A Perceptual-Motor Intervention Programme for Grade 1-Learners with Developmental Coordination Disorder

By

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Magister Artium

In fulfillment of the requirements for the degree Philosphiae Doctor in Human Movement Science, Kinderkinetics in the Faculty of Humanities, Department of Exercise and Sport Sciences at the University of the Free State

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Summary

A Perceptual-motor intervention programme for grade 1 learners with Developmental Coordination Disorder

Background

Developmental coordination disorder (DCD) is recognised as one of the most common developmental dysfunctions during childhood. Developmental coordination disorder is diagnosed in children who experience significant difficulties in motor learning and in the performance of functional motor tasks that are critical for success in their daily lives. However, one of the major concerns regarding children with DCD is that they are often not formally diagnosed, but rather described by their parents and teachers as lazy or awkward. In an attempt to identify children with DCD, several research tools, such as questionnaires for screening purposes and norm-referenced tests to measure the degree of movement difficulties, can be used. Even though children will not outgrow this disorder as previously believed, children can be helped by means of various interventions.

Aims

The first aim of this study was to determine the prevalence of DCD among Grade 1 children in Bloemfontein. The second aim was to establish the ability of parents to identify Grade 1 children with DCD at home; in addition the third aim was to establish the ability of teachers in identifying Grade 1 children with DCD in the classroom. The fourth aim was to explore the influence of DCD on learning related skills. Aim five and six was to determine if the application of a perceptual-motor intervention as well as a sport stacking intervention will significantly improve the motor proficiency status of Grade 1 children identified with DCD independently.

Method

Participants

For the purpose of aim 1, 559 participants' between the ages of 5 and 8 years took part in this study. There were n=321 girls and n=238 boys. Aim 2 include 410 participants and consisted of n=226 girls and n=184 boys, whilst aim 3 had 506 participants and there were n=289 girls and n=217 boys. Furthermore, aim 4 had 347 participants including n=190 girls and n=157 boys. Aim 5 and 6, which relates to the two interventions used in this study was as follows. Seventy six (76) participants took part in the perceptual-motor intervention. The group consisted of girls (n=34) and boys (n=42) classified with DCD. The intervention had a pre-test/post-test experimental design (n=36) with a control group (n=40). With reference to the sport stacking intervention, 18 children between the ages of 6 and 7 years took part in this study. The group consisted of girls (n=6) and boys (n=12) classified with DCD. This intervention also had a pre-test/post-test experimental design (n=10) with a control group (n=8).

Measuring instruments

The instrument used to assess the participants motor proficiency levels and to identify symptoms of DCD was the Movement Assessment Battery for Children-2 (MABC-2 Test). This test includes manual dexterity, balance as well as aiming and catching, in addition the three sub-tests constitute a total test score. In order to determine if parents possess the ability to identify symptoms of DCD at home the Developmental Coordination Disorder Questionnaire '07 (DCDQ'07) was used.

With the purpose of determining if teachers possess the ability to identify DCD in the classroom the Movement Assessment Battery for Children-2 Checklist (MABC-C) was used. It is designed to identify primary school children likely to have movement difficulties.

The Aptitude Test for School Beginners (ASB) was administered by qualified teachers to all participating children in the first two months of the school year. A requirement of the ASB is that it must be presented and completed in a child's mother tongue. The ASB is a norm-based instrument and consists of eight sub-items, which include perception, spatial skills, reasoning, numerical skills, gestalt, coordination, memory and verbal comprehension. Each sub-item is evaluated by means of a standard score out of five. An evaluation score of 1 is regarded as below average and an evaluation score of 5 as above average. The aim of the ASB is to obtain a differentiated picture of certain aptitudes of grade 1 children.

Data analysis

Analysis of the data was done by a biostatistician using Statistical Analysis Software Version 9.1.3. Descriptive statistics, namely frequencies and percentages, were calculated for categorical data. Medians and percentiles were calculated for numerical data. Median differences were tested by calculating p-values using the signed-rank test. The Chi-square statistics were used to test for proportion differences. This was used to determine the prevalence of DCD (article 1), as well as for learning related skills and DCD (article 4) and for the sport stacking intervention (article 6). Furthermore, data analysis was performed using the Statistical Package for the Social Sciences (SPSS) for Windows (SPSS version 16.0), in order to determine if parents and teachers possess the ability to identify children with DCD. The convergent validity of the classification of motor problems (no motor difficulties or motor difficulties) using the MABC-2 Test and the classification of motor difficulties (no motor difficulties or motor difficulties) by the parents of the participants using the DCDQ'07 and the teachers using the MABC-C, the kappa (k-) coefficient was used. Finally, the Mann-Whitney-U test

was used to compare differences between the experimental- and control group with reference to the perceptual-motor intervention for children with DCD (article 5). Probability level of 0.05 or less was taken to indicate statistical significance.

Results

The results of aim 1 revealed the prevalence of DCD amongst Grade 1 learners in Bloemfontein is estimated to be 15%. The results also indicate that boys have a significantly higher ($p=0.050$) prevalence of DCD although marginally when compared to their female counterparts. Aim 2 indicated a 15% convergent validity between the MABC-2 Test and the DCDQ'07, similar results were obtained for aim 3, indicating a 11% convergent validity between the MABC-2 Test and the MABC-C. Therefore, it can be argued that parents using the DCDQ'07 and teachers using the MABC-2 could not identify children with DCD at home or in the classroom. The results in aim 4 indicated the prevalence of DCD to be 12%. Additionally, DCD had a significant effect ($p=0.050$) on five of the eight learning-related subtypes, namely reasoning, numerical skills, gestalt, coordination and memory. Furthermore, the results of aim 5 indicated that a perceptual-motor intervention only improved balance as a sub-test of the MABC-2 Test. Interesting to note is that children taking part in Physical Education classes presented by the teachers also prove to be beneficial. In contrast, aim 6 (sport stacking intervention for DCD) showed that the intervention had a significant effect ($p=0.050$) on two of the three sub-tests, namely manual dexterity, balance, as well as the total test score. This suggests that sport stacking can be used as an effective intervention programme for children with DCD.

Conclusions

The results revealed that the school age children in the current study had a higher incidence of DCD (15%) compared to the findings reported in the literature (5-6%). This information is important, and indicates that appropriate screening tools should be used to identify children earlier. Unfortunately the reliability of the MABC-C and the DCDQ'07 completed by parents and teachers to identify children with DCD was found to be low. Therefore it is recommended that specific norms should be developed for South African children. Furthermore, the results revealed that children with DCD do struggle with learning related skills. This knowledge enables teachers to address the specific needs of children with DCD. It can be concluded that perceptual-motor interventions have more often than not positive effects on children with DCD; however it is recommended that a combination of the bottom-up approach and top-down approach should be used for optimal results.

Key words: Developmental Coordination Disorder, Movement Assessment Battery for Children - 2, Movement Assessment Battery for Children - 2 Checklist, Developmental Coordination Disorder Questionnaire ‘07, Aptitude Test for School Beginners, Children

Opsomming

’n Perseptueel-motoriese intervensieprogram vir graad 1-leerders met Ontwikkelingskoördinasiesteurnis

Agtergrond

Ontwikkelingskoördinasiesteurnis (*developmental coordination disorder* – DCD) word erken as een van die mees algemene ontwikkelingsdisfunksies tydens die kinderjare. Ontwikkelingskoördinasiesteurnis word gediagnoseer in kinders wat beduidende probleme ervaar met motoriese leer en in die uitvoering van funksionele motoriese take wat deurslaggewend vir sukses in hul daaglikse lewens is. Een van die vernaamste bekommernisse met betrekking tot kinders met DCD is egter dat hulle dikwels nie formeel gediagnoseer word nie, maar eerder deur hul ouers en onderwysers as lui of lomp beskryf word. Verskeie navorsingsinstrumente, soos vraelyste vir siftingsdoeleindes en normverwysde toetse om die mate van bewegingsprobleme te meet, kan gebruik word ten einde kinders met DCD te probeer identifiseer. Selfs al sal kinders nie die versteuring ontgroei, soos vantevore geglo is nie, kan hulle gehelp word deur middel van verskeie intervensies.

Doelstellings

Die eerste doelwit van hierdie studie was om die voorkoms van DCD onder graad 1-leerders in Bloemfontein te bepaal. Die tweede doelstelling was om die vermoë van ouers om graad 1-leerders met DCD tuis te identifiseer, te bepaal; daarbenewens was die derde doelstelling om die vermoë van onderwysers om graad 1-leerders met DCD in die klaskamer te identifiseer, te bepaal. Die vierde doelstelling was om die invloed van DCD op leerverwante vaardighede te ondersoek. Doelstellings vyf en

ses was om te bepaal of die toepassing van ’n perseptueel-motoriese intervensie sowel as ’n sportstapelingsintervensie graad 1-leerders wat onafhanklik met DCD gediagnoseer is se status van motoriese vaardigheid beduidend sal verbeter.

Metode

Deelnemers

Vir doelstelling een het N=559 deelnemers tussen die ouderdomme van vyf en agt jaar aan hierdie studie deelgeneem. Daar was n = 321 meisies en n = 238 seuns. Doelstelling twee het 410 deelnemers gehad, saamgestel uit n = 226 meisies en n = 184 seuns, terwyl doelstelling drie 506 deelnemers gehad het, bestaande uit n = 289 meisies en n = 217 seuns. Voorts was daar 347 deelnemers vir doelstelling vier, saamgestel uit n = 190 meisies en n = 157 seuns. Vir doelstellings 5 en 6, wat verband hou met die twee intervensies wat in hierdie studie gebruik is, was die syfers soos volg. Sewe-en-sestig (76) deelnemers het aan die perseptueel-motoriese intervensie deelgeneem. Die groep het uit meisies (n = 34) en seuns (n = 42) wat met DCD geklassifiseer is, bestaan. Die studie het ’n voortoets-natoets-eksperimentele ontwerp gehad (n = 36) met ’n kontrolegroep (n = 40). Met betrekking tot die sportstapelingsintervensie het 18 kinders tussen die ouderdomme van ses en sewe jaar aan die studie deelgeneem. Die groep het uit meisies (n = 6) en seuns (n = 12) wat met DCD geklassifiseer is, bestaan. Hierdie studie het ook ’n voortoets-natoets- eksperimentele ontwerp (n = 10) met ’n kontrolegroep (n = 8) gehad.

Meetinstrumente

Die instrument wat gebruik is om die deelnemers se vlakke van motoriese vaardigheid te assesseer en om DCD te identifiseer was die Bewegingsassesseringsbattery vir Kinders-2 (“*Movement Assessment Battery for Children-2”* – MABC-2-toets). Hierdie toets sluit handvaardigheid, balans en mik-en-vang in, en daarbenewens vorm die drie subtoetse saam ’n totale toetstelling. Ten einde te bepaal of ouers oor die vermoë beskik om DCD tuis te identifiseer, is die Ontwikkelingskoördinasiesteurnissvraelys ’07 (“*Developmental Coordination Disorder Questionnaire ’07”* – DCDQ’07) gebruik.

Ten einde vas te stel of onderwysers oor die vermoë beskik om DCD in die klaskamer te identifiseer, is die Bewegingsassesseringsbattery vir Kinders-2: Kontrolelys (“*Movement Assessment Battery for Children-2 Checklist”* – MABC-C) gebruik. Dit is ontwerp om laerskoolkinders wat waarskynlik bewegingsprobleme het, te identifiseer.

Die Aanlegtoets vir Skoolbeginners (ASB) is in die eerste twee maande van die skooljaar vir al die deelnemende kinders deur gekwalifiseerde onderwysers afgeneem. ’n Vereiste van die ASB is dat dit in die kind se moedertaal aangebied en voltooi moet word. Die ASB is ’n normgebaseerde instrument en bestaan uit agt subitems, wat persepsie, ruimtelike vaardighede, redenering, numeriese vaardighede, gestalt, koördinasie, geheue en verbale begrip insluit. Elke subitem word deur middel van ’n standaardtelling uit vyf geëvalueer. ’n Evaluasietelling van een word as ondergemiddeld beskou en ’n evaluasietelling van vyf as bogemiddeld. Die doel van die ASB is om ’n gedifferensieerde beeld van sekere aanlegte van graad 1-leerders te verkry.

Data-analise

Data-analise is deur ’n biostatistikus gedoen met die gebruik van *Statistical Analysis Software*, weergawe 9.1.3. Beskrywende statistieke, naamlik frekwensies en persentasies, is vir kategoriese data bereken. Mediane en persentiele is vir numeriese data bereken. Mediaanverskille is getoets deur p-waardes te bereken met gebruik van die betekenderang-toets. Die chi-kwadraatstatistieke is gebruik om vir proporsieverskille te toets. Dit is gebruik om die voorkoms van DCD te bepaal (artikel 1), sowel as vir leerverwante vaardighede en DCD (artikel 4), en vir die sportstapelingsintervensie (artikel 6). Voorts is data-analise gedoen deur middel van die *Statistical Package for the Social Sciences for Windows* (SPSS weergawe 16.0). Ten einde te bepaal of ouers en onderwysers oor die vermoë beskik om kinders met DCD te identifiseer. Die konvergerende geldigheid van die klassifikasie van motoriese probleme (geen motoriese probleme of motoriese probleme) deur middel van die MABC-2-toets en die klassifikasie van motoriese probleme (geen motoriese probleme of motoriese probleme) deur die ouers van die deelnemers deur middel van die DCDQ’07 en die onderwysers deur middel van die MABC-C, is die kappa- (k-) koëffisiënt gebruik. Laastens is die Mann-Whitney U-toets gebruik om verskille tussen die eksperimentele en die kontrolegroep met betrekking tot die perseptueel-motoriese intervensie vir kinders met DCD te vergelyk (artikel 5). ’n Waarskynlikheidsvlak van 0.05 of minder is gebruik om statistiese beduidendheid aan te dui.

Resultate

Die resultate van doelstelling een het getoon dat die voorkoms van DCD onder graad 1-leerders in Bloemfontein op 15% bepaal is. Die resultate dui ook daarop dat seuns ’n beduidend hoër (p=0.050) voorkoms van DCD het as meisies, hoewel margimaal. Doelstelling twee het ’n konvergerende geldigheid van 15% tussen die MABC-2-toets en die DCDQ’07 aangedui; soortgelyke resultate is vir doelstelling 3 verkry, waar ’n konvergerende geldigheid van 11% tussen die MABC-2-toets en die MABC-C aangedui is. Dit kan dus aangevoer word dat ouers wat die DCDQ’07 gebruik het en onderwysers wat die MABC-C gebruik het, nie kinders met DCD tuis of in die klaskamer kon identifiseer nie. Die resultate van doelstelling 4 het getoon dat die voorkoms van DCD 12% is. Daarbenewens het DCD ’n beduidende effek (p = 0.050) gehad op vyf van die agt leerverwante subtipes, naamlik redenering, numeriese vaardighede, gestalt, koördinasie en geheue. Verder het die resultate van doelstelling 5 getoon dat ’n perseptueel-motoriese intervensie slegs balans as ’n subtoets van die MABC-2-toets verbeter het. Dit is interessant om daarop te let dat kinders se deelname aan Liggaamlike Opvoeding-klasse wat deur onderwysers aangebied is, ook voordelig bewys is. In teenstelling hiermee het doelstelling ses (sportstapelingsintervensie vir DCD) getoon dat die intervensie ’n beduidende effek (p = 0.050) op twee van die drie subtoetse, naamlik handvaardigheid en balans, sowel as op die totale toetstelling gehad het. Dit dui daarop dat sportstapeling as ’n effektiewe intervensieprogram vir kinders met DCD gebruik kan word.

Gevolgtrekkings

Die resultate het getoon dat die kinders van skoolgaande ouderdom in die huidige studie ’n hoër voorkoms van DCD (15%) gehad het as die bevindings wat in die literatuur gerapporteer word (5%-6%). Hierdie inligting is belangrik, en dui daarop dat geskikte siftingsinstrumente gebruik moet word om kinders vroeër te identifiseer. Ongelukkig is daar gevind dat die betroubaarheid van die MABC-C en die DCDQ’07 wat deur ouers en onderwysers voltooi is om kinders met DCD te kan identifiseer,

laag is. Dit word daarom aanbeveel dat spesifieke norme vir Suid-Afrikaanse kinders ontwikkel moet word. Voorts het die resultate getoon dat kinders met DCD wel problem ervaar met leerverwante vaardighede. Hierdie kennis stel onderwysers in staat om aan die spesifieke behoeftes van kinders met DCD aandag te gee. Daar kan tot die gevolgtrekking gekom word dat perseptueel-motoriese intervensies gewoonlik ’n positiewe uitwerking op kinders met DCD het; daar word egter aanbeveel dat ’n kombinasie van die onder-na-bo- en bo-na-onder-benaderings gebruik moet word vir optimale resultate.

Sleutelwoorde: Ontwikkelingskoördinasiesteurnis, Bewegingsassesseringsbattery vir Kinders-2, Bewegingsassesseringsbattery vir Kinders-2: Kontrolelys, Ontwikkelingskoördinasiesteurnisvraelys ‘07, Aanlegtoets vir Skoolbeginners, Kinders

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List of Abbreviations

Developmental Coordination Disorder	DCD
Movement Assessment Battery For Children	MABC Original Version
Movement Assessment Battery For Children-2	MABC-2 Test
Developmental Coordination Disorder Questionnaire	DCDQ Original Version
Developmental Coordination Disorder Questionnaire ’07	DCDQ’07
Movement Assessment Battery for Children-2 Checklist	MABC-C
Aptitude Test for School Beginners	ASB
Motor difficulties	MD
No Motor difficulties	NMD
At risk	AR
Severe motor difficulties	SMD
Sample size	n
Manual Dexterity	MD
Aiming and Catching	AC
Balance	B
Total Test Score	TTS
Experimental group	Ex
Control group	Con
Standard deviation	sd

CHAPTER 1

Problem statement and aim of the study

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1.1 Introduction

Developmental coordination disorder (DCD) can be defined as a *"*marked impairment in the development of motor coordination that is not explicable in terms of general intellectual retardation or of any specific congenital or acquired neurological disorder" (Henderson, Sugden & Barnett, 2007:6). Missiuna, Rivard and Bartlett (2006:72) state that children with DCD experience significant difficulties in motor learning and in the performance of functional motor tasks that are critical for success in their daily lives, such as activities at home, at school and during play. DCD is therefore a disorder that influences children's daily activities, although no obvious cause is evident.

A large number of school-aged children have been identified with motor proficiency problems. Literature indicates that DCD affects 5-6% of school-age children (American

Psychiatric Association, 5th edition (APA), 2013:74; Gaines & Missiuna, 2006:326; Prado, Magalhães & Wilson, 2009:237). Gender also plays a role with regard to DCD. Literature indicates that boys experience more problems than girls, with a boy-girl ratio of 2:1 (Wright & Sugden, 1996a:1099). According to Wessels, Pienaar and Peens, (2008:494) the ratio is 2-3:1. Although children diagnosed with DCD have certain difficulties, with motor dysfunction being the core of all the problems, the children are a heterogenic group (Gillberg, 1998:107; Geuze, Jongmans, Schoemaker & Smits-Engelsman, 2001:7; Dewey, & Wilson, 2001:9). This implies that no two children are the same and negative effects experienced by each child thus differ.

Major concerns relating to DCD are the considerable harmful effects associated with this disorder. Developmental coordination disorder influences children’s daily activities at home (dressing and using various tools), during play (running, riding a bicycle, swimming and ball games) and at school (writing and cutting activities) (Schoemaker, Smits-Engelsman & Jongmans, 2003:426; Sugden & Wright, 1998, cited in Iversen, Ellertsen, Tytlandsvik & Nodland 2005:67). Secondary problems associated with DCD are physical health, such as obesity and lower aerobic levels due to lower activity levels (Tsiotra, Nevill, Lane & Koutedakis, 2009:186; Cantell, Smyth & Ahonen, 2003:413.), and social, emotional and academic problems (Piek & Edwards, 1997:55; Cantell et al., 2003:413). Other co-occurring problems linked to DCD are attention deficit hyperactivity disorder (ADHD) (Pitcher, Piek & Hay, 2003:525; Watemberg, Waiserberg, Zuk & Lerman-Sagie, 2007:920; Wessels et al., 2008:494), speech and language disorders (Gaines & Missiuna, 2006:325), and visual-motor deficits (Wilmut, Brown & Wann, 2007:47).

