post-test scores for Subject 12 did not show much improvement (see Table 5). Five of the subtest scores remained unchanged. These are subtests one, two, three, four, five and eight. The one board, static balance activity, subtest six showed a decrease in performance and a score of 4 points was obtained. There was an increase in performance in subtest seven, the dynamic balance activity, hopping in squares from 4.5 to 3 points. Her overall performance on the post-test did not improve much, see figures 3 and 4. The final TMI score for subject 12 was 31 points on the M-ABC Test and performance remain on the 1st percentile.

The post-test results of Subjects 10, 11 and 12 show a definite deviation from the pattern of consistent improvement seen across the final scores of the previous nine test subjects. It seems as if these subjects made no improvement after an eight-week motor and cognitive development intervention program.

- Subject 10 has an obesity problem and physical participation in most of the activities seemed to be problematic for her. The slight improvement that she made could be attributed to a learning effect and perhaps the implementation of the cognitive skills (G-P-D-C) taught during the intervention program.

- In observing Subject 11 during the intervention program and also during the pre- and post-test of the M-ABC, it seemed that he found it difficult to concentrate on the tasks at hand. He would start a task and attempt, for example, to hit a target, but his body position would not be in line with the target and his eyes would not be on the target. When there are others are around, he would look around and find something funny or just look at what the others are doing and totally miss the target. During the times when he was focussed, and reminded about the plans (the G-P-D-C cognitive strategies) he had to make, he could execute the tasks with greater success. As stated before, the investigator maintains that Subject 11 should ideally receive individual intervention or in a very small group, with no more than three children in the group.

- The observations made about the performance of Subject 12 on the M-ABC Test and during the intervention program were that she seemed to be focused, but at times also wanted to rush through the activities. However, most of the time she really tried her best at the tasks presented to her. It also seemed as if she understood the cognitive strategies of G-P-D-C taught during the intervention sessions. At the times when she seemed to rush through the tasks, it was clearly noted that the rate of success at attempts was badly compromised. Her eyes would not be on the target or the task to be executed and the entire movement it seemed would be executed in a very awkward way. For example, when attempting to throw a ball at a target, her feet would not be in position with the right foot in the front, as she throws with the right hand and she may or may not even look at where she is throwing the ball to at the time she swings the arm back and when she releases the ball.

The post-test scores for Subject 12 may have been influenced by two additional factors that were not under control of the investigator:

- The noise level seemed to be higher outside the room where we did the post-tests. This could have influenced her ability to perform better on the post-test.
- She seemed a little rushed in executing the tasks and it seemed that concentration levels were much lower than during the pre-test.

The investigator did consider re-testing Subject 12, based on the observed obviously lowered concentration levels. However, a decision against re-testing was reached because the author did not want to interfere by manipulating test conditions. In all situations of testing, it must be noted that there are so many factors that might influence children's performance and test results. Henderson and Sugden (1992) suggested that the examiner should be aware of the children losing interest quite suddenly. Some of these factors, the author of this study propose, may include the mood of the child at the time of testing, noise level or even whether the child is hungry. Henderson and Sugden (1992) recommended that whenever it seems as if performance is weakening, a break should be given and testing should continue on another day.

In the opinion of the investigator, Subject 12 showed a good understanding of the G-P-D-C cognitive strategies and was able to recall all the plans made in order to execute a plan more successfully. She showed genuine increased levels of concentration and always tried her best at the activities during the intervention program.

Background of Category Three Subjects

The investigator of this study found it appropriate to provide additional background information on the three subjects that performed the poorest in the pre- and post-tests on the M-ABC Tests. In the light of this information, we might gain a better understanding of their performance on the M-ABC Tests and why improvement was problematic.

Subject 10 was a full term baby and born at 40 weeks, weighing in at 3.13kg. She is the second child in the family. She is overweight for her height and age. Being overweight made several of the activities in the M-ABC Test and the intervention program difficult to execute. She was not diagnosed with diabetes or any other condition that would prevent or interfere with participation in the M-ABC Test or the intervention program. Her mother gave informed consent for her to participate in the M-ABC Test and the intervention program. During informal interviews with her class teacher, it became clear that she has a learning problem in addition to the movement problem that was identified by the M-ABC Checklist and Test. At the end of the third term, the teacher expressed her concern that Subject 10 might have to repeat Grade 2.

The investigator would like to propose that the movement problem is directly as a result of being overweight, but at the same time caution should be exercised not to label too quickly and the link between DCD and learning problems should not be disregarded. However, when one looks back at activities that does not require gross muscle involvement, it seems as if there are underlying factors, unknown to the author and that does not fall in the scope of this study, which could be responsible for poor performance on the M-ABC Test. Subject 10 cooperated well on all activities, but clearly preferred activities that did not require too much movement. She particularly enjoyed doing play dough, clay and pen-and-paper activities.

Subject 11 is an only child, born at full-term (40 weeks) and weighing in at a healthy 3.5kg. No prenatal or postnatal complications were reported. He comes from a dysfunctional family, where the father works in another city and he sees him occasionally (not on a regular basis). His mother does not play a role in his upbringing and he lives with his grandparents. He enjoys spending time with his dad and on the weekends he saw his dad, he could not stop talking about him and cooperation and active involvement in the intervention program was higher. Throughout the program he had to be encouraged much more than any other subject, to attempt and to participate in the activities. Certain activities where he knows he is not good at, he would simply refuse to attempt although several other subjects also could not do them. Only with lots of encouragement he would attempt the activities and at times, successful execution would occur, which was followed by lots of praise and big smiles on his face. He would then generally continue because he experienced success and accomplishment.

The investigator found that an intervention program for Subject 11 should take place individually or in a very small group. The group should not consist of more than three children. The reason for this is that he requires a lot of individual attention and he is prone to get distracted quite easily. He is not on any medication and never received medication for problems with attention.

Subject 12 was born prematurely at 26 weeks and weighed 750g. She is one of twins (the other one did not survive at 610g). There were postnatal complications due to the early birth and drugs were administered to strengthen her lungs. No brain damage or neonatal lesions were reported and today she is a normal ten-year old. She is the oldest of three siblings and physically smaller than the average ten-year old girl. Due to the medication received as a neonatal infant, she developed a slight squint in one eye. She wears corrective lenses to assist in the realignment of the eye muscles.

When the initial screening took place she was in Grade Three. The previous year she changed schools and after an academic assessment it was found that she should be placed in Grade 3. After a few days it was found that she did not cope well in grade three and she was subsequently placed in Grade 2. Therefore, she is one year older than her peers for Grade 3. Not formally diagnosed as ADHD, but on the request of her class teacher, she was placed on Ritalin during school hours. The dosage of Ritalin was low enough to be ineffective by the end of the school day.

According to the class teacher, the Ritalin helped her to focus better in class and her academic performance improved above expectation. Her parents were initially very sceptical about the use of this drug, but they weighed the observed benefit up against perceived negative reports they have read about the drug. She did not receive any drugs before any of the intervention sessions nor prior to the pre- and post-tests.

Subject 12 received individual intervention, due to the fact that she was the only one at her school involved in the program and she was available for the prescribed time after school to be involved in the program. She is a lively ten-year old and would, despite her coordination difficulties and contrary to the norm, eagerly participates in physical activities. However, when she is put under the spotlight, she would rather not attempt after initial failure. This is understandable because her peers would sometimes become impatient and exclude her from a team game or hardly pass the ball to her. During observation of several of her Physical Education lessons, it seemed as if she started to slow down and not rush the execution of tasks in order to be more successful, especially in target activities. The greater success rate brought about increased levels of competence and big smiles to her face. External motivation from the teacher and peers also contributed to higher rates of success.

Discussion According to Test Items

Manual Dexterity Tasks

The tasks on subtest one of the M-ABC Test, manual dexterity tasks of placing pegs, placing pegs by rows and threading nuts on bolt, were executed with varied levels of proficiency. Subjects 10 and 12 scored very poorly on this test item in the pre- and post-test. A possible reason for this could have been that more cognitive involvement was called for by these tasks than by others on the test. That is, the task of placing the pegs by rows, needed more planning instead of just placing the twelve pegs in three rows, irrespective of the order in which it is done. Another reason could have been that the children sometimes push the pegs in too deeply and then struggle a bit to get them out. This automatically leads to an increase in the performance time on the task. Of course, pincer grip is of vital importance when such a manual dexterity task requires speed and accuracy. It is noteworthy to mention here that these two subjects had not yet established proper use of the pincer grip in such manual dexterity activities. The same was true for Subjects 1, 3, 4,5,7,8 and 9 with regard to the awkward manner in which the objects were held when it is clear that the pincer grip would be the obvious choice (but not for these children). It seems as if these children have established this odd way of holding a pencil or other objects and that the pincer grip does not occur "naturally". Four subjects performed poorer on the post-test of this first manual dexterity task. These were Subjects 5, 6, 7 and 11.