Even though children will not outgrow this disorder as previously believed (Losse, Henderson, Elliman, Hall, Knight & Jongmans, 1991:55; Henderson & Henderson, 2002 cited in Sherrill, 2004:548; Sugden & Chambers, 2006:521), Barnett’s (2008:114-115) five-step assessment process may be used for identifying children with motor difficulties. The first step focuses on using questionnaires for screening and identifying children with motor problems. The second step entails using norm-referenced tests for measuring the child’s motor performance. The third step of this motor assessment process entails formally diagnosing DCD by assessing the qualitative and quantitative performance in motor tasks. The fourth step focuses on understanding the nature of the condition. The final step involves planning an intervention programme.

The importance of various intervention programmes for children with DCD was reported in only a few studies such as those done by Iversen et al., (2005:67), Pienaar and Lennox (2006:69) with regard to intervention on DCD and Attention Deficit Hyperactive Disorder (ADHD); as well as Sugden and Chambers (2006:520) to determine improvement in motor performance. The literature thus indicates various types of intervention programmes that can be used to improve motor proficiency among children with DCD. However, according to Davidson and Williams, (2000:10), Sugden and Chambers, (2003:546), Pienaar and Lennox (2006:79), as well as Van Waelvelde, (2009:224) research is still inadequate with regard to the effectiveness of intervention programmes for children with DCD.

1.2 Problem statement

Even though researchers have shown an increased interest in DCD, this disorder is not fully understood and many questions still remain regarding the aetiology or the reason for this disorder, suitable screening tools for early identification and appropriate intervention approaches (Barnett, 2008:113; Peters & Henderson, 2008:97). Children diagnosed with DCD have common symptoms, but the degree of motor difficulties varies from childhood to adolescence, and between children (Barnett, 2008:113; Peters & Henderson, 2008:97). In addition to these medical and educational systems, DCD in children is often not identified (Gaines & Missiuna, 2006:325; Missiuna, Moll, King, King & Law, 2007:82).

According to Kamps (2005:100) DCD is under-diagnosed, due to the high costs of formal tests, time consuming processes and long waiting periods (Piek & Edwards, 1997:55; Junaid, Harris, Fulmer & Carswell, 2000:158; Loh, Piek & Barrett, 2009:39). Screening instruments should be used at an early age in order to identify children who might have motor difficulties (Junaid et al., 2000:159; Loh et al., 2009:38). Independent use of questionnaires is not recommended (Junaid et al., 2000:158), but numerous sources of information gathered from parents and teachers by means of questionnaires can assist to identify young children in need of further assessment from professionals using normative instruments (Missiuna & Pollock, 1995:57; Wright & Sugden, 1996a:1099). Additional reasons for early identification are firstly, to implement intervention as soon as possible as young children are more willing to take part (Pienaar, 1994 cited in Pienaar & Lennox, 2006:70) and secondly, because optimal outcomes for children with DCD are associated with early interventions (Polatajko, Fox, & Missiuna, 1995:3).

Interventions are not only important to improve current motor abilities and quality of life but also to prevent the development of secondary impairments associated with DCD (Sugden & Chambers, 2003:546; Missiuna et al., 2006:73; Gaines & Missiuna, 2006:325). Two obstacles affect interventions. The first obstacle, as stated earlier in this chapter, is that research with regard to the effectiveness of intervention programmes on children with DCD is still inadequate (Davidson & Williams, 2000:10; Sugden & Chambers, 2003:546; Pienaar & Lennox, 2006:79 and Van Waelvelde, 2009:224). The second obstacle relates to intervention approaches. Two intervention approaches usually used among researchers are process orientated and task orientated approaches (Sugden & Chambers, 2003:546). Literature indicates controversies between these two approaches. Researchers such as Sims, Henderson, Hulme, and Morton (1996a:976), as well as Sugden and Wright (1998:35) noticed improvements when using the process orientated approach. On the other hand, Wright and Sugden (1996a:1099) report significant differences between pre- and post-test results using the task orientated approach. From the above statement it is clear that both approaches can be successful, but it is still not clear which approach would be most beneficial for children with DCD.

In conclusion, it is clear that DCD is a broad concept. Researchers as well as the public need to understand the term DCD and the negative effects associated with this disorder. Parents and teachers need to recognise the importance of a screening process, and their role in assisting professionals to identify young children who have motor difficulties. Children can receive formal assessments promptly and follow appropriate intervention approaches if they are identified timeously.

1.3 Research questions

The following questions arise:

1. What is the prevalence of DCD amongst grade 1-learners in Bloemfontein?
2. Do parents have the competency to identify DCD in grade 1-learners at home?
3. Do teachers have the competency to identify DCD in grade 1-learners in the classroom?
4. Does DCD influence the learning-related skills of grade 1-learners?
5. Will the application of a perceptual-motor intervention programme improve the status of grade 1-learners classified with DCD?
6. Will the application of a sport stacking intervention programme improve the status of grade 1-learners classified with DCD?

1.4 Aims

The specific aims of this study are to:

- Determine the prevalence of DCD among grade 1-learners in Bloemfontein;
- Establish the ability of parents in identifying grade 1-learners with DCD at home;
- Establish the ability of teachers in identifying grade 1-learners with DCD in the classroom;
- Explore the influence of DCD on learning-related skills of grade 1-learners.

- Determine if a perceptual-motor intervention will significantly improve the motor proficiency status of grade 1-learners identified with DCD; and

- Determine if a sport stacking intervention will significantly improve the motor proficiency status of grade 1-learners identified with DCD.

1.5 Structure of thesis

This thesis is presented in nine parts. Chapter 1 introduces the problem statement, research questions and aims of this study. Chapter 2 focuses on a literature review with regard to DCD. Chapters 3 to 8 are presented in article format and the research methods will be discussed in each article. Article titles are as follows: Chapter 3: To investigate the prevalence of DCD amongst grade 1-learners in Bloemfontein. Chapter 4: To establish the competency of parents to identify grade 1-learners with DCD at home. Chapter 5: To establish the ability of South African teachers to identify grade 1-learners with DCD in the classroom. Chapter 6: The prevalence and effect of DCD on learning-related skills in grade 1-learners in South Africa. Chapter 7: Perceptual-motor intervention for DCD in grade 1-learners. Chapter 8: Sport stacking intervention programme for children with DCD. The final chapter is a collective summary, conclusion, and recommendations of the study. Chapter 9 is followed by appendices. Referencing is done according to the Harvard method and a list of references is presented at the end of each chapter.

The thesis is submitted in article format, as approved by the senate of the University of the Free State (UFS), according to the guidelines for post-graduate studies. Chapters 1, 2 and 9 have been written according to the prescribed standards of the UFS Guidelines for References. The articles have been prepared for publication in accredited peer-reviewed journals. Articles have been written according to the guidelines to authors of the various journals (see the relevant appendices). Article 1 was prepared for the African Journal for Physical, Health Education, Recreation and Dance. Articles 2; 4; 5 and 6 were prepared for the South African Journal for Research in Sport, Physical Education and Recreation. In addition article 6 was prepared for an international Journal, namely the Adapted Physical Activity Quarterly. For the purpose of quality and examination, the font and spacing is kept the same throughout the thesis. The tables and figures are also placed in the text and not at the end of each article as prescribed. The results of the research articles in Chapters 3 to 8 are presented and interpreted in each chapter respectively.

The structure of the thesis is presented in Figure 1.1.

Perceptual-motor intervention programme for Grade 1 learners with Developmental Coordination Disorder

Chapter 1:

- Introduction, problem statements, research questions, aims, structure of dissertation and references.

Chapter 2:

- Literature review on developmental coordination disorder.

Chapter 3:

- Article 1: The prevalence of developmental coordination disorder amongst grade 1-learners in Bloemfontein.

Chapter 4:

- Article 2: The competency of parents to identifying grade -1 learners with developmental coordination disorder at home.

Chapter 5:

- Article 3: The ability of South African teachers in identifying grade -1 learners with developmental coordination disorder in the classroom.

Chapter 6:

- Article 4: The prevalence and effect of developmental coordination disorder on learning-related skills in grade -1 learners in South Africa.

Chapter 7:

- Article 5: Perceptual-motor intervention for developmental coordination disorder in grade -1 learners.

Chapter 8:

- Article 6: Sport stacking intervention programme for children with developmental coordination disorder.

Chapter 9:

- Summary, conclusions and recommendations.

Appendices

Figure 1.1: Structure of the thesis

1.6 Ethical considerations

Privacy is considered as essential, therefore subjects were evaluated individually and their information treated confidentially. Each child and parent signed an informed consent document which outlines the aim and procedures of the study. Participants received this document in the language of their choice (either Afrikaans or English). Participation was voluntary and the subject could withdraw at any time during testing or intervention. Approval was obtained from the Ethics Committee of the Faculty of Health Sciences (ECUFS57/2012).

1.7 Explanation on how confidentiality was ensured

Participants were placed alphabetically, and each received a unique number. This unique number ensured that each participant was compared to him- or herself. In order to compare the DCD experimental group to the DCD control group as well as the participants without DCD, all participants participated in some form of intervention. The control group participated in a physical activities programme and the experimental group participated in the perceptual-motor intervention programme. This procedure prevented the exclusion of certain participants or emphasising the participants with DCD. Regarding the post-test, all participants participated in the post-test (even the participants without DCD) in order to ensure confidentiality. Upon completion of the project every participant received a report with regard to their motor proficiency.

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CHAPTER 2

Literature review on developmental coordination disorder

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2.1 Introduction

The aim of Chapter 2 is to summarise the main issues regarding DCD. Developmental coordination disorder is very complex and diverse, and to assist children with this disorder, researchers need to grasp the total process. This implies a sound background knowledge on what DCD is, from detection to intervention.

2.2 Terminology and definitions

According to Missiuna, Moll, King, King and Law (2007:82), Orton first recognised children with movement difficulties in 1937. Since Orton had recognised children with movement difficulties, it took nearly 25 years before studies and systematic experimental work were presented in the literature (Walton, Ellis & Court, 1962:603). Various terms were used previously to label children with movement difficulties, such as syndrome of clumsiness, awkward, dyspraxic and perceptual motor difficulties, (Sugden & Chambers, 2003:546; Missiuna et al., 2007:82; Sugden, Kirby & Dunford, 2008:173). However, these labels have been replaced with a new term accepted across the world, known as developmental coordination disorder (DCD) (Sugden et al., 2008:173).

Although there are various definitions of DCD, two definitions are generally used. The International Classification of Diseases (World Health Organisation [WHO], 1992:196) defines DCD as follows: “The main feature of this disorder is a serious impairment in the development of motor coordination that is not solely explicable in terms of general intellectual retardation or of any specific congenital or acquired neurological disorder (other than the one that may be implicit in the coordination abnormality). It is usual for the motor clumsiness to be associated with some degree of impaired performance on visuo-spatial cognitive tasks”.

The Diagnostic and Statistical Manual of Mental Disorders (5th ed.) (American Psychiatric Association [APA], 2013:74) states that the fundamental features of DCD include a significant impairment in the development of coordination and interferes with academic performance and daily activities. The difficulties are not due to a general medical condition (such as mental retardation or cerebral palsy), thus, DCD can be seen as a disorder that influences children's academic performance as well as activities of daily living.

2.3 Prevalence of developmental coordination disorder

A significant number of school-aged children have been identified with motor proficiency problems. Literature findings indicate that DCD affects 5-6% of school-age children (APA, 2013:74; Gaines & Missiuna, 2006:326; Prado, Magalhães & Wilson, 2009:237). According to Wilmut, Brown & Wann (2007:47) the prevalence of DCD is even higher at 5-10%.

Developmental coordination disorder affects children all over the world. Researchers in the United Kingdom estimated the prevalence between 4-5% (Lingam, Hunt, Golding, Jongmans & Emond, 2009:694). According to Hamilton (2002:1435) 6% of children in the United States of America are diagnosed with DCD. Junaid, Harris, Fulmer & Carswell (2000:158) found that approximately 8 to 15% of Canadian children have some form of coordination problems. America and Europe have a higher prevalence than the United Kingdom and New Zealand: between 5 and 19% of children have been found to have motor problems (Miler, Missiuna, Macnab, Malloy-Miller & Polatajko, 2001:6). The real prevalence of DCD among younger developing children might even be higher, since medical as well as educational systems frequently fail to identify this disorder in young children (Gains & Mussiuna, 2006:325; Missiuna et al., 2007:82; Miyahara, Yamaguchi & Green, 2008:355).

Gender also plays a role in the prevalence of DCD. The literature indicates that boys experience more problems compared to girls, with a boy-girl ratio of 2:1 (Wright & Sugden, 1996a:1100). Wessels, Pienaar and Peens, (2008:494) found the ratio to be 2-3:1. Furthermore, Rivard, Missuina, Hanna and Wishart (2007:634) estimated that the gender difference could even be as high as 3-4:1. Hoare & Larkin (1991:3) also found that more boys than girls attend remedial programmes for DCD (9:1), supporting the belief that boys experience problems with DCD more often.

Although gender related differences do occur, researchers need to take into consideration that it is a normal phenomenon in children's attainment of motor skills.

Literature indicates that girls perform better in fine motor skills, while boys are better at gross motor skills (Gallahue & Ozmun, 2006:255). Junaid and Fellowes (2006:8) mention that, when using the Movement Assessment Battery for Children, girls outperform the boys with regard to manual dexterity items and the boys were superior on the ball skills items. No differences between the balancing skills of boys and girls were noted. Junaid and Fellowes (2006:9) also argue that these differences are due to the disparity between the attainment of motor skills among boys and girls.

Although children diagnosed with DCD have specific difficulties with motor ability, which is the core of all related problems, the children are a heterogenous group (Gillberg, 1998:107; Geuze, Jongmans, Schoemaker, Smits-Engelsman, 2001:7; Dewey, & Wilson, 2001:9; Missiuna, 2003:10; Sugden & Chambers, 2003:546; Peters & Henderson, 2008:97). This implies that no two children with the same 'label' are similar in all aspects of their development and the negative effects experienced could vary between children.

2.4 Characteristics of comorbidity

For better understanding of the characteristics of comorbidity between different developmental disorders, Pennington (2006:404) explains the overlap between various disorders by means of a multiple deficit model:

> *"(1)The etiology of a complex behavioural disorder is multifactorial and involves the interaction of multiple risk and protective factors, which can either be genetic or environmental; (2) these risk and protective factors alter the development of cognitive function necessary for normal development thus producing behavioural symptoms that define these disorders; (3) no single etiological factor is sufficient for a disorder and few may be necessary; (4) consequently comorbidity among complex behavioural disorders is to be expected because of shared etiologic and cognitive risk factors; and (5) the liability distribution for a given disease is often continuous and quantitative, rather than being discrete and categorical, so that the threshold for having the disorder is somewhat arbitrary".*

This model implies that DCD would have its own profile of risk factors and that some of these factors are shared by other disorders, resulting in comorbidity. Various researchers describe DCD as multidimensional in nature, as noted in the following paragraphs.

Major concerns relating to DCD are the considerable harmful effects associated with this disorder. Developmental coordination disorder influences children's daily activities at home (self-care tasks), during play (running, riding a bike, swimming and ball games) and in school (writing and cutting activities) (Schoemaker, Smits-Engelsman & Jongmans, 2003:426; Gaines & Missiuna, 2006:325; Sudgen & Wright, 1998, cited in Iversen, Ellertsen, Tytlandsvik & Nodland, 2005:67).

Secondary problems associated with DCD are physical health issues such as obesity and lower aerobic capacity due to lower activity levels (Tsiotra, Nevill, Lane & Koutedakis, 2009:186; Cantell, Smyth & Ahonen, 2003:413.); social, along with emotional problems, due to withdrawal or exclusion from peers, as well as academic problems such as difficulty with tracing, writing and learning (Piek & Edwards, 1997:55; Cantell et al., 2003:413; Wilmut et al., 2007:47).

Other co-occurring problems linked to DCD are speech and language disorders (Missiuna, 2003:2; Gaines & Missiuna, 2006:325), visual-motor deficits, (Wilmut et al., 2007:47) and attention deficit hyperactivity disorder (ADHD) (Pitcher, Piek & Hay, 2003:525; Watemberg, Waiserberg, Zuk & Lerman-Sagie, 2007:920; Wessels, et al., 2008:494). Although children with DCD experience countless problems, the reason(s) therefore are still unclear.

2.5 Etiology

According to Sugden et al., (2008:176) etiology is derived from a Greek word meaning: *"*giving a reason for". Although researchers do not know the exact cause of DCD (Hamilton, 2002:1436; Visser, 2003:481), a variety of factors have been implicated. These factors include genetics, birth trauma, developmental delays, as well as perceptual problems (Hoare & Larkin, 1991:5). Missiuna (2003:3) is of the opinion that motor difficulties can occur during the four stages of information processing. Thus, there is no straightforward answer as to why children have motor coordination difficulties.

Cluster analyses have been used to identify subgroups of children with DCD (Macnab, Miller & Polatajko, 2001:49; Visser, 2003:482). Subgroups of DCD tend to find disparities between children's performance with reference to sensorimotor measurements. Visser (2003:480) is of the opinion that subgroups of DCD would give a better understanding of the nature of DCD. During 1994, three studies were conducted. In the first, according to Hoare (1994 cited in Visser, 2003:483), five subtypes of children with DCD were identified using measurements such as visual perception, visual-motor integration, manual dexterity, kinaesthetic acuity, and balance and running speed. On the other hand, Dewey and Kaplan (1994, cited in Visser, 2003:483) identified four subtypes using balance, bilateral coordination, upper limb coordination, transitive gestures and motor sequencing. Finally, Miyahara (1994, cited in Visser, 2003:483) identified four subtypes, but they were different from those identified by Dewey and Kaplan. Miyahara (1994, cited in Visser, 2003:483) made use of running speed, agility, balance, strength, upper limb speed and dexterity. Although discrepancies were found across these three studies, one subtype, characterised by difficulties in all sensorimotor measures, was evident. Discrepancies might be due to sample differences, differences in the variables used as well as the statistical procedures (Macnab et al., 2001:49). Due to these discrepancies, some researchers are of the opinion that cluster analysis should be discarded because the subtypes do not give researchers a better understanding pertaining to the reasons for DCD (Visser, 2003:483). Other researchers call for the justification of previously defined subtypes, since it can be used as a valuable approach if sufficient information is available (Macnab et al., 2001:49). Visser (2003:483) states that additional studies are needed to distinguish subtypes in terms of underlying deficits or comorbidities, the reason being that subtypes of DCD vary with respect to comorbidities. (Cf. 2.4: Comorbidity characteristics).

Missiuna (2003:3-4) also states that coordination difficulties can occur at various stages as children process information in order to execute a movement. Children continuously receive information from the environment through different senses. The first reason for these coordination difficulties may be a result of a child finding it hard to interpret and to integrate the information received from the various senses (vision, touch, balance and sound). The second reason may arise from finding it difficult to choose the type of motor action appropriate for the current situation. Thirdly, children struggle to form a plan of action in the correct sequence. Finally, a message is sent to the muscles with reference to the speed, force, direction and distance in order to perform a movement. It is sometimes expected to alter the message to guide and control the movement while it is taking place. Figure 2.1 represent the perceptual-motor process.

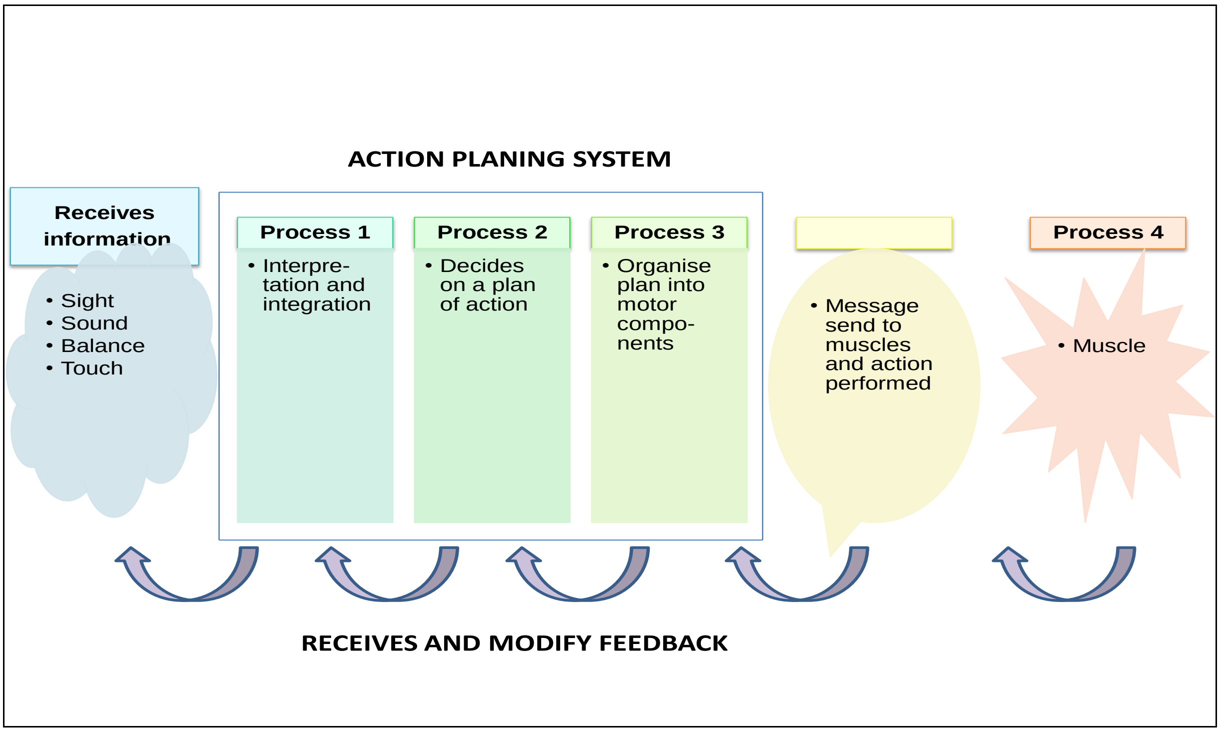

Figure 2.1: Perceptual-motor process Adapted from Missuina, 2003:3.

2.6 Basic principles of neurophysiology

Sherril (2004:263) is of the opinion that it is important to take the central nervous system (CNS) into consideration when managing children who have DCD, in order to illustrate the complexity of the distribution of functions that determines effective motor control within the CNS, the various components are mentioned with a brief description of their role in motor control, and by default in DCD.

The nervous system is divided into two parts, namely the central nervous system (CNS) consisting of the brain and spinal cord, and the peripheral nervous system (PNS). The brain and spinal cord are located within the skull and vertebral canal where it is protected. The brain includes the cerebrum, cerebellum and brain stem. The PNS includes sensory receptors, nerves, plexuses and ganglia (Meij & Van Papendorp, 1997:42; Sherill, 2004:263; Van Putte, Regan & Russo, 2011:370).

2.6.1 Central nervous system

2.6.1.1 Spinal cord

The spinal cord is formed by sensory and motor fibres. The fibres with similar functions are grouped together in order to form tracts. Tracts that conduct impulses to the brain are known as ascending or sensory tracts, while the descending or motor tracts carry impulses from the brain towards the spinal cord (Meij & Van Papendorp, 1997:45; Van Putte et al., 2011:370). Motor coordination and control are determined by the speed with which the impulses are carried up and down these tracts (Sherrill, 2004:295).

2.6.1.2 Brain stem

The brain stem consists of three parts, namely the midbrain, the pons and the medulla oblongata. (Meij & Van Papendorp,1997:43). The brain stem helps to control reflexes. Except for vision and smell, the brain stem comprises all the sensory modalities (Sherrill, 2004:296).

In the brain stem is the reticular formation which consists of a multi-synaptic network of various nerve cells and fibres which connects the midbrain, pons, as well as the medulla oblongata with each other. It consists of a motor nucleus with ascending connections to the thalamus and the cerebral cortex in addition to descending connections to the spinal cord. Impulses from the muscles, joints and collateral fibres from the main sensory pathways reach the reticular formation which is situated in the upper part of the brain stem. As a result of its exceptional location it is able to monitor all the incoming and outgoing information. It is also known as the reticular activating system, because the reticular formation is stimulated by incoming impulses and activates the cerebral cortex (Meij & Van Papendorp, 1997:45; Sherrill, 2004:296; Van Putte et al., 2011:370).

2.6.1.3 Midbrain

The midbrain's function is to transmit impulses important for righting and postural reactions (Sherrill, 2004:296).

2.6.1.4 Pons

The pons forms a bridge between the medulla and the cerebellum. This is an important component of the brain stem since it regulates reflex control of the head, neck as well as the eyes and it plays a role in regulating coordination, in addition to posture (Sherrill, 2004:296).

2.6.1.5 Medulla

The medulla is situated in the upper part of the spinal cord. The function of the medulla is to regulate respiration, heart rate as well as blood pressure. It is also important for tongue movement and speech (Sherrill, 2004:296).

2.6.2 Cerebellum

The cerebellum is situated posterior from the pons and medulla oblongata. It is connected to the brain stem by means of three bundles of nerve fibres. It consists of three parts, namely the vestibule-cerebellum, spino-cerebellum and cerebro-cerebellum. The function of the vestibule-cerebellum is to control muscle tone, balance as well as the coordination of eye movements. The spino-cerebellum receives information (feedback) from proprioreceptors with reference to tension in muscles, joints and tendons. It is also important in order to execute fine motor coordination skills. The cerebro-cerebellum is necessary for the planning and practicing of complex motor tasks (Meij & Van Papendorp, 1997:56; Sherrill, 2004:296; Van Putte et al., 2011:491).

2.6.3 Thalamus

The thalamus' function is to act as a servomechanism in order to relay sensory impulses in the regulation of arousal in relation to activity. All the impulses of the senses are relayed through the thalamus except for smell (Sherrill, 2004:296).

2.6.4 Hypothalamus

The hypothalamus is formed from a variety of structures as well as nuclei at the base of the brain and midbrain. Functions associated with the hypothalamus include controlling of appetite and body temperature, regulation of the autonomic nervous system and the production of hormones in order to control the endocrine glands (Meij & Van Papendorp, 1997:44; Sherrill, 2004:296).

2.6.5 Basal ganglia

According to Sherrill (2004:296) the basal ganglia help with posture as well as slow movements. According to Diamond (2000:49), the basal ganglia is important for movement control, such as selecting the proper movement, the appropriate muscles to perform a movement, or the appropriate force with which to execute the movement. Children with DCD find it difficult to perform adequate, fluent and sufficient motor skills and find it hard to avoid unwanted patterns (Gillberg & Kadesjo, 2003:59).

2.6.6 Cerebral cortex

The cortex is responsible for the higher level functions such as voluntary movements, perception, thought, memory in addition to creativity. The cortical areas are named according to the function the specific area needs to perform. The sensory area interprets impulses from the various sensory receptors. The association areas link the sensory and motor input and create associations important for verbalisation, memory, reasoning, judgment and creativity. Voluntary movements are controlled by the motor and premotor areas (Sherrill, 2004:297).

2.6.7 Corpus callosum

The function of the corpus callosum is to connect the cerebral hemispheres with one another. This allows the transfer of learning from the one side to the other (Sherrill, 2004:297). Figure 2.2 represent the limbic system.

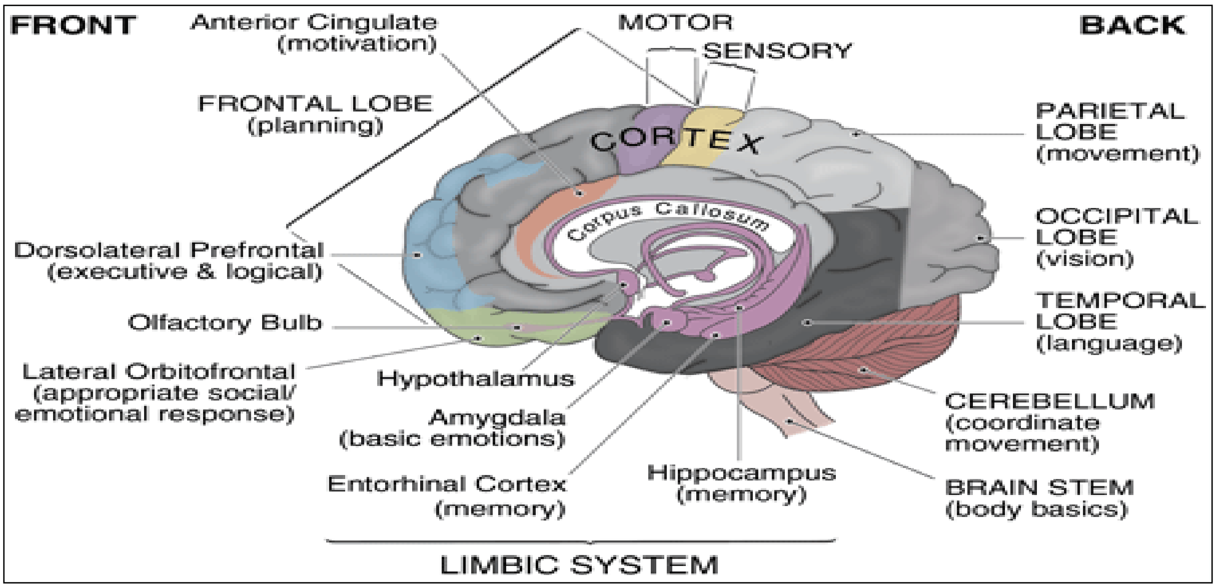

Figure 2.2: Limbic system Adapted from Gamon and Bragdon, 2003:1

2.6.8 Peripheral nervous system

The peripheral nervous system (PNS) can be divided into two subdivisions, called the sensory division and the motor division. The sensory division sends action potentials from a sensory receptor towards the central nervous system (CNS). The motor division sends action potentials from the CNS to the muscles. Furthermore, the motor division can be divided into the somatic nervous system (SNS) which controls all voluntary movements and this system is also responsible for sensory perception. The autonomic nervous system (ANS) is responsible for the visceral organs such as the heart and digestive tract. The ANS is further subdivided into a sympathetic division which regulates physical activity in contrast to the parasympathetic division which regulates resting functions (Van Putte et al., 2011:371).

Thus, the sensory division of the PNS detects stimuli from various senses and by means of an action potential the information is sent to the CNS. The CNS receives the input and processes, and stores the incoming information in order to create an appropriate response. After the execution of the skill, propriokinaesthetic feedback takes place with the intention of evaluating the movement. The motor division of the PNS conducts action potentials from the CNS to the various muscles in order to execute a movement (Van Putte et al., 2011:371).

2.6.9 Major psychomotor problems related to the nervous system

According to Sherrill (2003:264), various psychomotor problems are related to the nervous system.

1. **Muscle or postural tone irregularities:** Refers to abnormal amount of tension within a muscle or muscle group. It can be divided into hypotonus (too little tension in the muscles) and hypertonus (too much tension in the muscle).
2. **Sensory input system problems:** Problems are experienced by the structure or the function of the sensory organs or the nerve fibres responsible for carrying impulses to the brain. This aspect is also further divided into hypersensitivity or hyposensitivity.
3. **Sensory and perceptual central processing problems:** Refers to difficulty translating the input into appropriate output, thus organisational problems occur in the brain.
4. **Reflex integration problems:** Is involuntary and predictably change within a muscle as a response to various sensory inputs.
5. **Postural reaction problems:** Denotes automatic responses to a sensory input in order to maintain the body parts in alignment, to have efficient control, maintain the upright position and prevent one to fall.
6. **Associated movement:** Refers to a movement in conjunction with another body part which is not directly involved in the movement.
7. **Stereotypes:** Refers to rhythmical, patterned movements of various body parts, but without purpose.
8. **Ataxia:** Is motor clumsiness associated with balance and coordination problems.

9. **Spasticity:** originates either from the cerebral cortex or spinal cord and is associated with impairment of voluntary movements.

Adapted from: Sherrill, 2003:264

It is clear from the literature that the causes for DCD are still largely unknown and that a complex relationship exists between DCD and other developmental disorders. These overlapping influences prevent professionals to make a clear-cut diagnosis of DCD.

2.7 Diagnosis

In order to make a scientific, clinical or sound clinical diagnosis of DCD, one can make use of the DSM-5, diagnostic criteria for DCD (APA, 2013:74). Four criteria are given and should be taken into consideration before a final decision can be made. Table 2.1 provides the diagnostic criteria for DCD.

Table 2.1: Diagnostic criteria for DCD

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

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

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

D. If Mental Retardation is present, the motor difficulties are in excess of those usually associated with it.

Diagnostic criteria for DCD Adapted from: APA, 2013:47.

According to Barnett (2008:119), Criteria A and B relate to motor difficulties as well as the extent to which these motor difficulties influence a child's daily activities. Criteria C and D focus on differential diagnoses and exclude children with motor difficulties coupled with medical conditions. Thus, children who meet Criteria A and B are normally referred due to an alleged movement difficulty; but the application of Criteria C and D can change the current diagnosis considerably (Peters & Henderson, 2008:98).

Consequently, if movement difficulties are suspected, it is recommended that children should undergo screening assessments. If necessary, children should be referred to a professional in order to conduct norm-referenced assessments to determine the extent of the movement difficulties experienced by these children (Peters & Henderson, 2008:98).

2.8 Assessments

According to the South-African pocket Oxford Dictionary (2005:46), "assessment" can be defined as: "to evaluate or estimate the value, importance, or quality of". Assessments can therefore evaluate children's motor proficiency levels or determine the quality of these movements. Assessments for DCD can be done by means of several instrument tools, such as questionnaires for screening purposes such as the Developmental Coordination Disorder Questionnaire (DCDQ) and the Movement Assessment Battery for Children-2 Checklist (MABC-C); and norm-referenced test (Movement Assessment Battery for Children-2 (MABC-2 Test) to measure the degree of movement difficulties (Barnett, 2008:117). Due to the high costs involved with norm-referenced tests, time consuming processes and long waiting periods (Piek & Edwards, 1997:55; Junaid et al., 2000:158; Loh, Piek & Barrett, 2009:39) screening tools can be used in order to identify children who might have motor difficulties (Junaid et al., 2000:159; Loh et al., 2009:38).

Barnett (2008:115) argues that the validity and reliability in assessments are crucial for motor assessments to be useful. Therefore, validity implies that the assessment instrument measures what it claims to measure and reliability indicates that similar results will be obtained across time and between different examiners (Barnett, 2008:115). Test developers are responsible for the validity and reliability of their assessment instruments.

The validity and reliability of questionnaires have been investigated and it was found that the DCDQ is valid and reliable and can be used for boys and girls (Wilson, Kaplan, Crawford, Campbell & Dewey, 2000:491; Schoemaker, Flapper, Verheij, Wilson, Reinders-Messelink, & De Kloet, 2008:671), although it had been recommended that the questionnaire can be used with confidence for children between the age sof 8 to 14 years and 6 months only (Wilson et al., 2000:491). In 2009 Wilson and colleagues conducted another study using the same instrument and concluded that children as young as 5 years of age can be screened (Wilson, Crawford, Green, Roberts, Aylott & Kamplan, 2009:185). Brazilian researchers adapted the language and two of the items in the questionnaire due to cultural differences. Still the questionnaire was found to be equivalent to the original DCDQ.

The DCDQ-Brazil also demonstrated validity and reliability (Prado, Magalhàes & Wilson; 2009:242). In contrast, Loh et al., (2009:51) found that the DCDQ had a low sensitivity in detecting children with mild motor difficulties.

With regard to the reliability and validity of the MABC-C, Junaid et al. (2000:163) found that in comparison with the MABC Test, the MABC-C showed a lack of sensitivity. A similar finding was obtained by Schoemaker et al. (2003:439), who stated that it was only applicable to children up to 6 years of age. In the age group 7 to 9 there was a limitation with regards to either the sensitivity or specificity, resulting in a large percentage of false positives. Although these limitations were observed by Schoemaker and colleagues, they still recommend the use of the 15th percentile as the cut-off criterion for screening purposes.

The use of questionnaires such as DCDQ and the MABC-C is encouraged by Missiuna & Pollock, (1995:57), as well as Wright and Sugden (1998:37), who state that numerous sources of information should be used to gather information from parents and teachers. Questionnaires may be used to identify young children in need of further assessment from professionals, using normative assessment tools subsequently. The use of these questionnaires has both limitations and advantages.

Some of the limitations of these questionnaires are the following: Wilson et al., (2000:491) indicate a 27% agreement between the therapist and the DCDQ, demonstrating that the questionnaire did not identify children as frequently as a therapist with regard to motor difficulties. Results described by Loh et al. (2009:48), also indicate that the DCDQ was insufficient in distinguishing children with motor difficulties from those who did not experience any difficulties. A study by Junaid et al. (2000:162), concludes that the independent use of the MABC-C cannot be justified, because children at risk for motor difficulties based on the MABC Test were not identified. Green et al., (2005:2) came to the same conclusion, stating that it was not beneficial to use teachers to identify children with motor difficulties. Another limitation arising from using questionnaires with parents of children with attention deficit/hyperactivity disorder (ADHD) was that they tended to indicate that their children experienced motor problems while norm-reference standardised tests indicated the opposite (Kroenke, 2001 cited in Wilson et al., 2009:185). Similar findings were obtained by Loh et al. (2009:47) in a study conducted among Australian children, because the questionnaire was not able to differentiate the ADHD symptoms.

An advantage of the DCDQ was the positive results obtained from a study done by Green et al. (2005:3). The researchers concluded that parents could identify DCD, if no other developmental problems were present. Another advantage is that the limitations (subtests needed to be changed and different cut-off scores for various ages need to be established) were revealed. The questionnaire was revised (DCDQ'07) in order to improve the ability to identify children with motor difficulties (Wilson, Kaplan, Crawford & Roberts, 2007:1). Although the DCDQ was originally developed in Canada, cross-cultural adaptations of the DCDQ have been made and similar results were obtained as those in Canada (Prado et al., 2009:241). Another alternative was established for the MABC-C, using physical education teachers instead of the class teachers, since the physical education teachers could be more experienced in observing children in a changing environment (Piek & Edwards, 1997:65). The results of Piek and Edwards' study (1997:65) conclude that the physical education teachers identified more children with motor difficulties compared with the class teachers. Even if the advantages are few, the independent use of questionnaires by researchers is not recommended (Junaid et al., 2000:158; Schoemaker et al., 2003:425). Schoemaker et al. (2003:425) are of the opinion that it is more beneficial to identify all the children with potential DCD, even if some children present false positives. Using a norm-referenced standardised test after the screening process will correct the false positive diagnoses. The researcher makes the argument that it is ethically more responsible to over-identify children than to fail to identify the children who need interventions.

Screening tools for DCD include the DCDQ'07 (Wilson & Crawford, 2007:17) and the MABC-C (Henderson,Sugden & Barnett, 2007:114). Norm-referenced instruments that can be used are the Bruininks-Oseretsky Test of Motor Proficiency or the Movement Assessment Battery for Children-2 (MABC-2 Test) (Henderson et al., 2007:114). Further discussion is limited to the DCDQ'07, MABC-C and the MABC-2 Test, as these assessment instruments were used in the current study.