The second manual dexterity task, threading- nuts and bolt, lace or beads, showed initial difficulty and only Subject 6 performed well in this subtest. Subject 6 was the only one that performed poorer in the post-test of this subtest. A possible reason for the poorer post-test scores in the first two manual dexterity tasks, i.e. posting coins and threading beads, could be that he was attempting to do the tasks as quickly as possible and compromised accuracy. The author of this study propose this assumption because during intervention and the M-ABC pre- and post-tests, it seemed as if he was quite competent in using the pincer grip for writing tasks and other tasks that required the use of the index finger and thumb. All other subjects, with the exception of Subjects 10 and 12, performed better in the post-test of the second manual dexterity task.

The third manual dexterity task, bicycle or flower trail did not have a time factor involved. Thus, the children could take their time to complete this subtest. From the results on this subtest, it shows that the children performed much better if they were not told to execute a task as quickly as possible. With increased pressure to execute a task as quickly and accurately as possible, success on the tasks seems to be compromised.

Eye-hand Coordination Tasks

The fourth subtest, the ball skills task that involved either catching a beanbag, one hand bounce and catch or a two-hand catch all the subjects improved performance on this task, except for Subject 12. During the intervention program, Subject 10 found several gross motor activities quite challenging and less time was therefore spend on these, with the result that those activities such as catching and throwing and other fine motor skills received more attention. This may explain her satisfactory performance on this test item. Subject 10 is overweight and found quite a number of activities physically and emotionally stressful. The author had to exercise caution with regard to her breathlessness and the physical limitations that is as a direct result of the excess weight.

Throwing/aiming Tasks

In subtest five, a ball skills task of throwing the beanbag into the box, Subject 9 performed weaker on the post-test. This could be due to rushing to get as many beanbags into the box, at the expense of accuracy. Throughout the intervention program the children were constantly reminded to *look* at where they want the ball or beanbag to go to and to talk themselves through the movement, that is, applying the cognitive strategies of G-P-D-C. At several sessions, the tempo of the activities had to be slowed down because the rate of accuracy seemed to be compromised.

Subjects 11 and 12 showed no improvement on their post-test percentile scores. These two, the investigator suspects, could have underlying co-morbid factors that interfere with their ability to focus and pay attention to the task at hand. It is thus proposed that these two subjects could also display symptoms of ADHD. As it was noted earlier, co-morbidity is the rule rather than the exception as Kaplan et al. (1998) found, that children who are DCD often have other symptoms, such as ADHD and or a Learning Problem. Henderson and Henderson (2002) noted that some children with ADHD may appear as if they are DCD because of their inattentiveness. This is directly linked to the inability to perform motor tasks. The parents of Subject 12 have expressed their awareness that she displays symptoms of ADHD. The author of this study suspect that Subject 11 might also fall in this group. Personal observation by the author and the class teacher of Subject 11 has acknowledged the symptoms of ADHD displayed by him. It is interesting to note that both these subjects are described as 'quite intelligent' by their educators and caregivers. It is said that they perform above average on several academic tasks.

Static Balance Tasks

Performance on subtest six, the static balance task, i.e. one leg balance or stork balance or one-board balance seemed less difficult for most subjects in the post-test. Subjects 5, 11 and 12 performed weaker in the static balance task during the post-test. Subject 5 improved overall performance in the post-test and such a very low; 0.5 point decline in subtest six, i.e. the static balance task and subtest one, i.e. the manual dexterity task, can perhaps be attributed to brief decreased moments in attention.

Dynamic Balance Tasks

The result of subtest seven, a dynamic balance task of jumping over cord, jumping in squares or hopping in squares, is the only task that indicates an improvement in performance for Subject 12. Perhaps there could be a learning effect that can be observed in this post-test score. However, Subject 12 did indicate her willingness to verbally guide herself through several movement activities during the intervention program. It is possible that she used the cognitive skills of G-P-D-C taught during the intervention program or she was simply more focused on the task at hand. It would be interesting to test this subject again to draw further conclusions.

Subject 11 also showed improvement on this test item, from 5 to 3 points. He was not so eager to guide himself verbally through the movement tasks, when compared to subject 12. It is therefore suggested that subject 11 was more focussed on the task at hand and perhaps remembered to *look* at what he was doing and consequently controlled the jump better than in the pre-test.

Subject 8 also slightly improved performance on this subtest and she obtained a score of 2 points. All other subjects performed well on the post-test and scored 0 points each. The improvements in performance on this subtest could be attributed to the positive influences of the perceptual-motor intervention program in conjunction with the cognitive approach.

Subtest eight, a dynamic balance task of walking heels raised, heel-to-toe walking or ball balance task is the only subtest that showed a huge improvement in the post-test results of Subjects 5, 6 and 10. This subtest continued to be challenging for subject 12, her score remained at 4 points.

Results and Discussion of the DTVP-2

The two subjects that were pre- and post-tested on the DTVP-2 were Subjects 10 and 12. Their raw scores indicate the total number of points that they earned on each subtest. The raw scores were then converted to standard scores and percentiles (Hammill et al. 1993). A comparison between subtests can be made when standard scores are used. Composite quotients were found to be the most reliable measure of the DTVP-2 Test because it is composed of several representative subtests (Hammill et al. 1993).

Subject 10

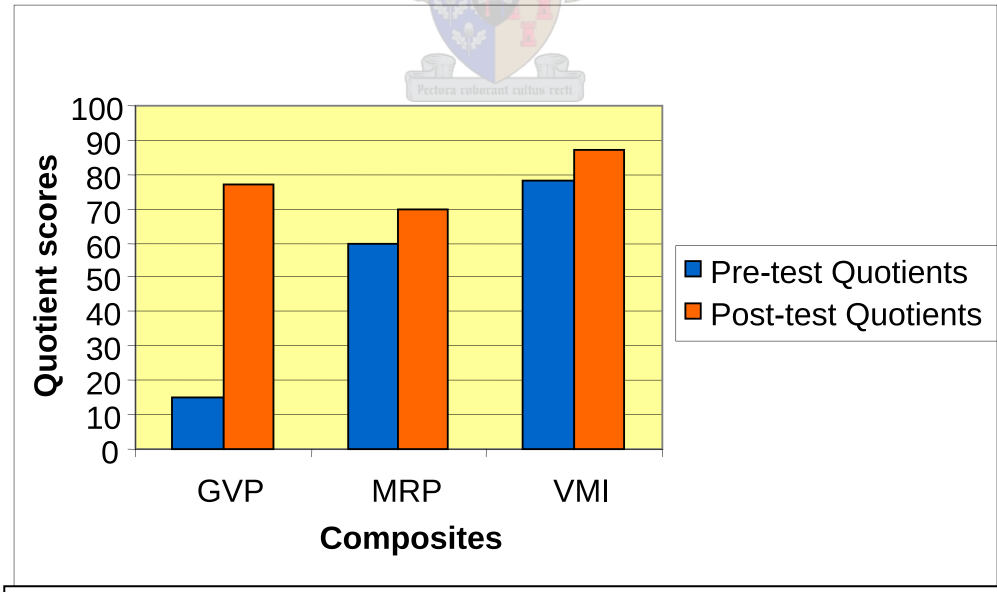
Pre- and post-test results of Subject 10 are presented on Tables 6 and 7. Figure 3 provides a graphic presentation of the pre- and post-test composite quotients and Figure 4 illustrates a comparison of pre- and post-test percentiles.

Table 6: DTVP-2 Pre- and Post-test Scores for Subject 10

Subtest		Percentile		GVP		MRP		VMI	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	Eye-Hand Coordination	63	75	11	12			11	12
2	Position in Space	0	1	1	3	1	3		
3	Copying	16	37	7	9			7	9
4	Figure-Ground	25	9	8	6	8	6		
5	Spatial Relations	1	9	3	6			3	6
6	Visual Closure	0	5	1	5	1	5		
7	Visual-Motor Speed	9	5	6	5			6	5
8	Form Constancy	9	8	6	8	6	8		
	Standard Scores Sum			43	54	16	22	27	32

Table 7. DTVP-2 Pre- and Post-test Composite Scores for Subject 10

Composite	Quotients		%tiles	
	Pre	Post	Pre	Post
General Visual Perception	15	77	<1	6
Motor Reduced Visual Perception	60	70	<1	2
Visual-Motor Integration	78	87	7	19



GVP= General Visual Perception; MRP= Motor Reduced Visual Perception & GVP= General Visual Perception.

Figure 3

DTVP-2 Pre and Post-test Quotients for Subject 10

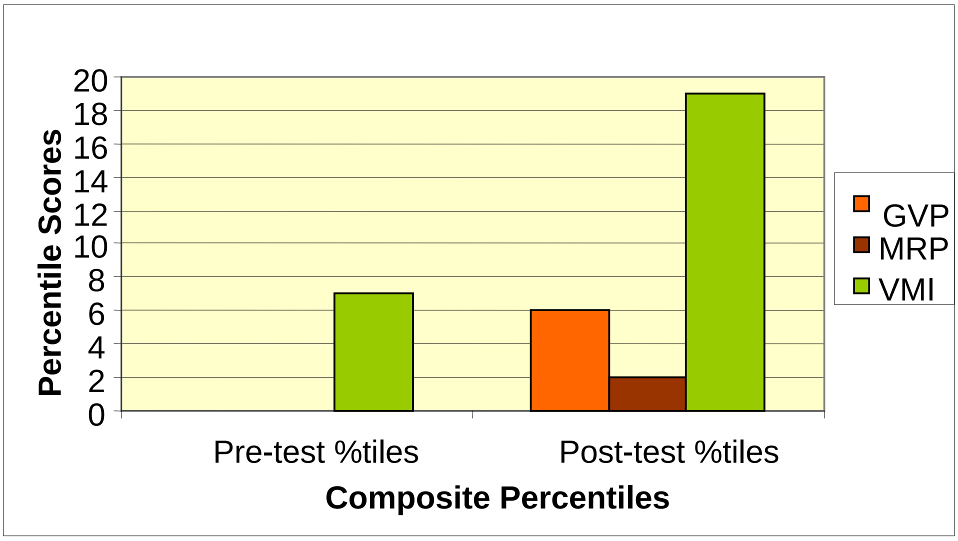


Figure 4

DTVP-2 Pre and Post-test Percentiles for Subject 10

In terms of Visual Motor Integration (VMI), Subject 10 achieved her best pre-test score on the eye-hand coordination task. She obtained the highest percentile (63) for this subtest. The second VMI subtest standard score for copying was performed below average and a score of 7 was obtained. Performance was at the 16th percentile**.** The third VMI task, spatial relations, was performed very poorly and a subtest standard score of 3 was obtained. Performance for this subtest was at the 1st percentile. The fourth VMI subtest standard score obtained for the visual motor speed task was 6. Performance was below average and at the 9th percentile. Composite scores for Visual Motor Integration was poor, a quotient of 78 and performance at the 7th percentile was obtained.

In the Motor-Reduced Visual Perception tasks, the best score was obtained for the figure ground activity. She obtained a subtest standard score of 8 (the 25th percentile). In the first and third subtests of the MRP tasks, position in space and visual closure, her subtest standard score was 1 for both tasks. Performance was very poor and she scored 0 percentile on these tasks. In the fourth subtest of the MRP tasks, she obtained a subtest standard score of 6, which is below average, and performance was at the 9th percentile. Composite scores for MRP were very poor, a quotient of 60 was obtained and performance was below the 1st percentile.

The General Visual Perception of subject 10 was very poor on the pre-test. Her composite score was 15 and performance was below the 1st percentile. Although minor improvement may be noted on the post-test, overall performance remained poor. MRP performance improved to a quotient of 70, which is poor and at the 2nd percentile. VMI composite score improved very little to the 19th percentile and a composite quotient score of 87 was obtained. Performance on the post-test VMI composite was below average. Her General Visual Perception was poor with a quotient score of 77 and performance at the 6th percentile. The post-test percentile that remained high and improved by 12 percentiles to the 75th percentile is the subtest for eye-hand coordination. The subtest of copying also shows an improvement to the 37th percentile, up by 21 percentile points. The last subtest, form constancy, also shows an improvement to the 25th percentile, up by 16 percentile points. The subtest of figure-ground, shows a decrease in subtest standard score of 6, down two points to below average performance and at the 9th percentile. Her spatial relations subtest standard score improved slightly, to a score of 6. Performance is below average for this subtest. Performance on the visual closure subtest standard score was up from a score of 1 to 5. Visual closure subtest standard score decreased by one to a score of 5. This translates to a decrease from the 9th percentile to the 5th percentile. Her post-test General Visual Perception composite score was poor at 77 and performance was at the 6th percentile.

It was hoped that Subject 10 would perform much better, because the type of activities in the DTVP-2 test items does not require gross motor physical activity (required in the M-ABC test and the intervention activities) which was clearly problematic to execute, due to her weight problem. Her post-test VMI quotient indicates an increase of 9 points and an increase of 12 percentile points. The post-test MRP quotient indicate an increase of 10 points which, when converted to percentiles, is on the 2nd percentile. The greater increase in the VMI quotient is responsible for a score of 6 percentile points on the General Visual Perception of the post-test.

It seems as though Subject 10 may have general visual perceptual problems associated with the identified DCD. Problems in visual perception could also have serious implications for academic learning. The teacher of Subject 10, as stated before, has indicated her concern about the learning problems experienced by Subject 10 and that she might have to repeat a grade.

Subject 12

Pre- and post-test results of Subject 10 are presented on Tables 8 and 9. Figure 5 provides a graphic presentation of the pre- and post test composite quotients and Figure 6 illustrates a comparison of pre- and post-test percentiles.

Table 8. DTVP-2 Pre- and Post-test Scores for Subject 12

Subtest		Percentile		GVP		MRP		VMI	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	Eye-Hand Coordination	37	25	9	8			9	8
2	Position in Space	37	25	9	8	9	8		
3	Copying	63	37	11	9			11	9
4	Figure-Ground	95	75	15	12	1	12		
5	Spatial Relations	9	75	6	12			6	12
6	Visual Closure	50	5	10	5	10	5		
7	Visual-Motor Speed	9	5	6	5			6	5
8	Form Constancy	63	50	11	10	11	10		
	Standard Scores Sum			77	69	45	35	32	34

Table 9. DTVP-2 Pre- and Post-test Composite Scores for Subject 12

Composite	Quotients		Percentiles	
	Pre	Post	Pre	Post
General Visual Perception	97	90	42	25
Motor Reduced Visual Perception	108	92	70	30
Visual-Motor Integration	87	90	19	25

For Subject 12, below average scores were earned for all VMI tasks (scores of 9, 11, 6 and 6 were obtained respectively). Among the VMI tasks, the highest percentile score obtained was for copying, where performance was at the 63rd percentile. Performance on the eye-hand coordination subtest was at the 37th percentile. Composite score for Visual Motor Integration quotient is 87 and performance was at the 19th percentile.

Subtest standard scores for MRP shows performance scores of 9, 15, 10 and 11 for subtests two, four, six and eight respectively. Position in space results indicated performance at the 37th percentile, and figure-ground perception indicated performance at the 95th percentile, which is superior performance. Performance on visual closure showed a percentile score of 50 and the subtest on form constancy indicated performance at the

63rd percentile. Composite scores for the MRP were at a quotient score of 108 (the 70th percentile).