2.8.1 Developmental Coordination Disorder Questionnaire’07 (DCDQ’07)

This questionnaire is a brief parent questionnaire intended to screen for DCD in children between 5 and 15 years of age (Wilson & Crawford, 2007:7). The original DCDQ was developed at the Alberta Children’s Hospital in the late 1990s (Wilson & Crawford, 2007:7). A later revision was developed and is known as the DCDQ’07. The questionnaire consists of 15 items (motor skills) where children either use their hands or move around in order to complete the skill. Children’s performance on each is rated by the parent in terms on a likert scale from one to five. A rating of one indicates ‘not at all like your child’ whereas a five indicates ‘extremely like your child’ (Wilson et al., 2007:1-3). The rating values are summed to provide a total score. The interpretation of the total score, as well as the cut off scores, varies between three different age groups. (See Table 2.2).

Table 2.2: Interpretation of the total score

Age group:	Indication of DCD or suspect DCD	Probably not DCD	Cut off scores
5 year 0 months to 7 years 11 months	15-46	47-75	Sensitivity=75.0% Specificity=71.4%
8 year 0 months to 9 years 11 months	15-55	56-75	Sensitivity=88.6% Specificity=66.7%
10 year 0 months to 15 years	15-57	58-75	Sensitivity=88.5% Specificity=75.6%

Interpretation of the DCDQ’07 total score Adapted from: Wilson and Crawford, 2007:7

2.8.1.1 Psychometric properties of the Developmental Coordination Disorder Questionnaire’07 (DCDQ’07)

2.8.1.1.1 Reliability

According to Baechle and Earle (2008:240), reliability refers to a measure of the degree of consistency or repeatability of a test. A test must be reliable to be valid, because highly variable results have little meaning.

The internal consistency, according to Wilson et al. (2009:184), was sound (Cronbach's alpha coefficient is 0.89). Corrected item-total correlations varies between 0.42 and 0.67 (p<0.001). With regard to the test-retest reliability, the original version (Canadian) of the DCDQ did not include a measure of test-retest reliability. Although two translated versions of the DCDQ have found a high reliability of 0.94 in the Chinese version (Tseng, Fu, Wilson & Hu, 2010:39) and 0.97 among Brazilian children(Prado et al., 2009:240). According to Wilson and Crawford (2010:23) the reliability between inter-rater assessments had not been conducted.

2.8.1.1.2 Validity

Validity refers to the degree to which a test or test item measures what it is supposed to measure; this is the most important characteristic of testing (Baechle & Earle, 2008:239).

Wilson and Crawford (2010:23) investigated the construct validity of the DCDQ by assessing a group of 136 children with DCD or who were suspected of having DCD. These children scored significantly lower on the DCDQ'07 when compared to 96 children without DCD (F (1,230) = 81.7, p <0.001). A concurrent validity exists between the DCDQ'07 and the MABC (r = 0.55, p <0.001), as well as the Visual Motor Integration Test (r = 0.42, p <0.001).

2.8.1.1.3 Gender factors

Wilson et al. (2009:189), as well as Wilson and Crawford (2010:23) established that the DCDQ scores do not differ significantly between girls and boys (F (1,284) = 0.8, p = 0.37). In contrast, Tseng et al. (2010:40), state that the mean value of the total score was affected, with girls having a higher mean DCDQ total compared to boys.

2.8.1.1.4 Sensitivity and specificity

Sensitivity refers to the ability of the parents and teachers using the checklist to correctly identify children with moderate- (amber zone) and severe (red zone) motor problems (Ellinoudis, Kyparisis, Gitsas and Kourtesis (2009:291). According to Ellinoudis et al., 2009:291), specificity refers to the ability of the parents and teachers using the checklist to correctly identify children with no motor difficulties (green zone).

When using the age related cut-off scores for the three adjusted age groups, the overall sensitivity and specificity are 84.6% and 70.8% respectively (Wilson et al., 2009:189).

2.8.2 Movement Assessment Battery for Children-2 Checklist

According to Henderson et al. (2007:114) the Movement Assessment Battery for Children-2 Checklist (MABC-C) is designed to identify primary school children likely to have movement difficulties. The MABC-C consists of three sections; Section A and B address progressively more complex interactions between children and their physical environment. Section C concerns non-motor factors that may adversely affect children's movement. This is done by means of a list of specific motor behaviours that can be observed in an everyday setting such as a classroom or playground. Children's performance proficiency on each item in the MABC-C is rated by an adult observer. The ratings are summed to provide a total score, which is then mapped onto a 'traffic light' system indicating whether children fall into the age-expected normal range (also known as the green zone), show signs of some minor movement problems that need to be monitored (the amber zone) or is highly likely to have more serious movement problems (red zone).

2.8.2.1 Psychometric properties of the Movement Assessment Battery for Children-2 Checklist

2.8.2.1.1 Reliability

Research conducted on the original MABC is as follows: the internal consistency, according to Schoemaker et al. (2003:430), was very high (Cronbach's alpha coefficient is 0.96) for all 48 items. With regard to Section 1 the coefficient was 0.83; Section 2 was 0.90; Section 3 was 0.88 and Section 4 was 0.85, indicating that the checklists measure the same construct. Since their study made use of the new version of the MABC-C, Henderson et al. (2007:154) concluded that they had been unable to collect reliability data on the new Movement ABC-2 Checklist. The researchers consider the overlap in content of the old and the new checklist to be sufficient.

2.8.2.1.2 Validity

Schoemaker et al., (2003:431) investigated the construct validity of the checklist since it is expected that the scores should increase from Sections 1 to 4. Alpha was set at 0.008 in order to correct for multiple comparisons. The results indicate that Section 1 differed significantly from Section 2, $F(1,119) = 13.44$, $p<0.001$; Section 2 also differed significantly from Section 3, $F (1,119) = 71.874$. $p <0.001$. A trend only towards significance was found between Section 3 and Section 4, $F(1,119) = 9.877$, $p= 0.002$. According to Schoemaker et al. (2003:437), concurrent validity exists between the MABC Checklist and the MABC performance test ($r= 0.44$).

2.8.2.1.3 Gender factors

Henderson et al. (2007:153) found that girls had a 20% difference on Section A of the new version, indicating a statistically significant difference between boys and girls (Chi square=17.7 df = 1, $p<0.001$). Section B did not indicate a statistically significant gender difference (Chi square=0.16, df = 1, $p= 0.69$). With regards to the total motor score, no significant gender difference was observed (Chi square = 0.24, df = 1, $p = 0.64$).

2.8.2.1.4 Sensitivity and specificity:

Best results were obtained when the 15th percentile was used as the cut-off criterion for the checklist. The overall sensitivity was 80% in all age groups, except for children aged 8-years of age. This indicates that the checklist did not identify a large number of 8-year old children on the MABC with motor problems. The specificity was 90% for 6-year old children; for the remaining age groups the specificity rates were poor. This indicates that children in the older age groups will pass the MABC performance test but fail on the checklist (Schoemaker et al., 2003:437).

2.8.3 Movement Assessment Battery for Children-2 Performance Test

The Movement Assessment Battery for Children-2 (MABC-2 Test) is a standardised test (Henderson et al., 2007:114) and requires children to perform a series of motor tasks in a specified manner. In addition to age-related norms, the test also provides qualitative information on how children approach and perform the tasks. The MABC-2 Test assesses the participants' motor proficiency levels and identifies children with DCD. The first assessment component of this test battery contains a total of 24 items organised into three sets of eight tasks. Each set is designed for use with children of a different age band. The eight tasks are grouped under three headings, namely manual dexterity (MD), balance (B) and aiming and catching (AC) (Henderson et al., 2007:114). Age-adjusted standard scores and percentiles are provided, as well as a total score for each of the three components of the test. The total test score can be interpreted by cut-off point in terms of a 'traffic light' system. The green zone indicates performance in a normal range (> 15th percentile), while the amber zone indicates a child as being at risk and needing to be carefully monitored (5th – 15th percentile). The red zone is an indication of definite motor impairment (< 5th percentile).

2.8.3.1 Psychometric properties of the Movement Assessment Battery for Children-2 Performance Test

2.8.3.1.1 Reliability

The only literature available with reference to the psychometric properties of the MABC-2 is found in the test's manual, as well as in limited, and more often than not, unpublished studies (Mayson, 2007:4).The authors of the original Movement Assessment Battery for Children (MABC) believe the item content of each edition of the MABC to be adequately comparable and thus feel that studies that used the MABC are still relevant (Mayson, 2007:2). According to Henderson et al. (2007:136), the reliability for the scaled scores were measured by means of Pearson's product moment correlations. With regard to the components, the coefficients exceeded the criterion of >70. Manual dexterity was r = 0.77; aiming and catching was r = 0.84 and balance r = 0.73. The reliability coefficient for the total test scores was 0.80 (Henderson et al., 2007:136; Mayson, 2007:3). With reference to the test-retest reliability, as well as the inter-rater assessments, the coefficient was as high as 0.95 (Henderson et al., 2007:133-34; Mayson, 2007:3).

2.8.3.1.2 Validity

A large volume of research literature is available with regards to the validity of the original MABC. Unfortunately, there is currently a lack of research with reference to the MABC-2 (Mayson, 2007:3). Henderson et al. (2007:144) state that the MABC performance test is a valid test to use. The authors observed the correlations between the test components which ranged between 0.25 and 0.36, indicating a relatively low correlation. A moderate to good correlation was established between the test components and the total test score 0.65 and 0.73 (Mayson, 2007:3).

2.8.3.1.3 Sensitivity and specificity:

The best results were obtained when the 15^{th} percentile was used as the cut-off criterion for the MABC performance test (Schoemaker, 2003:437).

In conclusion, the various assessment tools, namely the DCDQ'07, MABC-C and the MABC-2 Test are all reliable and valid tools for the assessment of movement difficulties and can therefore be used to assess the children in this study.

Subsequently, if movement difficulties are identified by the various screening assessments as well as the norm reference test, it is recommended that children should undergo interventions. Children should be referred to a professional to initiate the appropriate intervention.

2.9 Interventions

Even though children will not outgrow this disorder, as previously believed (Losse, Henderson, Elliman, Hall, Knight & Jongmans, 1991:55; Henderson & Henderson, 2002 cited in Sherrill, 2004:548; Sugden & Chambers, 2003:521), children can be helped by means of intervention programmes. Intervention can be defined as "the action of intervening to improve or control a situation" (South-African pocket Oxford Dictionary 2005:472). However, for an intervention programme to be either a failure or successful, it is important to take into consideration the dynamic interaction between the child, environment and the task (Sugden & Henderson, 2007:3).

This implies that the development of a child is a complex process consisting of various personal characteristics, such as the cognitive, social, linguistic, emotional and motor characteristics. These personal characteristics interact with one another over a period of time. Therefore, if a child experiences difficulty in one of these characteristics it will influence or be influenced by the other (Sugden & Henderson, 2007:3). According to Sugden and Henderson, (2007:3): "the environment in which a child operates has a crucial role to play in the success, or failure of any intervention programme". Examples include at home, school support, health services as well as recreational facilities. On the other hand the task can be seen as learning a particular skill for a particular context and later on using the new learned skill in a various circumstances (Sugden & Henderson, 2007:3).

Two intervention approaches normally used among researchers are the task orientated and process orientated approaches (Sugden & Chambers, 2003:546; Auxter, Pyfer & Huettig, 2005:118). Selecting an intervention approach depends on various factors, including the amount of time available, age and level of readiness of the children, capabilities and experience of the facilitator as well as the number of individuals available to assist in the intervention (Auxter et al., 2005:118).

The task and process orientated approaches are discussed, with emphasis on the perceptual-motor aspect of the process orientated approach since this intervention was used in the current study.

2.9.1 Task orientated approach

A task orientated approach is also known as a top-down approach, or to teach specific skills. This approach focuses on a skill causing the problem and differs from the process orientated approach, since there is no emphasis on the underlying process (Sugden & Chambers, 2003:547; Bernie & Rodger, 2004:24; Niemeijer, Schoemaker, Smits-Engelsman, 2006:1223). According to Auxter et al. (2005:120), this approach emphasises the teaching of skills and behaviours that are crucial for children to function independently in a community as they get older. If the skill is mastered, it should be practiced in a variety of conditions to ensure that children will be able to use the specific skill in different situations. This approach is ideal for children older than 12 years of age as well as children with physical disabilities (Auxter et al., 2005:122).

2.9.2 Process orientated approach

The process orientated approach is also known as the bottom-up or developmental approach. The aim of this approach is to improve the underlying process which is not developed fully for their age. This includes sensory functions, attention and planning and is considered a prerequisite for the attainment of motor skills. It can therefore be considered to eliminate motor deficiencies (Sugden & Chambers, 2003:546; Bernie & Rodger, 2004:24). According to Auxter et al. (2005:123) the underlying principle of this approach is to ensure that the supporting building blocks and integration processes are functioning optimally in order to facilitate skill development. For clearer understanding of this approach, a summary of the levels of motor functioning are addressed.

The levels of motor functioning consist of four levels. According to Auxter et al. (2005:118), the first level is the basic neurological building blocks and entails that the sensory input system should function efficiently. Sensory input systems include the primitive and postural reflexes, the vestibular, kinesthetic, tactile, and auditory systems, as well as refractive and orthoptic vision.

The second level focuses on the integration processes, and quality movement experiences are crucial. The integration processes consists of three aspects: physical fitness (strength, flexibility, muscular and cardiovascular endurance); motor fitness (agility, power, speed and coordination), in addition to perceptual motor fitness (balance, laterality, directionality and cross-lateral integration) (Auxter et al., 2005:119).

The third level, according to Auxter et al. (2005:119), refers to functional skills. Functional skills relate to functional living skills such as locomotor skills (running, hopping, jumping and skipping) or object control skills (kicking, catching, throwing and striking).

Finally, sports skills are specific skills necessary for sports participation, such as dribbling a ball, spiking a ball or diving. All the levels are interrelated and each level contributes to sound motor functioning (Auxter et al., 2005:119).

In the following paragraphs various research findings on interventions are discussed in more detail.

2.9.3 Research findings on interventions

Researchers traditionally used bottom-up approaches by means of sensory integration and perceptual motor training in children with DCD (Bernie & Rodger, 2004:24; Sugden et al., 2008:183). These approaches aimed to improve children's processing abilities or performance components and are still being used as an intervention by many therapists (Missiuna, Rivard & Bartlett, 2006:79; Sugden et al., 2008:183). According to Hamilton (2002:8), the most frequently used approaches were perceptual-motor therapy, sensory-integration therapy and kinesthetic training and all of these more often than not produced positive results.

Due to a lack of support for the bottom-up approach, new approaches, known as the cognitive or top-down approach, emerged (Bernie & Rodger; 2004:24). More researchers are in favour of this approach (Sugden et al., 2008:183). These new approaches are based on theoretical concepts of motor learning and cognition.

Motor learning is based on a conscious understanding of the processes involved when a motor problem needs to be solved. Thus, the interaction between the task environment and the child needs to be taken into consideration (Perry,1998:6). Cognition approaches use direct skill teaching, but differ in the sense of the unique problem-solving framework, attempting to help children generalise from the learning of one skill to the next (Missiuna et al., 2006:82).

According to Missiuna et al. (2006:80) and Sugden et al. (2008:183), even if the task-specific approach is aimed at increasing children's participations, it is preferable to consider how children can perform a specific task in a variety of real-life situations, rather than in one specific setting (splinter skills). Therefore, one should consider how to modify the task or to adapt the environment in order for children to participate and improve their learning capabilities.

A specific cognitive approach, Cognitive Orientation to Occupational Performance, has been examined successfully in clinical settings. Sugden et al. (2008:82) are of the opinion that on-going research will determine if this approach can be used effectively in other settings.

Sugden and Chambers (1998:139) propose that most interventions are successful with a good number of children diagnosed with DCD. This statement was supported by findings from the same authors (Sugden & Chambers, 2003:558), observing that interventions done by parents and teachers can also be successful. The researchers found that a 7-week intervention (task-orientated approach) conducted by parents and teachers helped a majority of children to obtain scores above the 15^{th} percentile. Miyahara et al., (2008:360) used university students in a clinical setting to apply a task-orientated approach and found that 40% of the participants improved beyond the cut-off scores. Intervention by means of a combination of the bottom-up and top-down approach through intense physical activity, conducted by Watemberg et al. (2007:924), concluded that 50% of the participants with DCD scored above the cut-off scores (>15 percentile) after a 4 week intervention.

It is clear that controversies exist between these different approaches and there is still not enough evidence to prove that one specific intervention approach is superior to another (Miller, Polatajoko, Missiuna, Mandich, Macnab, 2001:204; Miyahara et al., 2008:360). It is therefore recommended that these two approaches (bottom-up and top-down) should be combined in order to treat children with DCD (Peters & Wright, 1999:205; Davidson & Williams, 2000:496).

2.10 Perceptual-motor skills

According to Johnstone and Ramon (2011:v) perceptual-motor skills permit sensory information to be successfully obtained and understood with appropriate reaction. Thus, “perceptual” refers to obtaining information and “motor” deals with the outcome of the movement. Therefore perceptual-motor activities require children to use the brain and body together in order to accomplish tasks.

Johnstone and Ramon (2011:v) also state that meeting children’s gross motor needs will improve their academic readiness, as well as their overall behaviour. Neural pathways are built by means of physical activity. This process refers to the connections by which information travels through the brain. A child with more neural pathways will be able to learn more easily (Cf. 2.4: Basic principles of neurophysiology). Early intervention is very important in order to develop perceptual-motor skills.

A perceptual-motor intervention targets components such as laterality (unilateral, bilateral and cross-lateral activities), balance, body image, tracking, spatial relations, locomotor as well as manipulative skills. Taking part in perceptual-motor activities enables children to develop greater levels of body control and encourages greater effort in all areas of the school curriculum. Children with sufficient perceptual-motor skills enjoy better coordination, greater body awareness, stronger intellectual skills, as well as a more positive self-image (Johnstone & Ramon, 2011:v).

In addition to perceptual-motor interventions, sport stacking was launched in a South African setting in January 2009. Sport stacking is already recognised as a sport by more than 18 nations, including Australia and Germany in addition to South Africa (Krog, 2008:1). According to the World Sport Stacking Association (2009:1), sport stacking is defined as a sport where 12 specialised cups are used to build formations. A participant is called a stacker. Stackers must stack cups in predetermined sequences, competing against the clock or another player (Gibbons, Hendrick & Bauer, 2007:1).

Sport stacking can, therefore, be used as an innovative and exciting way of improving motor proficiency, such as hand-eye coordination, ambidexterity, speed, rhythm, self image and concentration while having fun in order to improve perceptual-motor skills (Udermann, Mayer, Murray, & Sagendorf, 2004:411; Krog, 2008:1).

2.11 Conclusion

Chapter 2 focused on important aspects relating to DCD. Researchers do not fully understand the etiology of this developmental disorder. It is therefore important to assess children continuously by means of questionnaires and formal tests. Once these children have been identified, appropriate interventions, either the bottom-up or top-down approaches, can be implemented in an attempt to prevent the secondary negative characteristics associated with DCD.

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CHAPTER 3

ARTICLE 1:

Developmental Coordination disorder in Grade 1-learners

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Developmental Coordination Disorder in Grade 1-learners

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ABSTRACT

Since the 1900's the scientific community has acknowledged a large group of children who develop well intellectually but experienced movement skill difficulties. Developmental Coordination Disorder (DCD) is defined as children who experience motor coordination difficulties which impedes functional performance and interfere with their academic achievement, physical- and psychological development as well as activities of daily living. Therefore, the purpose of the study was; to determine the prevalence of DCD amongst Grade 1 learners, to establish the boy-girl ratio regarding DCD and the prevalence of DCD amongst various ethnic groups. Five-hundred and fifty nine learners between the ages of 6 and 8 years took part in this study. There were n=321 girls (57%) and n=238 boys (43%) of various ethnical groups, which consisted of 57.4% Caucasian, 39.7% Black, 2.50% Mixed-race, 0.3% Hispanic and 0.1% Indian children. The Movement Assessment Battery for Children-2 (Movement ABC-2) was used to determine DCD. The results indicated that 85% participants had no motor difficulties (green zone), 8% of children in the group were identified with moderate motor difficulties (amber zone), while 7% were identified with severe motor difficulties (red zone). With regard to the boy-girl ratio, the boys had 9% moderate difficulties and 10% severe difficulties in contrast to 7% moderate difficulties and 5% severe difficulties amongst the girls. With reference to ethnical groups, 5.3% of Caucasian learners fell in the amber zone and 5.3% in the red zone, 10.6% of Black learners fell in the amber zone and 9.7% in the red zone, 14.2% Mixed-race learners fell in the amber zone and 21.4% in the red zone. The conclusions drawn from the results suggest that the prevalence of DCD amongst Grade 1 learners in Bloemfontein is estimated to be 15%. The results also indicate that boys have a significantly higher (p=0.0507) prevalence of DCD although marginally when compared to their female counterparts.