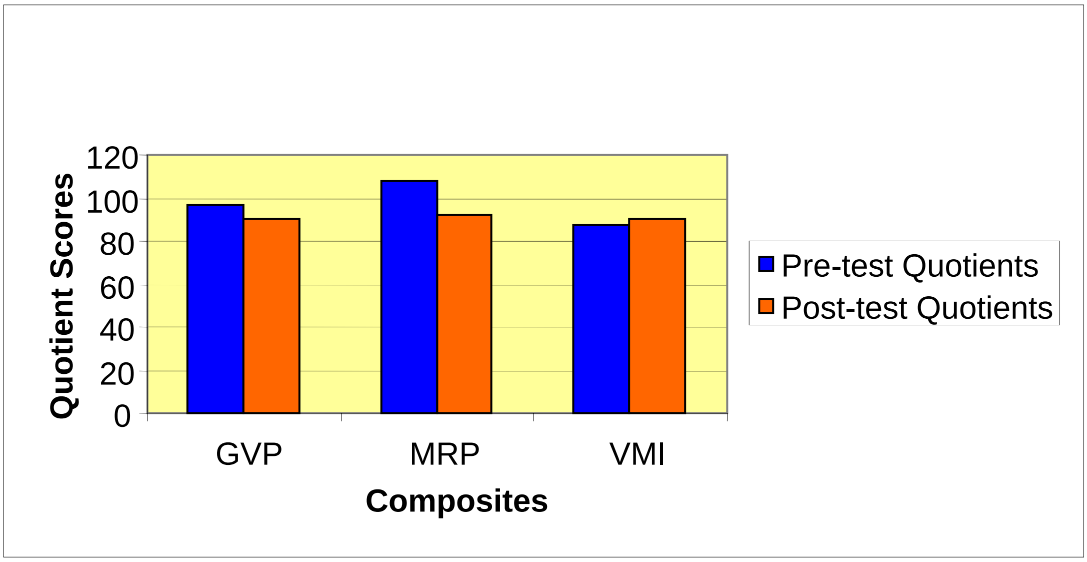


Figure 5

DTVP-2 Pre and Post-test Quotients for Subject 12

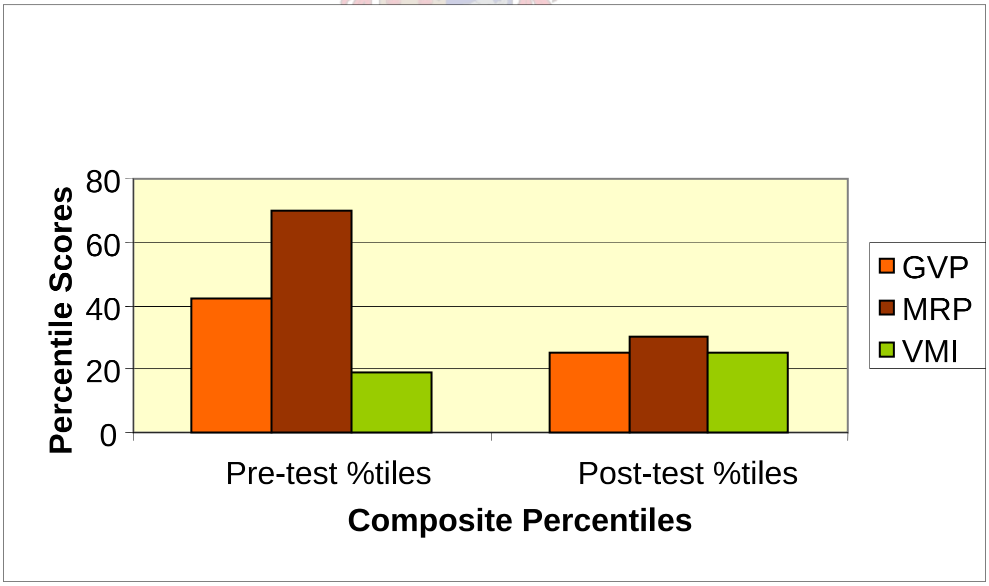


Figure 6

DTVP-2 Pre and Post-test Percentile Scores for Subject 12

Subject 12's pre-test General Visual Perception was at a quotient of 97 and performance was rated at the 42nd percentile. In terms of the post-test, three of the tasks on the VMI were performed poorer. These were the tasks of eye-hand coordination, copying and visual motor speed subtests. Subtest standard scores of 8, 9 and 5 were obtained respectively. Percentile scores were at the 25th, 37th and 5th percentile for each of these subtests (one, three and seven). Performance on the task of spatial relations improved to a score of 12 (the 75th percentile). The Composite quotient scores for VMI increased by three points to a quotient of 90 (the 25th percentile).

All the subtest standard scores obtained for MRP indicated a decrease in the post-test. Subtest standard scores for test items two, four, six and eight was 8, 12, 5 and 10 respectively. MRP composite quotient score decreased from 108 to 92, which indicated a decrease to the 30th percentile.

Her post-test Composite scores on General Visual Perception also decreased to a quotient of 90 and to the 25th percentile. The DTVP-2 post-test score of subject 12 indicate an improvement on the VMI to the 25th percentile and a composite score of 90.

These results can be interpreted to reveal a slight improvement in tasks that required motor skills. It is possible that the intervention provided for Subject 12 had a positive effect on the Visual Motor Integration task of spatial relations where she improved. The fact that the post-test standard scores of the MRP tasks decreased by 10 points provide strong evidence that Subject 12 could have associated factors that inhibit motor performance. As it was suggested earlier, this provides evidence of a possible attention problem. The investigator can only speculate at possible reasons why the other scores have decreased:

- A decrease in concentration levels and attempting to rush the test. The observation that was made of the subject doing the tasks quickly, seemingly without thinking about the possible outcome. The investigator asked her if we should stop the test if she felt tired, but she said that she was fine and wanted to continue.

- The venue for the post-test was different (still in familiar surroundings) and this could have also contributed to the decline in concentration levels. Observation of the body language made it seem as if she was somewhat restless and not quite paying attention to the details in the tasks as in the pre-test.

Answers to the Research Questions

The results show that some children seemed to have improved motor performance on the M-ABC post-test.

The first research question for subjects 1, 2, 3, 4, 5, 6, 7, 8, and 9 could be answered in the affirmative. After participation in the cognitive and motor eight-week intervention program, there was an increase in the post-test scores on the M-ABC test. The children did not benefit equally from the perceptual-motor and cognitive intervention program. Three subjects did not appear to benefit in this way. Post-test scores for Subjects 10, 11 and 12 indicated that there are possibly other underlying factors responsible for no real improvement in performance. The research question for these three subjects is answered in the negative.

It is important to note here that the children with very low initial M-ABC Test scores did not improve motor performance in real terms and performance remained very poor, on the 1^{st}, 2^{nd} and 5^{th} percentiles. This finding is in line with what Braun (1996) found. Braun (1996) used a water medium for the intervention program on children with DCD. The one subject, in the 1996 study, who displayed the most motor difficulty, is the one who did not improve much in the post-test on the M-ABC Test and remained on the 2^{nd} percentile after an eight week intervention program. Braun (1996) suggests that an eight-week intervention program is not sufficient to bring about motor improvement in individuals with severe motor coordination problems.

The current study introduced the cognitive strategies of G-P-D-C and incorporated it into the perceptual-motor intervention program. The results show that most of the children benefited from the program, even though their initial M-ABC Test scores were quite low, such as those on the 3^{rd}, and 5^{th} percentiles. Then there are those whose initial M-ABC Test scores were also quite low and did not achieve improvement, i.e. on the 1^{st} percentile to the 2^{nd} and 5^{th} percentiles. It seems therefore that whether intervention is through a water medium or with cognitive intervention, those children with severe motor coordination problems need a longer intervention period. It is also possible that they could have underlying co-morbid factors that impact on their motor proficiency.

In an intervention program where the way in which the tasks are presented is as important as the content, more time should be allowed for the children to practise the cognitive skills of G-P-D-C in order for them to apply these skills with the necessary guidance. However, more attention could be paid to the selection of specific content that would stimulate the perceptual-motor system in an appropriate manner.

For the second research question, which asked if there would be any changes in the visual perception of children after participation in the perceptual-motor program, the answer is negative. The subjects improved in some items, but overall performance was not affected. Post-test results of Subjects 10 and 12 on the DTVP-2, however, do confirm that co-morbid factors must be considered when working with children identified as having DCD. Programs aimed specifically at improving visual perception would be expected to have more positive results.

Chapter Five

Conclusions and Recommendations

Several conclusions can be made about intervention programs for children with DCD based on the results of this study:

1. The motor proficiency of nine of the 12 children who participated in this study improved to the point where they are no longer classified as DCD, according to the M-ABC. The reasons for this improvement are probably an interaction of the following:

    - The regular practice provided by the perceptual-motor activities that were the content of the program, was designed to help improve coordination.

    - The methods of presentation, i.e. the cognitive strategies, were child-centred, which could have helped build some self-confidence in the children.

    - The children worked in small groups during the intervention program (one group of five and one group of four). This may be a less complex or less intimidating movement environment for children with DCD.

    One question comes to mind: Are these children then no longer considered as children with DCD? The fact that the children have shown that they are capable of meeting the movement challenges in each of the tasks on the M-ABC, indicates that they are no longer classified as having DCD. This does not mean that they are skilful, however. They still must learn age-appropriate skills.

2. The children who performed most poorly on the M-ABC pre-test, and who could be considered to be "very affected" by DCD, did not improve very much over the course of the intervention program. Several options are worthwhile to consider:

    - A thorough examination of all their sensory systems could provide more information about the various factors that may contribute to their movement problems. Cheatum and Hammond (2000) indicated in their book that many times these sensory origins of movement problems are overlooked. Children are too quickly labelled with behavioural problems and/or movement problems.

- The program simply was not long enough for these children (they did not get enough practice).

- The cognitive approach was strange to them and they were not able to respond to this child-centred approach in such a short program.

From the literature and results of this study, it seems possible that DCD children may learn to gradually overcome (Schoemaker & Kalverboer, 1994) or cope with their movement problems. This study is in agreement with the findings of Schoemaker et al. (2001) that some children with DCD do experience deficits in visual, tactile and proprioceptive sensory systems. Cheatum and Hammond (2000) included the vestibular and auditory systems in addition to the visual systems. It is not a matter of placing a label on children with movement problems, but rather to find the true causes of these problems. Once this is done, one can work towards an appropriate movement intervention program in order to address the specific movement problems that these children have.

Remarks about the Cognitive Approach

The outcome of this study was similar to that of Braun (1996), who used a task centred approach and direct styles of teaching. This suggests that at least the cognitive approach used in this study did nothing to reduce the value of a movement program in helping children overcome their movement problems. The literature shows that cognitive intervention could assist children to use information from the intervention program and transfer it to other tasks, that is, to generalise the learnt skills in order to apply it in new situations. It seems as if children with DCD and co-morbid factors could benefit more from cognitive intervention and the transfer and generalisation of skills.

The literature suggests that there is a gradual move away from behaviourist to cognitive teaching and learning skills. We need to embrace these in order to provide the best possible teaching and learning environment for all children, especially those with DCD and co-morbid factors. Ashman & Conway (1997) argue that teachers' frame of mind need to change and they themselves need to be empowered in order to use methods and techniques that will encourage independence in learning and problem-solving. The importance of teacher support and facilitation remain an important feature in education and learning.

The vast field of Cognitive Studies out there should be explored to the benefit of young children with and without DCD. Cognitive intervention for children with DCD and those with factors that are associated with DCD have a positive role to play in providing meaningful movement intervention. When a child obtains the cognitive skills and strategies, mentioned in this study, they would be equipped with a life skill that can be applied to all areas of daily life, at this young age and later into adulthood.

Finally, Missiuna et al. (2001) found that elements of CO-OP include theories of problem solving, learning, motor learning, cognitive strategies, child centred intervention, goal setting and motivation. These elements are derived from various fields of study and are considered as internally consistent/compatible with each other and form the basis for cognitive intervention. Several authors used various aspects of CO-OP, however, in essence they have all attempted to involve and draw on cognitive strategies to improve performance and to encourage the transfer of skills for generalisation. In order for children to be able to "fix the problem" they need to be guided in an appropriate manner and only with a lot of practice will they be able to establish new neurological pathways in order for them to experience increased levels of success at whatever movement task or everyday task, they attempt.

Remarks about Visual Perception

The role that vision play in movement and academics and how it affects children with DCD is a worthy direction for substantially more research. Visual perception is important in different ways. Children who are unable to visually track have problems with reading and writing. These children will also find it difficult to catch a ball because as the object is moving closer to the child and the child is unable to visually track the ball, a successful catch is highly unlikely. Gross and fine motor movement activities and daily life activities all require adequate visual perception. Although it was possible only to gather data from two of the 12 subjects who completed this study, it was clear to the investigator that some children with DCD have problems with visual perception and some do not. This supports Hoare's (1994) findings. The assessment of visual perception becomes an important source of information when working with any child with DCD, since it cannot be presumed that there are, or are not, vision problems contributing to the movement problems.

Recommendations

Recommendations to Guide Future Research

- For practical purposes when conducting the M-ABC in field settings, use a plastic mat on which the rectangles are clearly marked for the hopping and jumping in squares activities. The investigator tested children from different schools and the venues changed for each group and the use of such a mat saved a lot of time.

- Future studies that intend to investigate children with DCD should be aware of the high incidence of co-morbid factors that accompany the symptoms of DCD, and data should be collected regarding these factors.

- Large groups of children with DCD would provide more information about the heterogeneity of the disorder. The use of control group studies could also be pursued if a large enough sample is available, providing the children with DCD in the control group also receive an intervention program after post-test data is collected.

Recommendations for Programs

- It was found that the time spent on the activities (up to 50 minutes per session) was too long and that not enough time was allocated to discuss the activities with the children and to evaluation the progress made. An intervention program should ideally consist of one-hour sessions, with one or two sessions per week (preferably two sessions a week).

- Intervention sessions should be clearly divided into two sections of thirty minutes each. The first section involves physical activity (gross and fine movement skills) and the second section involves cognitive intervention of about 30 minutes of discussion, i.e. talking about the activities and to encourage transfer of skills to academic skills.

- The physical activities should take place in a playful and fun manner with maximum involvement and the child learns to make decisions about movement choices. Gradually the role of the tutor becomes less and only serves to guide and assist in chosen movement activities. The reason for the physical activity is that the children love to play, "that's their job". And they can relate to movement easier than complex cognitive academic skills. Sufficient time should be allowed, as stated earlier, for the physical fine and gross motor activities and to encourage the use of cognitive strategies and skills

General Recommendations

- Working with children with movement problems requires special knowledge. There is a need to develop specialisation studies in Physical Education for young and very young children.

- The author became increasingly aware of the child's eyes and what they were fixated upon. A reminder for the child to *look* at where he or she wants the object to end up was found to be of great value in producing higher levels of success in the execution of tasks. More understanding of the role of vision in motor control and motor skill performance is needed.

- The M-ABC Test was a satisfactory test for DCD in this study. Although Pienaar (2004) recommended adjustment to the M-ABC Test for assessing children from the Northwest Province in South Africa because the test identified 60% of the children she tested as being affected by DCD. In this study the incidence among subjects was less than 10% of the children tested, well within international expectations for identification of DCD.

Concluding Remarks

Early intervention is very important if we want to help those who need it, as it was stated earlier in this study. Acronstam (2003) proposed that there is a need for different professions to establish their own fields of specialization. Then, there should be a "cross over" to other disciplines in order to operate in a multidisciplinary manner. The multidisciplinary approach that was suggested seems to be the ideal if we want to help children with DCD and those with associated symptoms. They are whole human beings, deserving a **holistic approach** to intervention.

The author would like to propose such a 'cross over' where a Physical Education teacher can work with the child and assist in the gross motor tasks and an Occupational Therapist assists in the finer motor tasks and the two of them, in conjunction with the class teacher, work together to help children with DCD and other or associated problems. The children who have problems with fine motor tasks can re-learn them, but it will take a lot of practice. Cheatum and Hammond (2000) remind us that it is possible to re-learn a task. However, this can only be achieved with a lot of practise as the brain's neural pathways are changed to adopt the new way of functioning. For example, holding the pencil the "wrong way", will gradually be eliminated if sufficient practice and reinforcement is provided for holding the pencil the "correct way."

Of course, someone has to notice that the child is having difficulties. In our pencil example, who will encourage children to change their grip. How often does the class teacher actually notice that the child does not hold the pencil in the proper way, especially when classes have up to 35-45 learners? It is hoped that if the expertise of the Occupational Therapist and the Physical Educator can be combined, that more attention and assistance will be given to finer detail of the children's development

The link between Physical Education and the development of perceptual-motor skills was noted earlier. The improvement of perceptual-motor skills is viewed as a requirement for academic learning. The Physical Education teacher will be able to monitor and maintain performance levels of all children and especially those who have movement or coordination problems and those who are identified as DCD. Physical Education should be seen as the tool to assist and support children fixate newly learned movement skills. The role of Physical Education should not be confused with playing competitive sport during school time. Competitive sport is in the category of extramural sport/activities or those who wish should joint sport clubs. The author of this study is adamant that Physical Education should include activities that are enjoyable for all who participate.