Keywords: Developmental coordination disorder, Movement Assessment Battery for Children-2, Grade 1 Learners

Developmental Coordination Disorder in Grade 1-Learners

INTRODUCTION

Developmental coordination disorder (DCD) can be seen as a disorder that influences children's daily living activities, although no obvious cause is evident. Developmental coordination disorder can be defined as a: *"marked impairment in the development of motor coordination that is not explicable in terms of general intellectual retardation or of any specific congenital or acquired neurological disorder*" (Henderson *et al.,* 2007). According to Missiuna *et al.* (2007), DCD also include children that experience significant difficulties in motor learning and in the performance of functional motor tasks that are critical for success in their daily lives such as activities at home, school and during play.

Developmental coordination disorder affects children all over the world. Researchers in the United Kingdom estimated the prevalence between 4-5% (Lingam *et al*., 2009). According to Hamilton (2002) 6% of children in the United States of America are diagnosed with DCD. Junaid *et al*., (2000) found that approximately 8-15% of Canadian children have some form of coordination problems. America and Europe have a higher prevalence than the United Kingdom and New Zealand. Between 5-19% of children have been found to have motor problems (Miler *et al*., 2001). The real prevalence of DCD among children might even be higher, since medical as well as educational systems frequently fail to identify this disorder in young children (Gains & Mussiuna, 2006; Missiuna *et al*., 2007; Miyahara *et al*., 2008).

Gender also plays a role with regard to DCD. Literature indicates that boys experience more problems than girls, with a boy-girl ratio of 3:1 (Hoare & Larkin, 1991) and 2:1 (Wright & Sugden, 1996). Reported in previous studies, according to Wessels *et al.* (2008) the ratio is 2-3:1. Although children diagnosed with DCD have certain difficulties, with motor dysfunction being the core of all the problems, the children are a heterogenic group (Gillberg, 1998; Geuze *et al.,* 2001; Dewey & Wilson, 2001). This implies that no two children are the same and that negative effects experienced could vary between children.

Major concerns relating to DCD are the considerable harmful effects associated with this disorder. Developmental coordination disorder influences children's daily activities at home (dressing and using various tools), normal play (running, riding a bike, swimming and ball games) and in school (writing and cutting activities) (Schoemaker *et al.,* 2003; Sudgen & Wright, 1998). Secondary problems associated with DCD are physical health, such as obesity and lower aerobic levels due to lower activity levels (Cantell *et al.,* 2003; Tsiotra *et al.,* 2009), social, emotional and academic problems (Piek & Edwards, 1997; Cantell *et al.,* 2003). Other related problems linked to DCD are attention deficit hyperactivity disorder (ADHD) (Pitcher *et al.,* 2003; Watemberg *et al.,* 2007; Wessels *et al.,* 2008); speech and language disorders (Gaines & Missiuna, 2006), as well as visual-motor deficits (Wilmut *et al.,* 2007).

METHODOLOGY

Study design

This empirical study made use of quantitative and qualitative approach to collect data. The study involved one testing procedure in order to determine the prevalence of DCD amongst Grade 1 learners in Bloemfontein. In addition, the boy-girl ratio regarding DCD as well as the prevalence of DCD amongst various ethnic groups were determined. The cut-off scores used in this study was based on Henderson *et al's.* (2007) recommendations, which are as follows: severe motor difficulties (≤5th percentile), moderate motor difficulties (5th-15th percentile) or children having no motor difficulties (>15th percentile). The participants were tested at their schools by eight Kinderkineticists who are familiar with the testing procedures of the relevant instrument. Each Kinderkineticist was responsible for one of the eight subtests to ensure consistency across the study.

Participants

Initially 13 schools in the Bloemfontein area were targeted to take part in the research project but only seven schools eventually agreed to participate. The Department of Education as well as the principals of each school gave permission for the research to be conducted on the school premises during the life orientation periods. Approval had been obtained from the Ethics Committee of the Faculty of Health Sciences, University of the Free State (ECUFS57/2012). The parents of the participants completed an informed consent form for each child participating in this study. All children in the identified classes were considered for inclusion into the study. Exclusion criteria included a child in the age group outside the expected range from 5-8 years, parental permission not obtained or the informed consent form not completed fully or parents indicating that they would be relocating during the study. Five-hundred and fifty nine (n=559) learners in Grade 1 (the youngest being 5 years and 8 months old and the oldest 8 years and 4 months old) took part in the study. The study consisted of boys (n=238) and girls (n=321) who belonged to various ethnic groups (Caucasian: n=320; Black: n=222; Mixed race: n=14; Hispanic: n=2; and Indian: n=1).

Measuring instruments

The Movement Assessment Battery for Children-2 (Movement ABC-2) is a standardised test (Henderson *et al.,* 2007) and the reliability coefficient for the total test scores was 0.80 (Henderson *et al.,* 2007; Mayson, 2007). Unfortunately research on validity is only available with regards to the original MABC (Mayson, 2007). Henderson *et al.,* (2007) state that the original MABC performance test is a valid test to use. The authors observed the correlations between the test components which ranged between 0.25 and 0.36, indicating a relatively low correlation. Although, a moderate to good correlation was established by Mayson (2007) between the test components and the total test score 0.65 and 0.73.

The Movement ABC-2 requires children to perform a series of motor tasks in a specified manner. In addition to age-related norms, the test also provides qualitative information on how children should approach and perform the tasks. The Movement ABC-2 assesses the subject's motor proficiency levels and diagnoses children with DCD. The first assessment component of this test battery contains 24 items organized into three sets of eight tasks. Each set is designed for use with children of a different age band. The eight tasks are grouped under three headings, namely manual dexterity (MD), balance (B) as well as aiming and catching (AC) (Henderson *et al.,* 2007). Age-adjusted standard scores and percentiles are provided, as well as a total test score for each of the three components of the test. The total test score can be interpreted in terms of a 'traffic light' system. The green zone indicates performance in a normal range (>15th percentile), while the amber zone indicates that a child is at risk and needs to be carefully monitored (5th-15th percentile). The red zone is an indication of definite motor impairment (≤5th percentile).

Statistical analysis of data

The researchers captured data electronically in Microsoft Office Excel 2007. Analysis of the data was done by a biostatistician using Statistical Analysis Software Version 9.1.3. Descriptive statistics, namely frequencies and percentages, were calculated for categorical data. Medians and percentiles were calculated for numerical data. Median differences were tested by calculating p-values using the signed-rank test. The Chi-square statistics were used to test for proportion differences. Probability level of 0.05 or less was taken to indicate statistical significance.

RESULTS

Table 3.1 represents the numerical data of the mean procedure for the various subtests of the Movement ABC-2 results.

Table 3.1: The mean procedure of the Movement ABC-2 results.

Variable	n	Lower Quartile	Median	Upper Quartile
MD	551	5.0	16.0	37.0
AC	551	37.0	63.0	84.0
B	551	37.0	50.0	75.0
TTS	551	16.0	37.0	63.0

Abbreviations: n = sample size, MD = Manual Dexterity, AC = Aiming and Catching, B = Balance, TTS = Total Test Score

Table 3.1 shows the results of the 551 children specific to each subtest using the median procedure. The lower quartile represents the 25th percentile, which means that 75% of the children will obtain better results. The upper quartile is the 75th percentile, thus implying that only 25% would obtain better results. The data in Table 3.1 indicates that the median score for manual dexterity was 16 with an interquartile range of 5 to 37. With reference to aiming and catching, the median score was 63 and the interquartile range was 37 to 84. Balance has a median score of 50 and ranged between 37 and 75. The total test score was derived from the three subtests. The median was 37 and the interquartile range was 16 to 63. It is clear that children had the greatest difficulty performing the manual dexterity subtest.

The distribution of the children according to the traffic light system (degree of motor difficulty) according to the MABC-2 test is illustrated in Figure 3.1.

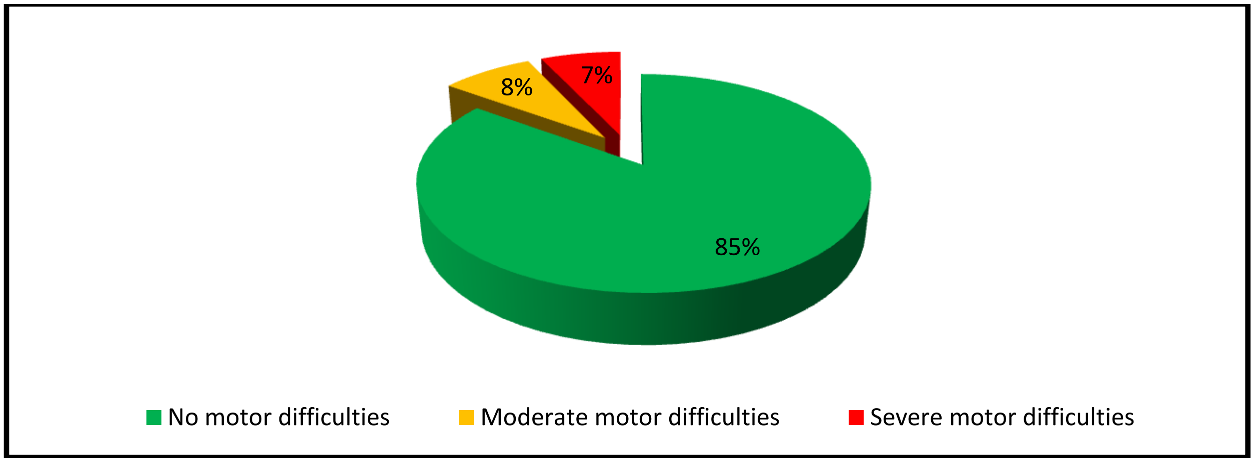
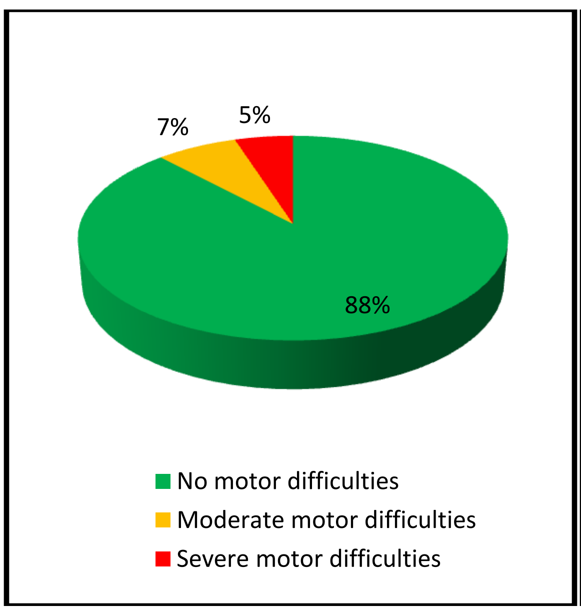


Figure 3.1: Prevalence of DCD in Grade 1 learners

Figure 3.1 presents the percentages with regard to the traffic light system. Green indicates no motor difficulties (85%), amber indicates moderate motor difficulties (8%) and the red zone indicates severe motor difficulties or DCD (7%) amongst Grade 1 learners in Bloemfontein. It is interesting to note that more children are experiencing motor difficulties then previously indicated.

The distribution of the girls and boys according to the traffic light system (degree of motor difficulty) according to the MABC-2 test is shown in Figures 3.2 and 3.3



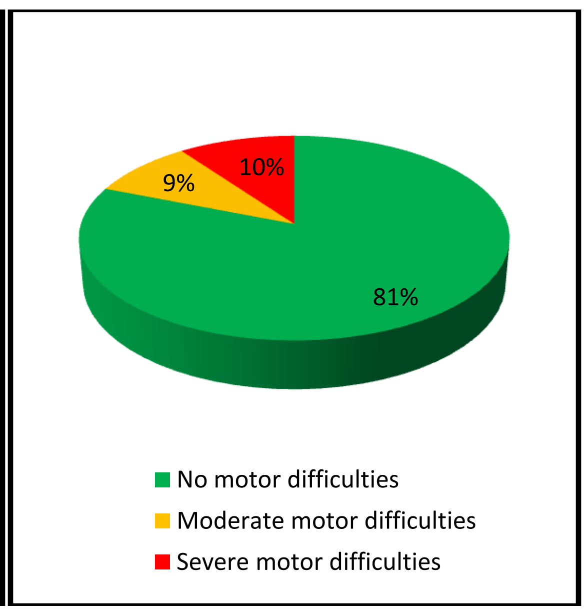


Figure 3.2: Traffic light categories for girls.

Figure 3.3: Traffic light categories for boys.

As expected Figures 3.2 and 3.3 indicated that boys had a significant (p=0.0507) higher prevalence of DCD than girls, although marginally. Eighty eight per cent (88%) of the girls fell in the green zone compared to 81% of boys. With reference to the amber zone, 7% of girls had moderate motor difficulties in contrast to 9% of boys. The red zone indicates that 5% of girls had severe motor difficulties compared to 10% of boys.

The distribution of the various ethnic groups according to the traffic light system (degree of motor difficulty) based on the MABC-2 Test is shown in Figure 3.4.

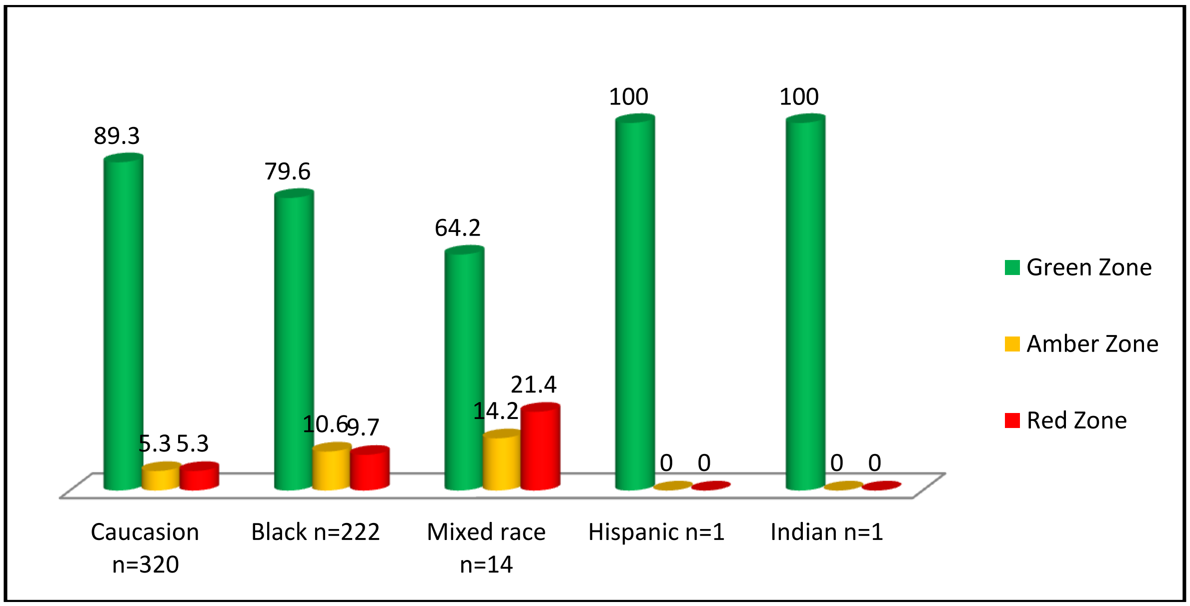


Figure 3.4: Prevalence of DCD in Grade 1 learners according to ethnic groups

While 89.3% of Caucasian children experienced no motor difficulties, 79.6% of Black children, 64.2% Mixed-race children and both the Hispanic and Indian child fell in the green zone (Figure 4). With regards to the amber zone, 5.3% of Caucasian children experienced motor difficulties, 10.6% of Black children and the percentage were even higher for the Mixed-race children 14.2%. Observing the red zone, 5.3% of Caucasian children experienced severe motor difficulties, 9.7% of Black children and again the percentage was higher for the Mixed-race children at 21.4%. There was a statistically significant difference (p=0.0192) in DCD between the various ethnic groups.

DISCUSSION OF RESULTS

DCD affects children all over the world, but the prevalence differs substantially in various countries. In the current study, it was found that at least 15% of the sample had moderate to severe motor difficulties. These statistics are in contrast to various findings reported in the literature where the researchers state that DCD affects more or less 5-6% of school-age children (APA, 2000; Gaines & Missiuna, 2006; Prado *et al.,* 2009). Researchers in the United Kingdom estimated the prevalence between 4-5% (Lingam *et al.,* 2009), which is much lower than the 15% found in the present study. Wilmut *et al.* (2007) found a higher
prevalence of DCD (5-10%), but this is still 5% lower than that obtained in the current study.

The research findings of Junaid *et al.* (2000) correlate best with that of the current study. These researchers found approximately 8-15% of Canadian children to have some form of coordination problems. Studies in America and Europe found an even higher prevalence of DCD, estimated at 5-19% (Miller *et al.,* 2001). According to Gains & Mussiuna, (2006), Missiuna *et al.,* (2007) and Miyahara *et al.,* (2008) medical- and education systems often fail to identify DCD in young children and therefore the prevalence might be higher.

The current study found that boys exhibit significant (p=0.0507) more moderate to severe motor difficulties compared to girls, with a boy-girl ratio of 1.6:1. However, this ratio is smaller compared to other research findings. The literature also indicates that boys experience more problems compared to girls, with a boy-girl ratio of 2:1 (Wright & Sugden, 1996). Wessels *et al*. (2008) found the ratio to be 2-3:1. Furthermore, Rivard *et al.* (2007) estimated that the gender difference could even be as high as 3-4:1. Hoare and Larkin (1991) also found that more boys than girls are attending remedial programmes for DCD (9:1), supporting the belief that boys experience more problems as found in the current study.

Although gender differences do occur, researchers need to take into consideration that gender differences are a normal phenomenon in the attainment of motor skills among children. Literature indicates that girls perform better in fine motor skills, whilst boys are better at gross motor skills (Gallahue & Ozmun, 2006). Junaid and Fellowes (2006) reported that, when using the MABC, girls outperformed the boys with regard to manual dexterity items and the boys were superior on the ball skills items. No differences were established between the balancing skills of boys and girls. Junaid and Fellowes (2006) also argue that these differences are due to the disparity between the acquisition of motor skills between boys and girls.

Limited research is reported on the difference between various ethnic groups. The current study indicates that Caucasian children experienced less moderate- and severe motor difficulties (5.3%). Similar findings were reported by Wessels *et al.,* (2008) on a smaller population sample of 99 children in Potchefstroom, North West Province. The Caucasian learners had a 9% prevalence of moderate motor difficulties and 5% severe motor difficulties. The Black learners of the current study demonstrate a 10.6% moderate motor difficulties and 9.7% severe motor difficulties. This higher prevalence amongst Black learners is supported by Wessels *et al.,* (2008) who reported an even higher prevalence of moderate motor difficulties (15%) and severe motor difficulties (17%). With reference to the Mixed-race a higher prevalence were established in the current study, moderate motor difficulties (14.2%) and severe motor difficulties (21.4%). Contrary Wessels *et al.,* (2008) found that the Mixed-race had the lowest prevalence of moderate motor difficulties (5%) and severe motor difficulties (1%) respectively. The current research indicates a trend towards a higher prevalence in Black learners with a suggestion of even a higher prevalence in learners of Mixed-race. Wessels *et al.,* (2008) stated that socio economic status may be a reason for differences between ethnic groups and the prevalence of DCD. A limitation in the current study was the unequal distribution between the various ethnic groups, which could have influenced the prevalence of DCD and should be therefore taken into consideration in future research.

CONCLUSION

The prevalence of DCD (15%) of school age children in the current study was higher compared to the findings reported in the literature (5-6%). It is also clear that although minor differences do exist in relation to gender, boys still have a significant higher incidence of DCD. Finally, it can be concluded that the research identified a trend towards a higher prevalence of DCD in Black- and Mixed-race learners.

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CHAPTER 4

ARTICLE 2:

The competency of parents to identify grade 1-learners with developmental coordination disorder at home

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The competency of parents to identify Grade 1-learners with developmental coordination disorder at home

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ABSTRACT

Developmental Coordination Disorder (DCD) is recognised as one of the most common developmental dysfunctions during childhood and a large number of children between six and twelve years of age are identified with DCD. The aim of the study was to examine the convergent validity of the classification of motor difficulties by Kinderkineticists-in-training using the Movement Assessment Battery for Children-2 (MABC-2 Test) and the classification of motor difficulties by the parents of the participants using the DCD Questionnaire '07 (DCDQ'07), in order to determine if parents possess the competency to identify Grade 1-learners with DCD at home. Four hundred and ten (N = 410) Grade 1-learners between the ages of five and eight years took part in this study. There were n = 226 girls (55%) and n = 184 boys (45%). The ethnic groups that took part consisted of 67% Caucasian and 33% Black children. The results indicated 91% specificity for the DCDQ'07. In contrast, the sensitivity was only 23%. The kappa coefficient of 0.151 indicated a 15% convergent validity between the two assessment tools. Therefore, it can be argued that parents using the DCDQ'07 could not identify children with DCD at home.

Keywords: Developmental Coordination Disorder (DCD), Movement Assessment Battery for Children-2 (MABC-2 Test), Developmental Coordination Disorder Questionnaire'07 (DCDQ'07), Grade 1-learners

The competency of parents to identify Grade 1-learners with Developmental Coordination Disorder at home

INTRODUCTION

Developmental Coordination Disorder (DCD) is recognised as one of the most common developmental dysfunctions during childhood (Ellinoudis *et al*., 2009). Literature indicates wide debate with regard to the prevalence of DCD (Giagazoglou *et al*., 2011) and varies with regard to the diagnostic criteria that are used (Carslaw, 2011). According to the American Psychiatric Association (APA) (2013), DCD affects 5%-6% of school-age children between five and eleven years of age, while Wilmut *et al*. (2007) indicated the prevalence of DCD between 5%-10%. In South Africa (Bloemfontein metropolitan area) the prevalence of DCD was even higher, as it was found that 15% of learners had DCD (De Milander *et al*., 2014). Alarmingly, Pienaar (2004) as well as Wessels *et al*. (2008) reported that children in the North West province of South Africa had a significantly higher prevalence of DCD, reported as 61% and 52% respectively. Pienaar (2004) concluded that the norms of the Movement Assessment Battery for Children should be adjusted for South African children.

DCD can be defined as a marked impairment in the development of motor coordination that is not explicable in terms of general intellectual retardation or in terms of any specific congenital or acquired neurological disorder (APA, 2013). It is diagnosed in children who experience significant difficulties in motor learning and in the performance of functional motor tasks that are critical for success in their daily lives such as activities at home (dressing themselves), school (handwriting) and during play (ball skills) (Edwards *et al*., 2011; Asonitou *et al*., 2012). These difficulties can be viewed as clumsiness, for example dropping objects, in addition to the slow and inaccurate performance of motor skills such as catching objects, using scissors or taking part in sports (APA, 2013).

Zwicker *et al*. (2012) argue that one of the major concerns regarding children with DCD is that they are often not formally diagnosed, but rather described by their parents and teachers as lazy or awkward. Furthermore, it is stated that the reason for not diagnosing these children is the lack of awareness of the disorder. The use of questionnaires is encouraged by Missiuna and Pollock (1995), as well as Wright and Sugden (1998), who stated that numerous tools should be used to gather information from parents and teachers. Questionnaires may be used to identify young children in need of further assessment by professionals using normative assessment tools; however, the use of these questionnaires has both limitations and advantages. In an attempt to identify children with DCD, several research tools, such as questionnaires for screening purposes and norm-referenced tests to measure the degree of movement difficulties, can be used (Barnett, 2008). In view of the high costs of norm-referenced tests, time-consuming processes and long waiting periods, screening tools are a cost-effective way of identifying children who might have DCD (Loh *et al*., 2009). Several screening tests and questionnaires have been developed to gather information, specifically from parents and teachers, concerning children's functional motor performance, for example the Movement Assessment Battery for Children Checklist (MABC-C) and the Developmental Coordination Disorder Questionnaire '07 (DCDQ'07) (Schoemaker *et al*., 2012).

The validity and reliability of the original DCD-Q has been investigated and it has been found that this questionnaire is a valid and reliable tool which can be used for boys and girls (Schoemaker *et al*., 2008), although it has been recommended that the test can be used with confidence for children between the ages of eight years and fourteen years and six months only (Wilson *et al*., 2000). In 2009 Wilson and colleagues conducted another study using the same instrument and concluded that children as young as five years of age can be screened (Wilson *et al*., 2009). Brazilian researchers adapted the language and two of the items in the questionnaire due to cultural differences. The resulting questionnaire was found to be equivalent to the original DCD-Q. The DCDQ-Brazil also demonstrated acceptable validity and reliability (Prado *et al*., 2009). In contrast, Loh *et al*. (2009) found that the DCD-Q had a low sensitivity in detecting children with mild motor difficulties.

With regard to the limitations of the original DCD-Q, Wilson *et al*. (2000) indicated a 27% convergent validity between the therapist and the DCD-Q, demonstrating that the questionnaire did not identify children with motor difficulties as frequently as a therapist. Loh *et al*. (2009) also indicated that the DCD-Q was insufficient in distinguishing children with motor difficulties from those who did not experience any difficulties. Additionally, studies using parents' reports have produced conflicting results (Faught *et al*., 2008). Another limitation arising from using questionnaires for learners with DCD are parents of children with attention deficit/hyperactivity disorder (ADHD) was that they tended to indicate that their children experienced motor problems, while norm-referenced standardised tests indicated the opposite (Wilson *et al*., 2009). Similar findings were obtained by Loh *et al*. (2009) in a study conducted among Australian children, because the questionnaire does not differentiate the ADHD symptoms.

Relating to advantages of the DCD-Q, positive results were obtained from a study done by Green *et al*. (2005). The researchers concluded that parents could identify DCD if no other developmental problems were present. Additional advantages of the questionnaire is that children might be identified before they enter school, thus preventing secondary impairments associated with DCD (Missiuna *et al*., 2006), such as physical health problems due to lower activity levels (Tsiotra *et al*., 2009), social problems, emotional problems due to withdrawal or exclusion from peers, as well as academic problems such as difficulties with tracing, writing and learning (Wilmut *et al*., 2007). The DCD-Q was revised in order to improve the ability to identify children with motor difficulties and is now known as the DCDQ'07 (Wilson *et al*., 2007). Changes included lowering the age range to children between the ages of five and seven years, modifying the items to ensure a better understanding of the activity as well as developing a new scoring method (Wilson *et al*., 2009). According to Wilson *et al.* (2009), the validity of the DCDQ'07 was also found to be good. Although the DCDQ'07 was originally developed in Canada, cross-cultural adaptations of this questionnaire have been made and similar results were obtained as those in Canada (Prado *et al*., 2009).

Although there are a few advantages, the independent use of questionnaires by researchers is not recommended (Junaid *et al*., 2000; Schoemaker *et al*., 2003). Schoemaker *et al*. (2003) are of the opinion that it is more beneficial to identify all the children with potential DCD, even if some children present false positives. Using a norm-referenced standardised test after the screening process will correct the false positive diagnoses. They make the argument that it is ethically more responsible to over-identify children than to fail to identify the children who need interventions (Schoemaker *et al.,* 2003).

Therefore, the aim of the study was to examine the convergent validity of the classification of motor difficulties by Kinderkineticists-in-training using the MABC-2 Test and the classification of motor difficulties by the parents of the participants using the DCDQ'07, in order to determine if parents possess the competency to identify Grade 1-learners with DCD at home. The DCDQ'07, used in the current study, has only had limited testing on South African children.

METHODOLOGY

Study design

This comparative study made use of quantitative data. The study involved one testing procedure by means of the Movement Assessment Battery for Children-2 (MABC-2 Test) in order to identify DCD among Grade 1-learners (N=410). The participants were tested at their schools during the Life Orientation periods by Kinderkineticists-in-training who had been trained to use the instrument. Each Kinderkineticist-in-training was responsible for one subtest in order to have consistency across the study. In addition, a parent of each participant completed the DCDQ'07. The next step was to compare the specificity and the sensitivity of the two measuring instruments. According to Ellinoudis *et al*. (2009), specificity refers to the ability of the parents using the DCDQ'07 to correctly identify children with no motor difficulties (green zone) as identified by the MABC-2 Test, while sensitivity refers to the ability of the parents using the DCDQ'07 to correctly identify children with moderate (amber zone) and severe (red zone) motor problems (Ellinoudis *et al*., 2009). The results of the MABC-2 Test scores were compared to the results of the DCDQ'07 in order to determine the convergent validity between the two measuring instruments and to establish the competency of parents to identify DCD in children at home, thereby aiding professionals in early identification.

Participants

Initially 13 schools in the Bloemfontein area were targeted to take part in the research project, but only seven schools eventually agreed to participate and the study thus made use of an availability sample. The Department of Education of the Free State province as well as the principal of each school gave permission for the research to be conducted on the school premises during the Life Orientation periods. Approval had been obtained from the Ethics Committee of the Faculty of Health Sciences, University of the Free State (ECUFS57/2012). The participants were treated in accordance with the ethical guidelines outlined by the Ethics Committee of the Faculty of Health Sciences. The parents/legal guardians of the participants completed an informed consent form for each child participating in this study. In addition, the children signed an assent form. Recruitment was targeted at children with and without DCD via the seven participating schools who had permission to take part in the study (inclusion criteria). Exclusion criteria included a child in the age group outside the expected range (younger than five years and older than eight years), parental permission not obtained, the informed consent form not fully completed, or parents indicating that they would be relocating during the study. Children who were absent during the testing procedure were also excluded due to incomplete testing. Additionally, the Diagnostic and Statistical Manual of Mental Disorders, fifth edition, (DSM-5) (APA, 2013) was used to exclude children who had associated symptoms according to the criteria for DCD as stated in the DSM-5. Children with motor difficulties should not meet criterion C (disturbance is not due to a general medical condition, for example, cerebral palsy, hemiplegia, or muscular dystrophy and does not meet criteria for a Pervasive Developmental Disorder) or criterion D (if mental retardation is present, the motor difficulties are in excess of those usually associated with it). None of the children met the criteria and therefore all of them were included for further data analysis.

Measuring instruments

According to Henderson *et al*. (2007), the Movement Assessment Battery for Children-2 (MABC-2 Test) requires children to perform a series of motor tasks in a specified manner. In addition to age-related norms, the test also provides qualitative information on how children should approach and perform the tasks. The MABC-2 Test is used to assess the subject's motor proficiency levels and to diagnose DCD in children. The first assessment component of this test battery contains 24 items organised into three sets of eight tasks. Each set is designed to use with children of a different age band. For the current study age band 1 and age band 2 were used. The eight tasks are grouped under three headings, namely manual dexterity (MD), balance (B) as well as aiming and catching (AC) (Henderson *et al*., 2007). Age-adjusted standard scores and percentiles are provided, as well as a total test score for each of the three components of the test. The total test score can be interpreted in terms of a "traffic light" system. The green zone indicates performance in a normal range (> 15^{th} percentile), while the amber zone indicates that a child is at risk and needs to be carefully monitored (5^{th}-15^{th} percentile). The red zone is an indication of definite motor impairment (≤5^{th} percentile). Thus, high standard scores on the MABC-2 Test represent good performance. The MABC-2 Test is a valid and reliable tool to use with a reliability coefficient for the total test scores of 0.80 (Henderson *et al*., 2007).

The DCDQ'07 is a brief parent questionnaire intended to screen for DCD in children between five and fifteen years of age (Wilson & Crawford, 2007; Loh *et al*., 2009). The questionnaire consists of 15 items divided into three different categories (Wilson & Crawford, 2007). According to Wilson and Crawford (2007), the first category is "control during movement" and contains items relating to motor control while either the child or an object is in motion. The second category refers to "fine motor and handwriting" and the third category relates to "general coordination". A child's performance on each item is rated by the parent on a scale rating from one to five. A rating of one indicates "not at all like your child", whereas a five indicates "extremely like your child" (Wilson *et al*., 2007). The ratings are calculated to provide a total score. The interpretation of the total score, as well as the cut-off scores, differs for the three different age groups specified. The DCDQ'07 is a valid and reliable tool to use with a reliability coefficient of 0.89 (Wilson *et al*., 2009).

Analysis of data

The principle researcher used Microsoft Excel to electronically capture data from the MABC-2 Test as well as the DCDQ'07. Data analysis was performed by a statistician using the Statistical Package for the Social Sciences (SPSS) for Windows (SPSS version 16.0). In order to determine the convergent validity of the classification of motor problems (no motor difficulties or motor difficulties) using the MABC-2 Test and the classification of motor difficulties (no motor difficulties or motor difficulties) by the parents of the participants using the DCDQ'07, the kappa (k-) coefficient was used. This coefficient supplies information with regard to the convergent validity between the two measuring instruments. The higher the coefficient (whether it is a negative or a positive value), the greater the convergent validity between the two measuring instruments. A decision was made in an arbitrary way to assign a code 1 for the group that is identified with motor difficulties and a code 2 for no motor difficulties. This was done due to the fact that the DCDQ'07 has only a "yes" or a "no" option and thus the MABC-2 Test was adapted to two categories, namely the green zone (no motor difficulties) and the amber zone (at risk) and red zone (severe difficulties) grouped together for motor difficulties present. Further analysis was done on these two categories only. Whether the correlation coefficient is a positive or a negative value can be ignored due to the codes that have been chosen in an arbitrary way. A negative correlation only indicates that the average of the group with code 3 is lower than that of the group with code 1, while a positive correlation indicates the opposite.

The practical importance of the results was also investigated. As standard of practical significance, the effect size was calculated. Effect sizes (*r*) were calculated to determine the practical significance of the results according to Cohen (1988) by dividing the differences in the mean by the largest standard deviation of the test results. For the interpretation of practical significance, the following guideline values need to be used when the effect size is interpreted: $r = 0.1$: small effect; $r = 0.3$: medium effect and $r = 0.5$: large effect (Steyn, 1999). A probability level of 0.05 or less was taken to indicate statistical significance.

RESULTS

Table 4.1 indicates the frequency distribution of the participants according to gender and race. Four hundred and ten children (N = 410) between the ages of five and eight years took part in the study. The study consisted of boys (n = 184) and girls (n = 226), as well as an ethnic group distribution of Caucasian (n = 273) and Black (n = 137). The mean age for the children was six years and seven months with a standard deviation of 0.4. The minimum age was five years and eight months and the maximum age was eight years. As shown in Table 4.1, the majority of the participants consisted of Caucasian children (66.6%), with a greater representation of girls (55.1%) than boys (44.9%) for the whole group. The gender distribution is more or less equal between the two ethnic groups.

TABLE 4.1: **Frequency distribution of the participants according to gender and race**

Gender	Race		Total
	Caucasian	**Black**	
Boys	128 (46.9%)	56 (40.9%)	184 (44.9%)
Girls	145 (53.1%)	81 (59.1%)	226 (55.1%)
Total	273 (66.6%)	137 (33.4%)	410 (100.0%)

Table 4.2 presents the convergent validity between the classifications of motor difficulties by means of the MABC-2 Test and the identification of motor difficulties by the parents using the DCDQ'07 for the total group, two gender and race groups (Caucasian and Black) independently. Finally, the convergent validity between the two measuring instruments with regard to Caucasian boys and girls as well as Black boys and girls was established.

Specificity of the MABC-2 Test and the parent-completed DCDQ'07

As shown in Table 4.2, the specificity between the MABC-2 Test and the parent-completed DCDQ'07 is 91% (324/356) for the total group. Similar findings with regard to a high specificity were also established for boys 92% (139/151) and girls 90% (185/205). The specificity for Caucasian children was higher (93%, 227/243) than for Black children (86%, 97/113), and higher for Caucasian boys (96%, 105/110) than for Black boys (83%, 34/41). The results for the girls also indicated a higher specificity for the Caucasian girls (92%, 122/133) than for the Black girls (88%, 63/72).

Sensitivity of the MABC-2 Test and the parent-completed DCDQ'07

Table 4.2 shows that the sensitivity for the total group was 23% (12/52), indicating that the parents could not identify their children with motor problems. With regard to the boys, a higher sensitivity (32%, 10/31) was established than for their female counterparts (10%, 2/21). The results indicate similar findings comparing the Caucasian children (21%, 6/28) to the Black children (25%, 6/24). It is interesting to note that a higher sensitivity was established for the Caucasian boys (31%, 5/16) and the Black boys (33%, 5/15) than for the Caucasian girls (8%, 1/12) and the Black girls (11%, 1/9).

Convergent validity of the MABC-2 Test and the parent-completed DCDQ'07

As shown in Table 4.2, the calculated k-coefficient of 0.151 is on the 1% level and provides a small effect size, which means that the findings are of insignificant practical importance. There was, however, a significant difference of $p = 0.002$. The results indicate that there was only a 15% convergent validity between the two measuring instruments after correcting for chance for the total group. The results for the boys indicate that the calculated k-coefficient of 0.275 is on the 1% level and provides a medium effect size, which means that the findings are of average practical importance with a significant difference of $p = 0.000$. The convergent validity is only 28%. In contrast, the girls have a much lower k-coefficient of 0.002, which is not on the 5% level and therefore not significant, and no significant difference occurs ($p = 0.973$). The calculated k-coefficient for the Caucasian children is 0.164 with a significant difference of $p = 0.006$, although it is on the 1% level and provides a small effect size, which means that the findings are of insignificant practical importance. The convergent validity is 16% and in contrast to the Black children is not on the 5%-level and therefore not significant and indicates a k-coefficient of 0.112 with no significant difference ($p = 0.189$). The calculated k-coefficient of 0.318 for Caucasian boys is on the 1% level and provides a medium effect size, which means that the findings are of average practical importance. In this case the k-coefficient indicates that there is a 32% convergent validity between the two measuring instruments after correcting for chance and indicates a significant difference of $p = 0.000$. These findings provide evidence that the convergent validity of these two measuring instruments is reasonably high for Caucasian boys. In the case of Black boys, the results indicate that the k-coefficient of 0.174 is not on the 5% level and therefore no significant difference occurs (p = 0.189). For the girls the results indicate that the k-coefficient of 0.001 for the Caucasian girls and the k-coefficient of 0.013 for the Black girls are not on the 5% level and therefore insignificant for both groups. No significant differences were observed for the Caucasian girls (p = 0.994) or for the Black girls (p = 0.905). It can be concluded that there is also no significant convergent validity between the two measuring instruments (MABC-2 Test and the DCDQ'07) for the various variables, except for Caucasian boys.