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Appendix A

P.O. Box 44952
Claremont
Cape Town
7735
10 May 2004

Dear Sir or Madam:

Your child ………………………………… has been identified as a possible candidate for a sensory-motor intervention program. The program will consist of various activities that include eye-hand coordination, position in space, copying, visual-motor speed, figure ground and other activities.

The program will run during the third term (21/07/2004 until about 23/09/2004). Pre-tests will be done before the end of this term (24/06/2004).

This intervention program is done for the purpose of completing a master's degree at the University of Stellenbosch. I hereby kindly request permission to include your son or daughter for the study.

I, ______________________________ hereby give consent for my son or
Name of parent or guardian
daughter ______________________________ to participate in the study done by
Name of child
Yolinda Walters for the purpose of completing a master's degree at the University of Stellenbosch.

I ______________________________ will not hold liable or claim anything
Name of parent or guardian
against Y. Walters, the University of Stellenbosch or anyone assisting in the running or administration of the program.

____
Parent or Guardian sign

____
Witness sign

____
Date and Place

____
Date and Place

1 Meadow Way
Plumstead
7806
21 July 2004

Dear Sir or Madam:

Your child …………………………………….… has been identified as a candidate for participation in a sensory-motor skill development program that I am presenting as part of my Master's degree studies in Sport Science at Stellenbosch University.

From the results of the "pre-test" done at the end of last term, it seems that your child may benefit from a special movement education program. The program is free of charge and will be done during school time as decided by the Principal or class teacher. It will be offered at your child's school during the third term July 2004 until about September 2004. The program will be similar to "normal" Physical Education lessons, except for a few other activities for example: colouring, cutting and play-dough activities.

I am asking your permission to include your child in the program in order to see if (with the help of a special motor program) your child can improve his or her motor ability. The results of your child's performance will be reported to you. If you request, a short discussion and conclusion on the findings of the study will be available for you.

If you have any questions about this process, or the role of my research in defining the benefits of sensory-motor development programs for children, please do not hesitate to contact me (797-2703), or my promoter, Prof. Elizabeth Bressan, Department of Sport Science, Stellenbosch University (808-4722).

PLEASE RETURN THIS PORTION OF THE LETTER

I, ________________________________ hereby give consent for my son/
Name of parent or guardian
daughter ______________________________ to participate in the pre-test of skills
Name of child
conducted by Mrs. Yolinda Walters for the purpose of completing her Master's degree at Stellenbosch University.

______________________________	______________________________
Parent or Guardian sign	Witness sign
______________________________	______________________________
Date and Place	Date and Place

1 Meadow Way
Plumstead
7806
21 July 2004

Dear Parent/Guardian,

Thank you that I could do the "pre-test" of motor skills with your child. The result of the test indicates that your child's movement competence is adequate or better. Based on your child's test scores, it seems that the motor program that I intend running at the school will not benefit your child because she/he did much better than was expected. The program is mainly for children that scored lower than your child and that may benefit from such a program.

If you have any questions, or the role of my research in defining the benefits of sensory-motor development programs for children, please do not hesitate to contact me (797-2703), or my promoter, Prof. Elizabeth Bressan, Department of Sport Science, Stellenbosch University (808-4722).

Yours truly,

____

Yolinda Walters

Appendix B

The Intervention Program

A brief description of a typical session

A sample of the pen-and-paper tasks

The intervention program, i.e. Sessions 1-8

A brief description of a typical session (a session consists of two parts)

A typical session had four sections, broken down as follows:

Section one: The children arrived at the venue, either the hall or classroom or field as the weather permitted, dressed in their shorts, t-shirt and sport shoes. A warm-up game as indicated by the author and or a game chosen by one of the children would follow. The warm-up game would consist mainly of a lot of gross motor tasks. This game was necessary to prepare the children for the activities that followed and to make them more relaxed or at ease, because they were not familiar with the person conducting the intervention, i.e. the author of this study. The children were made aware of the fact that we were playing games and that we should all have fun. This section took about five to ten minutes in total.

Section two: The session then progressed to more complex tasks. At times there would be more than one task whereby the child could choose which one to do, or do first or the child could spend more time at a specific task if difficulty were experienced. A maximum of three tasks were presented at a time. At the initial section two, the children are introduced to the G-P-D-C strategies and reminded about these strategies throughout the sessions. The author of the study would then constantly remind the children about the four key words: Goal, Plan, Do and Check.

Firstly they had to identify what they had to do and say it out loud. Then the child had to loudly state the steps that would be followed, using the fingers to indicate the amount of steps that will be followed in order to achieve the goal. Next, the child had to execute the said plan. After completion, we checked whether the plan was sufficient to achieve the goal. If the task was unsuccessfully executed, then we said that the plan had to be fixed. We looked at what went wrong and possible reasons for that. In fixing the plan, we revised the plan and the child attempted the task again. At times the other children would all help and work out the plan to be followed, depending on whether or not there are other, less complicated tasks to perform, i.e. when the children can choose between tasks. This section was about fifteen to twenty five minutes long.

Section three: This section consisted mainly of fine motor activities. The same procedure was followed but only a maximum of two tasks were presented at a time. The G-P-D-C strategies were followed to a point, but more emphasis was placed on using the index finger and thumb as well as using the pincer grip for pen-and-paper tasks. This section was about ten to fifteen minutes long.

Section four: The final section was to consolidate what we did during the session. We discussed problems that they have experienced and looked at possible solutions. We reviewed the plans (in relation to the tasks) that were made and the children were encouraged think about other areas at home, in the classroom or on the play or sports ground were these plans could be of use and benefit to them. This section was about five to ten minutes long.

A few points worth mentioning:

- The author constantly asked questions to encourage the children to think about what they were doing and remind them about the plans they made.
- They were also reminded to repeat their plans out loud before execution, i.e. talk themselves through the problem.
- The children were reminded and encouraged not to giggle or laugh at the attempts of others.
- On the days when we only had 30 minute sessions, the time was shorter for each section and most of the time we used the 30 minute session to consolidate the work done in the previous session, with similar activities as in the longer (previous) session.
- The tasks and activities were executed in a safe environment and the safety of all children was priority.

- The children were reminded to *look* at where they want the ball or beanbag to go to, i.e. attention to visual details played a crucial role.
- At the individual intervention, the author assumed the role of the partner and gave the child the choice of which activity to do first if there was a choice between activities or more time was spent on the activity chosen and then only one activity was executed.
- The plans that the children had to make were the required tasks broken down into smaller parts or steps. For example, if they want to throw a beanbag into a box there are several steps they need to follow in order to be successful. The plans they make could be similar to the following:

The Goal is to throw the beanbag into the box

The Plan could be similar to the following:

1. First I have to stand on the line from which I must throw, if I throw with my right hand, then my left foot will be on the line and my right foot will be slightly back.
2. I must *look* at where the box is.
3. I must swing my right arm backwards (for underarm throw) while *looking* at the box
4. When I throw the beanbag, I swing the right arm forward, it must go in the direction of the box and my *eyes are on the box*. (I must use enough power to get the beanbag across the distance to the box)

Do, the task is executed and the beanbag is thrown.

Check: How well did my plans work? Did the beanbag go into the box? If the answer is affirmative, then the plans worked well if not, then we need to review the plans and also see if all the steps were adhered to or if some were left out or should we add more steps.

- At the end of each session a discussion followed and the children are encouraged to think of daily tasks that they will be able to apply the cognitive skills (G-P-D-C). Some of the tasks could include how to tie your shoe laces for school or sport, how to hold your pencil using the pincer grip when writing or colouring in at school or at home, etc. Here we refer to the skills that are transferred from the intervention program to the daily life activities.

A sample of the pen-and-paper tasks:

The Activity Pad of Travel Fun (the children were encouraged to colour in the pictures or selective objects on the picture after completing the task).