TABLE 4.2: Convergent validity of motor problems between the MABC-2 test and the parent-completed DCDQ'07

Total group			
	MABC-2 TEST		
DCDQ' 07	**MD**	**NMD**	**Total**
MD	12 (23.1%)	32	44
NMD	40	324 (91.0%)	364
Total	52	356	408
k-coefficient = 0.151, p = 0.002 Effect size (r) = 0.151 (small)			

Boys			
	MABC-2 TEST		
DCDQ' 07	**MD**	**NMD**	**Total**
MD	10 (32.3%)	12	22
NMD	21	139 (92.1%)	160
Total	31	151	182
k-coefficient = 0.275, p = 0.000 Effect size (r) = 0.280 (medium)			

Girls			
	MABC-2 TEST		
DCDQ' 07	**MD**	**NMD**	**Total**
MD	2 (9.5%)	20	22
NMD	19	185 (90.2%)	204
Total	21	205	226
k-coefficient = 0.002, p = 0.973 Effect size (r) = 0.001 (small)			

Caucasian children			
	MABC-2 TEST		
DCDQ' 07	**MD**	**NMD**	**Total**
MD	6 (21.4%)	16	22
NMD	22	227 (93.4%)	249
Total	28	243	271
k-coefficient = 0.164, p = 0.006 Effect size (r) = 0.165 (small)			

Black children			
	MABC-2 TEST		
DCDQ' 07	**MD**	**NMD**	**Total**
MD	6 (25.0%)	16	22
NMD	18	97 (85.8%)	115
Total	24	113	137
k-coefficient = 0.112, p = 0.189 Effect size (r) = 0.112 (small)			

Caucasian boys			
	MABC-2 TEST		
DCDQ' 07	**MD**	**NMD**	**Total**
MD	5 (31.3%)	5	10
NMD	11	105 (95.5%)	116
Total	16	110	126
k-coefficient = 0.318, p = 0.000 Effect size (r) = 0.329 (medium)			

Caucasian girls			
	MABC-2 TEST		
DCDQ' 07	**MD**	**NMD**	**Total**
MD	1 (8.3%)	11	12
NMD	11	122 (91.7%)	133
Total	12	133	145
k-coefficient = 0.001, p = 0.994 Effect size (r) = 0.001 (small)			

Black boys			
	MABC-2 TEST		
DCDQ' 07	**MD**	**NMD**	**Total**
MD	5 (33.3%)	7	12
NMD	10	34 (82.9%)	44
Total	15	41	56
k-coefficient = 0.174, p = 0.189 Effect size (r) = 0.175 (small)			

Black girls			
	MABC-2 TEST		
DCDQ' 07	**MD**	**NMD**	**Total**
MD	1 (11.1%)	9	10
NMD	8	63 (87.5%)	71
Total	9	72	81
k-coefficient = 0.013, p = 0.905 Effect size (r) = 0.013 (small)			

Abbreviations: MD = Motor difficulties; NMD = No Motor difficulties

DISCUSSION

The purpose of the study was to examine the convergent validity of the classification of motor difficulties by Kinderkineticists-in-training using the MABC-2 Test and the classification of motor difficulties by the parents of the participants using the DCDQ'07, in order to determine if parents possess the competency to identify Grade 1-learners with DCD at home. This convergent validity was determined for the total group (N = 410) as well as for the two genders and the specific race groups (Caucasian and Black) independently. Finally, the convergent validity between the two measuring instruments with regard to Caucasian boys and girls as well as Black boys and girls was established.

The research set out to provide possible answers to the questions pertaining to the specificity and sensitivity of the DCDQ'07 when completed by parents – an area in which a limited amount of research has been done (Schoemaker *et al*., 2006). No other studies have been conducted to compare the specificity and sensitivity between the parent-completed DCDQ'07 and the MABC-2 Test in order to determine the convergent validity of the identification of DCD among different ethnic groups (Caucasian and Black), thus no comparisons could be made with previous research.

Although the design of this study used the revised DCDQ'07, previous findings on the original DCD-Q are also discussed, but are limited to the findings for the total group. As is shown in Table 2, the current study indicates that the convergent validities for the boys and girls were 32% and 10% respectively, indicating that the boys had a convergent validity of average practical importance and the girls showed no convergent validity at all. According to the original DCD-Q, gender did not influence the scores in older age groups (nine years to fourteen years and six months) (Wilson *et al*., 2000; Schoemaker *et al*., 2006). However, for the younger age groups (four to eight years) boys scored significantly lower than girls. Similar findings were observed by Nakai *et al*. (2011) as well as Rivard *et al*. (2014), the researchers finding significant differences between gender groups: the girls scored constantly higher than the boys. In contrast, a study on Brazilian children (N = 30) concluded that there were no significant differences in the total scores of the different genders when the original DCD-Q was used (Prado *et al*., 2009). In order to correct this discrepancy, separate impairment scores by age and gender were developed for the revised DCDQ'07.

Specificity of the MABC-2 Test and the parent-completed DCDQ'07 for the total group

As can be seen in Table 2, the study succeeded in showing that the parents could identify a large percentage of children without motor difficulties, specificity of 91% (324/356), when using the age- related cut-off scores for the three adjusted age groups. Similar to the results of this study, the majority of previous research reported a high specificity on the original DCD-Q. The current study correlates with the findings of Wilson *et al*. (2000), who reported an even higher specificity of 95% (20/21), as well as Schoemaker *et al*. (2006), who tested a clinic-referred sample (N = 110) and found an 84% (42/50) specificity on the original DCD-Q. Schoemaker *et al*. (2006) also conducted the study on a population-based sample (N = 322) and found a higher specificity of 89% (218/246). Prado *et al*. (2009) adapted the DCD-Q for Brazilian children and found an 87% specificity, which correlates with the current study.

However, several authors have proposed lower specificity on the original DCD-Q. Wilson *et al*. (2000) reported lower specificity on the original DCD-Q (71%) than the current study for the DCDQ'07. Civetta and Hillier (2008) indicated that the specificity of the original DCD-Q on a total of 460 children in Australia was only 62%. Tseng *et al*. (2010) indicated a lower specificity of 54% on the Chinese version of the original DCD-Q, while Green *et al*. (2005) found an even lower specificity of only 19%.

With reference to the revised DCDQ'07, Wilson *et al*. (2009) established a 71% specificity with the DCDQ'07, while Parmar *et al*. (2014) established a higher specificity of 92%. Furthermore, in another recent study, Caravale *et al*. (2014) adapted the DCDQ'07 for Italian children (N = 26) and found a specificity of 96%. It is clear that conflicting results still occur and it is therefore recommended that the DCDQ'07 should be adapted to each country in order to adjust for cultural differences; in addition, larger samples should be tested.

Discussion on the sensitivity of the MABC-2 Test and the parent-completed DCDQ'07 for the total group

This study indicates that a large percentage of children with motor difficulties could not be identified by the parents, showing a sensitivity of only 23% (Table 2), which correlates with Loh *et al*. (2009), who found that the original DCD-Q had a low sensitivity in detecting children with mild motor difficulties. Schoemaker *et al*. (2006) also found a low sensitivity of 29% (22/76) with regard to a population-based sample (N = 322).

However, several authors have proposed higher sensitivity when using the original DCD-Q. Civetta and Hillier (2008) established 72% sensitivity for the original DCD-Q, while Tseng *et al*. (2010) found similar results of 73%. Wilson *et al*. (2000) found that the original DCD-Q had a high sensitivity of 86%, which correlates with research conducted by Schoemaker *et al.* (2006), who established a sensitivity of 82% (49/60) on the clinic-referred sample (N = 110), as well as with research done by Prado *et al*. (2009) with the Brazilian version, in which a sensitivity of 87% was reported. The highest sensitivity was established by Green *et al*. (2005), who found an even higher sensitivity of 93% among a sample of 98 children.

With reference to the revised DCDQ'07, Wilson *et al*. (2009) differ from the current study and found a higher sensitivity of 85%, as did Caravale *et al*. (2014), who established 88% sensitivity. However, a recent study conducted by Parmar *et al*. (2014) found a very low sensitivity of 21% on the DCDQ'07, which correlates with the findings of this study. Similar to the results with regard to specificity, the results for sensitivity differ between various authors since conflicting results occur. It is therefore recommended that more research should be conducted on this topic. In addition, the researchers propose that the norms might be adapted in order to address each country's specific needs.

The k-coefficient for the present study (0.151) differs from Schoemaker *et al*. (2006), who established a k-coefficient of 0.65 for the clinic-referred sample and 0.21 for the population-based sample, while Green *et al*. (2005) found a lower k-coefficient of 0.14.

Discussion on the convergent validity of the MABC-2 Test and the parent-completed DCDQ'07 for the total group

An overall analysis of the convergent validity between the MABC-2 Test and the DCDQ'07 in Table 2 indicates that the DCDQ'07 completed by the parents has a convergent validity of 15% (8/52) with the MABC-2 Test in identifying children with motor difficulties, and therefore the convergent validity is low (small effect). These results correlate with research conducted by Wilson *et al*. (2000), who established 27% convergent validity (4/15), as well as Crawford *et al*. (2001), who demonstrated that the questionnaire did not identify children with motor difficulties as frequently as a therapist. These results correlate with a recent study by Parmar *et al.* (2014), who also used the revised DCDQ'07 and performed an ROC analysis, concluding that the convergent validity between the MABC-2 Test and the DCDQ'07 was low.

The findings of Schoemaker *et al*. (2006) are in contrast with the current study, with a convergent validity of 83% (91/110) for the clinic-referred sample. For the population-based sample the convergent validity was lower, but at 75% (240/322) still higher than in the current study.

CONCLUSIONS

The aim of the study was to examine the convergent validity of the classification of motor difficulties by Kinderkineticists-in-training using the MABC-2 Test and the classification of motor difficulties by the parents of the participants using the DCDQ'07, in order to determine if parents possess the competency to identify grade 1 children with DCD at home. To our knowledge, this is the first study in South Africa to assess the competency of the parents to use the DCDQ'07 to correctly identify children with motor difficulties. This study showed only a 15% convergent validity between the MABC-2 Test and the DCDQ'07 as completed by the parents. The ability of parents in the Bloemfontein area, Free State province, to use the DCDQ'07 to correctly identify children with motor difficulties was therefore found to be low. Thus, the DCDQ'07 is useful to screen children without DCD, although the purpose of a screening tool is to identify children with a specific condition. The current study demonstrates the need for further research in identifying efficient and effective assessment screening tools for parents to help professionals in the early identification of motor difficulties. It is clear from the research that a screening tool alone will rarely identify all children with DCD and that the DCDQ'07 may not be the best screening tool for parents to identify DCD in children at home. It is therefore recommended that specific norms should be established for South African children.

LIMITATIONS

This study had some limitations. A comparison between the DCDQ'07 and the MABC-2 Checklist, which can also be completed by the parents, could have been conducted to determine which screening questionnaire yields the best results. The parents who took part in the current study were not specifically taught how to complete the DCDQ'07. The large number of parents may have affected the reliability of the scores according to the DCDQ'07. Furthermore, since this was a population-based sample, criterion B of the diagnostic criteria for DCD, which states that the academic performance of the children should also be considered (APA, 2013), was not used . It should also be recognized that the current study recruited children from the Bloemfontein metropolitan area only. Hence, a replication of this study in different provinces and regions in South Africa is recommended to provide more generalized and robust results. Another limitation was the use of Canadian norms in a South African population, and Canadian item development, including specific sports, which may not be applicable to South African children.

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CHAPTER 5

ARTICLE 3:

The ability of teachers in identifying grade 1 learners with motor coordination difficulties in the classroom

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The ability of South African teachers in identifying Grade 1 learners with developmental coordination disorder in the classroom

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ABSTRACT

Developmental coordination disorder (DCD) is a motor disorder of unclear etiology which severely interferes with a child's ability to perform daily motor tasks. The aim of the study was to examine the convergent validity of the Movement Assessment Battery for Children – Checklist (MABC-C) when completed by teachers with the Movement Assessment Battery for Children – Test (MABC-2) when completed by Kinderkineticists, in order to determine if teachers possess the competency to identify grade 1 children with DCD in the classroom. Five hundred and forty five (N = 545) grade 1 children in South Africa between the ages of five and eight years took part in this study. There were 234 girls and 311 boys. The ethnic groups that took part consisted of 321 Caucasian and 224 Black learners. The MABC-C demonstrated a specificity of 70.3% and a sensitivity of 46.5%. The convergent validity between the two assessment tools when completed by teachers indicated a kappa coefficient of 0.110 (11%), and thus had a small effect size (r = 0.125). Therefore, it can be argued that teachers using the MABC-C could not identify children with DCD in the classroom.

Keywords: Developmental Coordination Disorder, Movement Assessment Battery for Children-2, Movement Assessment Battery for Children-2, Checklist, Children

The Ability of South African Teachers to Identify Grade 1 Children with Developmental Coordination Disorder in the Classroom

INTRODUCTION

Developmental coordination disorder (DCD) is a neurodevelopmental disorder affecting approximately 1.8%–6% of school-aged children (Parmar, Kwan, Rodriguez, Missiuna, & Cairney, 2014). Children with DCD will execute coordinated motor skills significantly below the level expected based on the child's chronological age. This is not accounted for by their age, intellect or neurological disorders, and the impact is evident in their daily activities at home (self-care tasks), during play (running, riding a bike, swimming and ball games), and in academic performance in school (writing and cutting activities). These difficulties can be viewed as clumsiness, for example dropping objects, in addition to the slow and inaccurate performance of motor skills such as catching objects, using scissors or taking part in sports (American Psychiatric Association, 2013; Gaines & Missiuna, 2007; Schoemaker, Smits-Engelsman, & Jongmans, 2003).

Children with DCD share a common feature, namely experiencing difficulty in motor skills necessary for progress in both formal and informal learning experiences in a school environment (Sugden & Chambers, 2003). The impaired ability to control functional movements often continues throughout the school years, evidence that children do not outgrow this disorder (Henderson & Henderson, 2002; Losse et al., 1991; Sugden & Chambers, 2003).

According to Parmar et al. (2014) it is important to identify DCD early in a child's life to allow for proper and timely intervention and support, and to reduce the negative secondary consequences associated with this condition. Although early identification of DCD is recommended, Schoemaker, Niemeijer, Flapper, and Smits-Engelsman (2012) stated in this regard that correct identification is impeded by the lack of a universally accepted criterion standard for DCD. Children with DCD can be assessed in a variety of ways, and consequently there is presently no gold standard assessment instrument (Kirby & Sugden, 2010). Hillier (2007) came to the same conclusion, arguing that none of the tests was sufficient for all the different children being assessed, since children with DCD were a heterogenic group. Assessment tools can be either a screening test to identify children at risk for some type of developmental problem or a diagnostic test which provides clinical information regarding movement competencies and assists in designing treatment programs (Wilson, 2005).

In an attempt to identify children with DCD, several instruments, such as motor questionnaires for screening purposes and norm-referenced tests to measure the degree of movement difficulties (Barnett, 2008), can be used. Due to the high costs of norm-referenced tests, the time-consuming process, and long waiting periods in order for children to be assessed (Junaid, Harris, Fulmer, & Carswell, 2000; Loh, Piek, & Barrett, 2009; Piek & Edwards, 1997), screening tools can be used in order to identify children who might have DCD (Loh et al., 2009; Junaid et al., 2000). In this regard, several screening tests and questionnaires have been developed to gather information, specifically from parents and teachers, concerning functional motor performance of children, for example the Movement Assessment Battery for Children-2 Checklist (MABC-C) and the Developmental Coordination Disorder Questionnaire ’07 (DCDQ’07) (Schoemaker et al., 2012).

The instruments used in this study were the Movement Assessment Battery for Children-2 Performance Test (MABC-2 Test), conducted by trained Kinderkineticists in order to diagnose DCD, as well as the MABC-C, completed by the children’s teachers. The MABC-2 Test was developed by Henderson, Sugden, and Barnett (2007) and requires children to perform a series of motor tasks (involving manual dexterity, balance, and ball skills) in a specified manner. In addition to age-related norms, the test also provides qualitative information on how children should approach and perform the tasks. The MABC-2 Test is used to assess motor proficiency levels and to diagnose DCD in children. The MABC-C is designed to identify primary school children likely to have movement difficulties. The MABC-C consists of three sections. Sections A and B address progressively more complex interactions between children and their physical environment. Section C concerns non-motor factors that may adversely affect children’s movement. The checklist contains a list of specific motor behaviors that can be observed in an everyday setting such as a classroom or playground and is used to assess self-care skills, classroom skills and physical education/recreational skills (Henderson et al., 2007).

The advantages of these screening tools are that children might be identified during the early stages of their school career, which may minimize the prevention of secondary impairments associated with DCD (Missiuna, Rivard, & Bartlett, 2006; Sugden & Chambers, 2003). Secondary impairments include physical health problems due to lower activity levels (Tsiotra, Nevill, Lane, & Koutedakis, 2009), social problems, along with emotional problems, due to withdrawal or exclusion from peers, as well as academic problems related to aspects such as drawing and tracing, poor handwriting, cutting with scissors and learning difficulties (Hamilton, 2002; Wilmut, Brown, & Wann, 2007).

South-Africa is a very diverse country and, according to Gallahue and Ozmun (2006), motor development can be influenced by the individual, the task and the environment. According to Pienaar (2004), South Africa consists of an assortment of different population groups, as well as children from a variety of socio-economic statuses (SES). Furthermore, Pienaar (2004) argues that the diversity can impact the use of assessment tools standardized on populations from different backgrounds, particularly with regard to the child's socio-economic influences and how this factor can affect the development of children in South Africa. The socio-cultural context in which a child is reared forms certain demands for his/her motor development, favoring specific aspects of motor development and impairing others (Venetsanou & Kambas, 2010). Robinson and Goodway (2009) stated that children who grew up in disadvantaged environments showed deficits mostly due to a lack of opportunities. Pienaar (2004) conducted a study on 688 children from a low SES, and the results revealed that more than half of the participants had motor difficulties. Another study by Pienaar, Labuschagne, and Peens (2007) showed that 5- to 6-year-old South African children from low SES displayed developmental deficits of up to 12 months in comparison with children of the same age from more privileged environments.

A contributing factor to poor motor proficiency levels amongst South African children, may be a result of the lack of Physical Education (PE) in the school curriculum. Physical Education had been discarded from South African schools as a stand-alone subject and integrated with Life Orientation (LO) as part of a learning area (Rajput and Van Deventer, 2010; Cleophas 2014). The majority of South African children did not have the opportunity to take part in PE prior to the new regime and it was further argued that the post-apartheid regime was more concerned with promoting mass participation (Cleophas, 2014; Rajput & Van Deventer, 2010). However, currently most of South African children still do not receive purposeful PE in their schools (Cleophas, 2014). It can be concluded that children will not develop their fundamental motor skills if they do not receive opportunities for practice, encouragement, as well as instructions (Gallahue & Ozmun, 2006).

It is important to note that a wide range exists with regard to the prevalence of DCD across the globe in the literature (Hamilton, 2002; Pienaar, 2004; Gaines & Missiuna, 2007; Wilmut et al. 2007; Wessels, Pienaar, and Peens, 2008; De Milander, Coetzee, & Venter, 2014). The difference in prevalence might be due to the assessment tool used, the population and age being research for a specific topic.

Research indicates that DCD affects 5%–6% of school-age children (Gaines & Missiuna, 2007). According to Wilmut et al. (2007), the prevalence of DCD is 5%–10%. Hamilton (2002) found that 5%–15% of school-aged children had coordination difficulties serious enough to interfere with social integration as well as academic performance. In the Free State province of South-Africa the prevalence is even higher, as it was found that 15% of children had moderate to severe motor difficulties (De Milander, Coetzee, & Venter, 2014). Alarmingly, Pienaar (2004), as well as Wessels, Pienaar, and Peens (2008), also used the MABC and reported a significantly higher prevalence of DCD in the North West province of South Africa—61.2% and 52%

respectively. This clearly indicates that South African children appear to have more motor difficulties compared to other parts of the world.

There is also a difference in the prevalence of DCD between boys and girls. The literature indicates that boys experience more severe problems with regard to DCD compared to girls, with a boy:girl ratio of 2:1 (Wright & Sugden, 1996). Rivard, Missiuna, Hanna, and Wishart (2007) even estimated that the gender difference could be as high as 3–4:1. Hoare and Larkin (1991) also found that more boys than girls attended remedial programs (9:1), supporting the notion that more boys experience these problems than girls. These findings correlate with that of research done in South Africa, which found the ratio to be 2:1 (de Milander et al., 2014), while Wessels et al. (2008) estimated the ratio at 2–3:1.