The intervention program: (Each session consist of two parts)

Session: 1.1 (60 min)

Section one: (10 min)

Warm-up games:

- Woolfie-woolfie what's the time?
- Tag game (On-On) and … depending on time, perhaps a third game chosen by one of the children.

Section two: (25 min)

- Forward or log rolls (stimulating vestibular system)
- Hop in and out of hoops and increase the tempo (stimulating vestibular system)
- Forward roll or hopping and jumping in and out of hoops in a sequence of your choice- Choose one task and apply the G-P-D-C strategies

Section three: (15 min)

- Threading the dizzy discs only through the big holes and using only one colour (Stimulating the visual system and practice of fine motor tasks)
- Learning how to make a bow with the laces after threading, i.e. to tie the ends together

Section four: (10 min)

- Discussion about tasks and G-P-D-C strategies
- Positive points and points that we need to work on
- Link up with possible other areas where we can use the G-P-D-C strategies

Session: 1.2 (30 min)

Section one: (5 min)

Warm-up games either chosen by author and one game by one of the children.

- “Simon says” (stimulating the auditory system), and
- (The game chosen by one of the children) and perhaps a third one, depending on time.

Section two: (10 min)

- Forward or log rolls (stimulating vestibular system)
- Hop and jump in and out of hoops and increase the tempo (stimulating vestibular system)
- Forward, backward or shoulder roll or jumping in and out of hoops and over a few beanbags at the end - Choose a task and apply the G-P-D-C strategies

Section three: (10 min)

- Threading the dizzy discs only through the big holes and using more than one colour to make a pattern. (Stimulating the visual system and practice of fine motor tasks)
- Continue to learn how to make a bow with the laces after threading, i.e. to tie the ends together

Section four: (5 min)

- Discussion about tasks and G-P-D-C strategies
- Positive points and points that we need to work on
- Link up with possible other areas where we can use the G-P-D-C strategies

*****

Session: 2.1 (60 min)

Section one: (10 min)

Warm-up games either chosen by the author or one of the children.

- Run and try to tag (throw) one of the children with the beanbag (‘Stingers’) and
- ‘Freeze’ (Run and stop on a signal) (stimulating the auditory system).
- A third game that one of the children chose.

Section two: (25 min)

- Walking (forward, backward and sideways) across the bench.

(First with the bench right side up and then on the reverse side, stimulating the vestibular system.)

- Walking across a line while manipulating a hoop or balancing a beanbag on any part of the body.
- Review the Forward roll on mat
- Choose one of the following tasks and apply the G-P-D-C strategies:

    Forward roll on mat or walking across the bench while manipulating a hoop or beanbag

Section three: (15 min)

Pen-paper-task from the Travel Fun activity book (Stimulating the visual system)

- If time allows, a second or third task may be chosen

Section four: (10 min)

Discussion about tasks and G-P-D-C strategies

Positive points and points that we need to work on

Link up with possible other areas where we can use the G-P-D-C strategies

Session: 2.2 (30 min)

Section one: (5 min)

Warm-up games:

- "Shuttle Run-and-roll" children are divided into two teams: A's and B's. A's run to line where B's are but halfway through, they must stop to do a forward roll and continue running to the B's, tag the B's and the B's do the same. Every child does about six runs and six forward rolls (stimulating vestibular system).
- The game chosen by one of the children

Section two: (10 min)

- Crawling forward and backward on mat (relay races).
- Forward and backward rolling and log rolls -a review (stimulating vestibular system).
- Choose one of the following tasks and apply the G-P-D-C strategies: Crawling (forward or backwards- the child may choose) across the bench while balancing beanbag on any part of the body or walking backwards across bench while balancing a beanbag on any part of the body.

Section three: (10 min)

- Play dough activities: The children manipulate the play dough by squashing, pressing holes, squeezing and finally shaping it into their favourite animal (stimulating the tactile system, in-hand manipulation and fine motor tasks).

Section four: (5 min)

Discussion about tasks and G-P-D-C strategies.

Positive points and points that we need to work on.

Link up with possible other areas where we can use the G-P-D-C strategies.

*****

Session: 3.1 (60 min)

Section one: (10 min)

Warm-up games either chosen by the author or one of the children.

- ‘Stingers’ with the soft size 3 ball.
- The game that one of the children choose.

Section two: (25 min)

- Throwing and catching a beanbag up (towards the ceiling). Increase the height and change over to the soft, size 3 balls (stimulating the visual system).
- In 2’s, pass and catch beanbags, the soft size 3 balls or tennis balls (children may choose which one to start with).
- Choose one of the following tasks and apply the G-P-D-C strategies.

a) In 2’s: A throw beanbag or ball to B. B catches and throws at a target, about 5m away.

b) Individually, throw beanbag or ball into a box or into a hoop.

Section three: (15 min)

Pen-paper-task from the Travel Fun activity book (if time allows, a second task may be chosen).

See how the G-P-D-C strategies can be applied.

Section four: (10 min)

Discussion about tasks and G-P-D-C strategies.

Positive points and points that we need to work on.

Link up with possible other areas where we can use the G-P-D-C strategies.

Session: 3.2 (30 min)

Section one: (5 min)

Warm-up games:

- "Run and freeze" children run and on a signal they freeze and 'turn' into the animal indicated to them. They will hear walk like an elephant, gallop like a zebra/horse, hop like a bunny, etc. (stimulating the auditory system).
- A game chosen by one of the children.

Section two: (10 min)

Children may choose a task and apply the G-P-D-C strategies:

- Children bounce the size 4 netball or basketball balls while walking or slow jogging on a line (stimulating the visual, tactile and vestibular systems).
- Children balance ball or beanbag on any part of the body and walk across a line to drop the ball or beanbag into a box.

Section three: (10 min)

An introduction to the Where's Wally books. The children work in two's and attempt to locate the different characters and objects. (Stimulating the visual system)

Section four: (5 min)

Discussion about tasks and G-P-D-C strategies

Positive points and points that we need to work on

Link up with possible other areas where we can use the G-P-D-C strategies

*****

Session: 4.1 (60 min)

Section one: (10 min)

Warm-up games either chosen by the author or one of the children.

- Tag with beanbag (not throwing at others).
- "Simon says" and the ones that are out continue playing, but they stand inside hoops.
- A third game that one of the children chose.

Section two: (25 min)

Choose two or more of the following tasks and apply the G-P-D-C strategies:

- Rope skipping: stationary and running while skipping.
- Hopping zigzag over a line from one end to the other, about 6meters away, while holding a ball or beanbag in both hands (increase tempo).
- Child may assume any static balance position while balancing beanbag on head, change position slowly into another static balance without dropping beanbag.

Section three: (15 min)

See how the G-P-D-C strategies can be applied in the following tasks.

Pen-paper-task from the Travel Fun activity book (If time allows, a second task may be chosen).

Threading ten dizzy discs and review how to make a bow.

Section four: (10 min)

Discussion about tasks and G-P-D-C strategies.

Positive points and points that we need to work on.

Link up with possible other areas where we can use the G-P-D-C strategies.

Session: 4.2 (30 min)

Section one: (5 min)

Warm-up games:

- Run and on a signal change to hopping. Continue to hop and on the next signal, change to crawling, etc.
- and the game chosen by one of the children.

Section two: (10 min)

Rope skipping (review)

Children may choose a task or do both and apply the G-P-D-C strategies:

- Child jumps on one leg (e.g. left) zigzag across a line at 4m, picks up a beanbag or ball and continues to next marker (another 4m away), change legs and return to starting point and drop the beanbag or ball at the marker (4m from stating point) and continue.
- Static balance on bench. Balance a beanbag on head, shoulder or arm and change positions without losing balance.

Section three: (10 min)

- Play dough activities: The children manipulate the play dough by squashing, pressing holes, squeezing and finally shaping it into their favourite toy. (stimulating the tactile system, in-hand manipulation and fine motor tasks)

Section four: (5 min)

Discussion about tasks and G-P-D-C strategies.

Positive points and points that we need to work on.

Link up with possible other areas where we can use the G-P-D-C strategies.

******

Session: 5.1 (60 min)

Section one: (10 min)

Warm-up games:

- Tag game (On-On).
- Simon Says.
- And perhaps a third game chosen by one of the children, depending on time.

Section two: (25 min)

Apply the G-P-D-C strategies in the following tasks:

- Hop and jump up and down stairs (2-3) or a step, alternate the hop and jump. Increase and then decrease tempo and increase again. Execute task while holding a ball or beanbag in both hands.
- In 2’s or individually against a wall, throw the ball in different ways, i.e. underarm or over arm and catch with a bounce and then without a bounce before catching it.

Section three: (15 min)

Apply the G-P-D-C strategies in the following tasks:

- Threading the dizzy discs only through the small holes, using three different colours and making a pattern (e.g. two green, one red, three blue and repeating the pattern five or six times.
- Review to make a bow with the laces after threading.

Section four: (10 min)

- Discussion about tasks and G-P-D-C strategies.
- Positive points and points that we need to work on.
- Link up with possible other areas where we can use the G-P-D-C strategies.

Session: 5.2 (30 min)

Section one: (5 min)

Warm-up games:

- Stingers with the “spiky ball”.
- The game chosen by one of the children.

Section two: (10 min)

Apply the G-P-D-C strategies in the following tasks:

- Jump (feet land together) up and down stairs (2-3) or a step. Attempt to increase and then decrease tempo. Execute task while moving a ball or beanbag from left to right hand continually.
- In 2’s, throw the ball in different ways, i.e. underarm or over arm and catch with a bounce and then without a bounce before catching. Execute task with the non-preferred hand.

Section three: (10 min)

Choose one of the following:

- Threading the dizzy discs (choose what you want to thread) and continue to review how to make a bow with the laces after threading, i.e. to tie the ends together.
- Manipulate clay, choose any colour and make an object of your choice.

Section four: (5 min)

- Discussion about tasks and G-P-D-C strategies.
- Positive points and points that we need to work on.
- Link up with possible other areas where we can use the G-P-D-C strategies.

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Session: 6.1 (60 min)

Section one: (10 min)

Warm-up games:

- Children listen to instruction and move like a horse (gallop), on signal and instruction, they stop and move like a dinosaur (heavy big and 'into the ground' steps) etc.
- Children find own space on the floor and balance on different parts of the body, changing position on a visual signal. They may also choose to balance a beanbag during this activity.
- A third game that one of the children choose.

Section two: (25 min)

Child may choose any two of the following tasks and apply the G-P-D-C strategies:

- Choose a beanbag or any ball and throw up as high as possible and catch.
- Walking heel to toe, bounce ball on a line and continue to a marker, about 6m away, choose any way to return back to starting point.
- Stand on a line and throw 4 beanbags (one at a time) into a hoop that is at different distances (2m away, 3m away, 4m away and 5m away) start at 2m and increase difficulty to 5m away.

Section three: (15 min)

Apply the G-P-D-C strategies in the following tasks:

- Pen-paper-task from the Travel Fun activity book (stimulating the visual system).
- If time allows, a second or third task may be chosen.

Section four: (10 min)

Discussion about tasks and G-P-D-C strategies.

Positive points and points that we need to work on.

Link up with possible other areas where we can use the G-P-D-C strategies.

Session: 6.2 (30 min)

Section one: (5 min)

Warm-up games:

- ‘Woolfie woolfie what’s the time.
- Game chosen by one of the children.

Section two: (10 min)

Choose one of the following tasks and apply the G-P-D-C strategies:

- Walking heel-to-toe on bench, bounce ball and continue to the end of the bench, throw ball at a target and jump off (try to maintain balance).
- Stand on a line and throw 4 beanbags (one at a time) into a hoop that is at different distances (2m away, 3m away, 4m away and 5m away) start at 2m and increase difficulty to 5m away.

Section three: (10 min)

- Play dough activities: The children manipulate the play dough by squashing, pressing holes, squeezing and finally shaping it with cookie cutters (stimulating the tactile system, in-hand manipulation and fine motor tasks).

Section four: (5 min)

Discussion about tasks and G-P-D-C strategies.

Positive points and points that we need to work on.

Link up with possible other areas where we can use the G-P-D-C strategies.

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Session: 7.1 (60 min)

Section one: (10 min)

Warm-up games:

- "Shuttle Run, frog leaps and …" children are divided into two teams: A's and B's. A's run to line where B's are but halfway through, they must stop, to continue towards the B's with frog leaps, tag the B's and the B's do the same. The B's start the next round and halfway through the B's may choose how to move towards the A's (for example: move like a bunny, kangaroo, snake, snail, etc.) Every child has two opportunities to change the second part towards the line where the partner is waiting.
- A second game that one of the children choose.

Section two: (25 min)

- In 2's, throwing and catching beanbags and different sized and shaped balls. Increase distance and vary types of throws, i.e. throwing high balls/beanbags and partner catch ball/beanbag above the head, chest height, to the left and right and below the waist. One or both hands may be used to catch the balls/beanbags.
- Choose one of the following tasks and apply the G-P-D-C strategies:

  a) Individually, walk or run along a line on the ground and bounce a tennis or size 3 basket balls on the line.

  b) Individually, throw tennis ball or size 3 basket ball against the wall and catch it before it drops to the ground.

  c) In 2's. A bounce the soft size 3 balls or size 4 netball balls while walking, slow jogging or running on a line and at the end of the line, aim and throw the ball through a hoop, held by partner (B).

Section three: (15 min)

Apply the G-P-D-C strategies in the Pen-paper-task from the Travel Fun activity book (if time allows, a second or third task may be chosen).

Section four: (10 min)

Discussion about tasks and G-P-D-C strategies.

Positive points and points that we need to work on.

Link up with possible other areas where we can use the G-P-D-C strategies.

Session: 7.2 (30 min)

Section one: (5 min)

Warm-up games:

- "Dodge ball".
- and the game chosen by one of the children.

Section two: (10 min)

Children may choose a task and apply the G-P-D-C strategies

- Rope skipping: Children skip individually while walking and then hopping on one leg, change legs, and running on a line while skipping.
- Hop scotch: make your own sequence of hopping and jumping in and out of the squares and circles on the floor.

Section three: (10 min)

Where's Wally books. The children work in two's and attempt to locate the different characters and objects.

Section four: (5 min)

Discussion about tasks and G-P-D-C strategies.

Positive points and points that we need to work on.

Link up with possible other areas where we can use the G-P-D-C strategies.

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Session: 8.1 (60 min)

Section one: (10 min)

Warm-up games that two or three of the children may choose.

Section two: (25 min)

Choose two or more of the following tasks and apply the G-P-D-C strategies:

- Rope skipping: vary the method of travelling while skipping.
- Child may assume any static balance position while balancing beanbag on head, change position slowly into another static balance without dropping beanbag.
- Log, forward or backward rolling on mat and combinations of rolls and add different jumps (e.g. star jump).

Section three: (15 min)

Apply the G-P-D-C strategies in the following tasks:

Pen-paper-task from the Travel Fun activity book (if time allows, a second task may be chosen).

Threading any amount of dizzy discs and review how to make a bow.

Play dough activity: manipulate and squash and squeeze the play dough and then shape it into a mode of transport, e.g. a train, aeroplane, bus or car.

Section four: (10 min)

Discussion about tasks and G-P-D-C strategies.

Positive points and points that we need to work on.

Link up with possible other areas where we can use the G-P-D-C strategies.

Session: 8.2 (30 min) Final session

Section one: (5 min)

Warm-up games:

- Run and on a signal change to hopping. Continue to hop and on the next signal, change to crawling, etc.
- A game chosen by one of the children.

Section two: (10 min)

Rope skipping (review)

Children may choose a task or do both and apply the G-P-D-C strategies:

- Child jumps on one leg (e.g. left) zigzag across a line at 4m, picks up a beanbag or ball and continues to next marker (another 4m away), change legs and return to starting point and drop the beanbag or ball at the marker (4m from stating point) and continue.
- Static balance on bench. Balance a beanbag on head, shoulder or arm and change positions without losing balance.

Section three: (10 min)

Children may choose one or more of the following tasks:

- Using Play dough or clay: The children manipulate the clay or play dough by squashing, pressing holes, squeezing and finally shaping it into their favourite toy.
- Threading dizzy discs using different colours to make a pattern.
- Where's Wally book and children work in 2's or individually to find Wally and the others or the objects.

Section four: (5 min)

Discussion about tasks and G-P-D-C strategies.

Positive points and points that we need to work on.

Link up with possible other areas where we can use the G-P-D-C strategies.

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THE END