However, studies using these screening tools have produced conflicting results (Faught et al., 2008). Thus, it is still not clear which screening test is better to use and whether teachers can screen for or identify children with DCD (Schoemaker, Flapper, Reinders-Messelink, & de Kloet, 2008). Although various authors have conducted studies using these screening tools (Civetta & Hillier, 2008; Green et al., 2005; Prado, Magalhães & Wilson, 2009; Schoemaker, Flapper, Verheij, Wilson, Reinders-Messelink & de Kloet, 2006), their research has not been conducted in South Africa.

It is clear from the literature that discrepancies exist between the results from other parts of the world with regard to the prevalence of DCD and the results from South-Africa. This may be due to the diversity of the South African people as well as the lack of Physical Education (PE) between 1994 and 2011 in schools. The Curriculum Assessment Policy Statements (CAPS) according to the Department of Basic Education with regard to PE states that teachers should develop children’s gross- and fine motor skills in addition to perceptual development (Department of Basic Education, 2011). The personnel should focus on perceptual activities which include aspects such as locomotor, rhythm, balance and laterality. According to a study done by de Milander, Coetzee and Venter, (2015) the researchers concluded that a perceptual-motor intervention only improved balance. However, participation in PE classes presented by teachers also proved to be beneficial.

The results of this study will be provided to the Department of Education in the Free State province in order to indicate the importance of Physical Education in our schools. It is therefore important to investigate the use of screening tools by the teachers with the purpose to determine if the teachers have the competency to identify children with DCD in the classroom. This study will aid researchers in determining whether the MABC-C will be beneficial for teachers in South Africa. In addition, the identified children can undergo norm reference tests and, if necessary, remedial programs from Kinderkineticists as soon as possible (Peens, Pienaar & Nienaber, 2008; de Milander, du Plessis & du Randt, 2014; de Milander et al., 2015)

The aim of the study was to examine the convergent validity of the Movement MABC-C when completed by teachers with the MABC-2 when completed by Kinderkineticists, in order to determine if teachers possess the competency to identify grade 1 children with DCD in the classroom.

METHOD

Participants

The Department of Education of the Free State province as well as the principal of each school gave permission for the research to be conducted on the school premises during the Life Orientation periods. Approval had been obtained from the Ethics Committee of the Faculty of Health Sciences, University of the Free State (ECUFS57/2012). The participants were treated in accordance with the ethical guidelines outlined by the Ethics Committee of the Faculty of Health Sciences. The parents of the participants completed an informed consent form for each child participating in this study. In addition, the children signed an assent form. Furthermore, the teachers gave consent to take part in the study by means of completing the MABC-C.

The selection of the seven mainstream schools was part of a larger randomly selected sample of 13 schools who were invited to participate. The participating schools were located within a 30-km radius of the University of the Free State. A total of 806 recruitment letters containing the participant information sheet, parent/guardian consent form, a child assent form, and a reply envelope were distributed to prospective participants between the ages of six and eight years from the seven consenting schools. Of these, 545 children returned the relevant documents to the school and were recruited for participation. This indicates a 68% response rate. There were 234 girls and 311 boys. The ethnic groups that took part consisted of 321 Caucasian and 224 Black learners. The mean age for the children was six years and seven months with a standard deviation of 0.4. The minimum age was five years and eight months and the maximum age was eight years.

All children in the participating primary schools were considered for inclusion in the study. Exclusion criteria included a child in the age group outside the expected range of five to eight years, parental permission not obtained or the informed consent not completed fully, or parents indicating that they would be relocating during the study. Additionally the Diagnostic and Statistical Manual of Mental Disorders, fifth edition, (DSM-5) (American Psychiatric Association, 2013) was used to exclude children who had associated symptoms according to the criteria for DCD. Children with motor difficulties should meet criterion C (disturbance is not due to a general medical condition, for example, cerebral palsy, hemiplegia, or muscular dystrophy and does not meet criteria for a Pervasive Developmental Disorder) or criterion D (if mental retardation is present, the motor difficulties are in excess of those usually associated with it). None of the children met the criteria and therefore all of them were included for further data analysis.

A total of 28 teachers were involved in this study. As stated earlier, PE was discarded from South African schools in 1994. Thus, there was a difference in the training of the different teachers on their way to becoming a pre-school or foundation phase teacher. From the 28 teachers, 13 had received training where they completed a higher professional educational diploma over a period of four years, with PE included in the curriculum. The remaining 15 teachers were in possession of a four-year Baccalaureus

Educationis degree (pre-school and foundation phase). This curriculum included two modules addressing motor development (developmental games and developmental play); however, they did not receive formal training in PE. It is compulsory for all teachers in South Africa to register at the South African Council of Education.

This study made use of quantitative data. The study involved one testing procedure by means of the MABC-2 Test in order to identify DCD among grade 1 children. The participants were tested at their school by research staff (Kinderkineticists) who were trained to use the relevant instrument. All research staff underwent a rigorous training program created by the lead investigator and reviewed by a Kinderkineticist with extensive training and professional experience with children. In total, each of our research assistants received a minimum of 8 hours of preparatory training, and at least 6 hours of in-field observation/supervision. Each Kinderkineticist was responsible for one subtest in order to have consistency across the study. In addition, each participant's teacher completed the MABC-C. The principal researcher explained the procedure for the completion of the MABC-C to each head of department (HOD). The HOD explained the procedure in detail to the grade 1 teachers at each school they were responsible for. The teachers observed the children in their classrooms for a period of six months and had two months to complete the MABC-C. Since there were seven schools involved, each teacher had to observe her own class and assess each child. The number of children per class ranged between 25 and 32. The teachers were not informed of the results from the MABC-2 Test obtained by the Kinderkineticists and therefore could not have been influenced in any manner. The results of the MABC-2 Test were compared to the results of the MABC-C to establish the ability of teachers to identify DCD in children and aid professionals in early identification.

Measures

The Movement Assessment Battery for Children-2 (MABC-2 Test). The MABC-2 Test was developed by Henderson et al. (2007) and requires children to perform a series of motor tasks in a specified manner. In addition to age-related norms, the test also provides qualitative information on how children should approach and perform the tasks. The MABC-2 Test is used to assess the participants motor proficiency levels and to diagnose DCD in children. The first assessment component of this test battery contains 24 items organized into three sets of eight tasks. Each set is designed for use with children of a different age band. The eight tasks are grouped under three headings, namely manual dexterity (MD), balance (B) as well as aiming and catching (AC) (Henderson et al., 2007). Age-adjusted standard scores and percentiles are provided, as well as a total test score for each of the three components of the test. The total test score can be interpreted in terms of a “traffic light” system. The green zone indicates performance in a normal range (> 15th percentile), while the amber zone indicates that a child is at risk and needs to be carefully monitored (5th–15th percentile). The red zone is an indication of definite motor impairment (≤ 5th percentile).

The MABC-2 Test is a standardized test (Henderson et al., 2007) and the reliability coefficient for the total test scores was 0.80 (Henderson et al., 2007; Mayson, 2007). Unfortunately, research on validity is only available with regard to the original MABC (Mayson, 2007). Henderson et al. (2007) state that the original MABC Performance Test is a valid test to use. The authors observed the correlations between the test components, which ranged between 0.25 and 0.36, indicating a relatively low correlation. Still, a moderate to good correlation was established by Mayson (2007) between the test components (0.65) and the total test score (0.73). In a more recent study conducted by Ellinoudis, Evaggelinou, Kourtessis, Konstantinidou, Venetsanou and Kambas (2011) the researchers found Cronbach's alpha coefficient values were .51 (manual dexterity), .70 (aiming and catching) and .66 (balance) Furthermore, the researchers established that the correlation coefficients between each test item and the total score were moderate. These results indicate that the MABC-2 is a reliable and valid tool in order to assess motor difficulties amongst children.

The Movement Assessment Battery for Children-2 Checklist (MABC-C). As stated by Henderson et al. (2007), the MABC-C is designed to identify primary school children likely to have movement difficulties. The MABC-C consists of three sections. Sections A and B address progressively more complex interactions between children and their physical environment. Section C concerns non-motor factors that may adversely affect children's movement. The checklist contains a list of specific motor behaviors that can be observed in an everyday setting such as a classroom or playground. The children's performance in each item in the MABC-C is rated by an adult observer in terms of how proficiently it is executed. The ratings are summed to provide a total score, which is then mapped onto a traffic light system indicating whether children fall into the age-expected normal range (green zone), show signs of some minor movement problems that need to be monitored (amber zone) or is highly likely to have more serious movement problems (red zone).

According to Schoemaker et al. (2003), the original MABC-C is a valid and reliable tool to use with a reliability coefficient of 0.96 for all 48 items. Since their study made use of the new version of the MABC-C, Henderson et al. (2007) argued that they had been unable to collect reliability data on the new MABC-C. The researchers considered the overlap in content of the old and the new checklist to be sufficient.

Group Allocation

The assessment of learners with and without motor difficulties was based on the cut-off scores of the MABC-2 Test (Henderson et al., 2007). Children who had a performance in the normal range (> 15^{th} percentile) were classified as children without motor difficulties, while children at risk (5^{th}–15^{th} percentile) as well as those with an indication of definite motor impairment (≤ 5^{th} percentile) were grouped together as children with motor difficulties. The results indicated that 71 children (38 boys and 33 girls) were identified as children with motor difficulties. On the MABC-C, children who scored up to the 85^{th} percentile were considered as children with no motor difficulties. Children with results between the 85^{th} and 94^{th} percentile were at risk and were combined with the definite motor impairment group, who obtained scores of at or above the 95^{th} percentile, as the children with motor difficulties (Henderson et al., 2007). Based on the cut-off scores, 33 children (20 boys and 13 girls) were identified as children with motor difficulties. Thus, the current study had two categories: no motor difficulties and motor difficulties. The children were grouped accordingly and the results of the MABC-2 Test were compared to the findings of the MABC-C to determine the convergent validity.

Data Analysis

The principal researcher captured the data from the MABC-2 Test as well as the MABC-C electronically using Microsoft Excel. Data analysis was performed using the Statistical Package for the Social Sciences (SPSS) for Windows (SPSS version 16.0, SPSS Inc., Chicago, IL). In order to achieve the aim of this study, namely to examine the convergent validity of the classification of motor problems (no motor difficulties/motor difficulties) using the MABC-2 Test and the classification of motor difficulties (no motor difficulties/motor difficulties) by the teachers of the participants using the MABC-C, the kappa (k-) coefficient was used. This coefficient supplies information with regard to the convergent validity between the two measuring instruments. The higher the coefficient (whether it is a negative or a positive value), the greater the convergent validity between the two measuring instruments.

The practical importance of the results was also investigated. As standard of practical significance, the effect size was calculated. The following guideline values need to be used when the effect size is interpreted (Steyn, 1999): $r = 0.1$: small effect; $r = 0.3$: medium effect and $r = 0.5$: large effect. A probability level of 0.05 or less was taken to indicate statistical significance.

RESULTS

Table 5.1 presents the convergent validity between the classifications of motor difficulties by means of the MABC-2 Test and the identification of motor difficulties by the teachers using the MABC-C for the total group, gender and race groups (Caucasian and Black) independently. Finally, the convergent validity between the two measuring instruments with regard to Caucasian boys and girls as well as Black boys and girls was established.

TABLE 5.1: Convergent validity of motor problems between the MABC-2 Test and the teachers-completed MABC-C

Total group			
	MABC-2 TEST		
MABC-C	**MD**	**NMD**	**Total**
MD	306 (70.3%)	38 (53.5%)	344
NMD	129 (29.7%)	33 (46.5%)	162
Total	435	71	506
(k)-coefficient = 0.110, p = 0.005 Effect size (r) = 0.125 (small)			

Boys			
	MABC-2 TEST		
MABC-C	**MD**	**NMD**	**Total**
MD	125 (69.8%)	18 (47.4%)	143
NMD	54 (30.2%)	20 (52.6%)	74
Total	179	38	217
(*k*)-coefficient = 0.164, p = 0.008 Effect size (r) = 0.180 (small)			

Girls			
	MABC-2 TEST		
MABC-C	**MD**	**NMD**	**Total**
MD	181 (70.7%)	20 (60.6%)	201
NMD	75 (29.3)	13 (39.4%)	88
Total	256	33	289
(*k*)-coefficient = 0.059, p = 0.236 Effect size (r) = 0.070 (small)			

Caucasian children			
	MABC-2 TEST		
MABC-C	**MD**	**NMD**	**Total**
MD	183 (65.1%)	12 (37.5%)	195
NMD	98 (34.9%)	20 (62.5%)	118
Total	281	32	313
(*k*)-coefficient = 0.126, p = 0.002 Effect size (r) = 0.173 (small)			

Black children			
	MABC-2 TEST		
MABC-C	**MD**	**NMD**	**Total**
MD	123 (79.9%)	26 (66.7%)	149
NMD	31 (20.1%)	13 (33.3%)	44
Total	154	39	193
(*k*)-coefficient = 0.126, p = 0.079 Effect size (r) = 0.126 (small)			

Caucasian boys			
	MABC-2 TEST		
MABC-C	**MD**	**NMD**	**Total**
MD	79 (63.2%)	5 (27.8%)	84
NMD	46 (36.8%)	13 (72.2%)	59
Total	125	18	143
(*k*)-coefficient = 0.179, p = 0.004 Effect size (r) = 0.239 (medium)			

Caucasian girls			
	MABC-2 TEST		
MABC-C	**MD**	**NMD**	**Total**
MD	104 (66.7%)	7 (50%)	111
NMD	52	7 (50%)	59
Total	156	14	170
(*k*)-coefficient = 0.068, p = 0.210 Effect size (r) = 0.096 (small)			

Black boys			
	MABC-2 TEST		
MABC-C	**MD**	**NMD**	**Total**
MD	46 (85.2%)	13 (65%)	59
NMD	8 (14.8%)	7 (35.0%)	15
Total	54	20	74
(*k*)-coefficient = 0.219, p = 0.050 Effect size (r) = 0.223 (small)			

Black girls			
	MABC-2 TEST		
MABC-C	**MD**	**NMD**	**Total**
MD	77 (77%)	13 (68.4%)	90
NMD	23 (23%)	6 (31.6%)	29
Total	100	19	119
(*k*)-coefficient = 0.071, p = 0.425 Effect size (r) = 0.073 (small)			

Abbreviations: MD = Motor difficulties; NMD = No Motor difficulties

Specificity and Sensitivity of the MABC-2 Test and the Teacher-completed MABC-C

According to Ellinoudis, Kyparisis, Gitsas and Kourtesis (2009), specificity refers to the ability of the teachers using the MABC-C to correctly identify children with no motor difficulties (green zone) as identified by the MABC-2 Test. Sensitivity refers to the ability of the teachers using the MABC-C to correctly identify children with motor difficulties (Ellinoudis et al., 2009) as identified by the MABC-2 Test.

As shown in Table 5.1, the specificity between the MABC-2 Test and the teacher-completed MABC-C is 70.3% (306/435) for the total group. It is interesting to note that almost one third (29.7%) of these children were incorrectly identified by the MABC-C as children with motor difficulties. The sensitivity for the motor difficulties group was 46.5% (33/71) for the total group, indicating that the teachers could not identify the learners with motor difficulties, or that the instrument is not sensitive enough.

Although the specificity for boys (69.8%, 125/179) and girls (70.7%, 181/256) was high, the sensitivity (52.6%, 20/38) for boys was higher than for their female counterparts (39.4%, 13/33). As far as race was concerned, the specificity was high, although somewhat lower for Caucasian learners (65.1%, 183/281) than for the Black learners (79.9%, 123/154), even though the reverse was true for sensitivity (Caucasian learners: 62.5%, 20/32, Black learners: 33.3%, 13/39. The same trend is evident when comparing Caucasian and Black learners by gender.

Convergent Validity of the MABC-2 Test and the Teacher-completed MABC-C

The agreement was also investigated by calculating the percentage of convergent validity between the MABC-2 Test and the MABC-C in classifying children as those with motor impairment and those without motor impairment, and by calculating the sensitivity and the specificity of the two measuring instruments. Cohen's kappa was calculated to evaluate the proportion of convergent validities.

The calculated k-coefficient for the various groups that were investigated, namely the total group (11% convergent validity), boys (16.4% convergent validity), girls, Caucasian learners and Black learners (12.6%), Black boys, Caucasian girls as well as Black girls, was on the 1%-level and provides a small effect size, which means that the findings are of insignificant practical importance. The k-coefficient indicates that there was only an 11.0% convergent validity between the two measuring instruments after adjusting for the proportion of convergent validities that take place by chance (Cohen, 1960). For Caucasian boys, the results indicate a k-coefficient of 0.179 and provide a medium effect size, which means that the findings are of average practical importance. In this case the k-coefficient indicates that there is an 18.0% convergent validity between the two measuring instruments after correcting for chance.

DISCUSSION

The aim of the study was to examine the convergent validity of the classification of motor difficulties by trained Kinderkineticists using the MABC-2 Test and the classification of motor difficulties by the teachers of the participants using the MABC-C, in order to determine if teachers possess the competency to identify Grade 1-learners with DCD in the classroom. The results of the MABC-2 Test were compared to the MABC-C to determine the convergent validity of the two instruments.

Limited studies have been conducted in South Africa (Lombard and Pienaar, 2003) to compare the specificity and sensitivity between the teacher-completed MABC-C and the MABC-2 Test by Kinderkineticists in order to determine convergent validity of the identification of DCD among different race groups (Caucasian and Black) as well as with regard to gender. For this reason, no comparisons could be made to previous research.

Although the design of this study made use of the revised MABC-C, previous findings on the original MABC-C will also be discussed, but are limited to the findings for the total group.

Specificity of the MABC-2 Test and the Teacher-completed MABC-C for the Total Group

The study succeeded in showing that the teachers could identify a large percentage of children without motor difficulties, specificity of 70.3% (306/435), when using the age-related cut-off scores. The current study correlates with the findings of Green et al. (2005), who reported an even higher specificity of 75%.

However, several authors have proposed higher specificity on the original MABC-C. Reported specificity using either the original or revised MABC, ranged between 80-90% (Ellinoudis et al. (2009), Schoemaker et al. (2003 Schoemaker et al. (2012).. From the results of the current study, it is clear that the teachers were able to identify a large percentage of children without motor difficulties correctly using the revised MABC-C. The relativelower specificity amongst South African teachers might be due to the fact that the majority of the teachers who participated in this study have not been trained in the field of P.E.

Sensitivity of the MABC-2 Test and the Teacher-completed MABC-C for the Total Group

This study found that teachers could not identify a large percentage of learners with motor difficulties, with a sensitivity of 46.5% (33/71). The findings of several authors using the original MABC-C correlate well with the findings of the current study. Henderson and Sugden (1992) found a sensitivity of 43.8%. Green et al. (2005) reported a sensitivity of 44% and Shoemaker et al. (2012), using the revised MABC-C, found a low sensitivity of 41%, similar to the current study. Some researchers, using the original MABC-C reported even lower sensitivity levels, ranging from 14-27% (References With the exception of Schoemaker et al. (2003), who reported a sensitivity of 80% using the revised MABC-C, the literature clearly indicates that the majority of researchers found a low sensitivity when using the MABC-C. This may represent an inherent characteristic of this instrument, rather than the skills of the persons using them.

Convergent Validity of the MABC-2 Test and the Teacher-completed MABC-C for the Total Group

An overall analysis of the convergent validity between the MABC-2 Test and the MABC-C indicates that the MABC-C completed by the teachers had a convergent validity of 11% (k-coefficient of 0.110) with the MABC-2 Test in identifying learners with motor difficulties, and therefore the convergent validity was low (small effect) for the total group. With reference to the original MABC-C similar results were found. These results correlate well with Green et al. (2005), as well as Ellinoudis et al. (2009), who also reported low convergent validities with a k-coefficient of 0.14. In a recent study by Schoemaker et al. (2012) on the revised MABC-C the researchers also established that the convergent validity was low, with a k-coefficient of 0.28.

However, several authors have found an average convergent validity when using the original MABC-C. Piek and Edwards (1997) found a 50% convergent validity where severe motor difficulties could be identified by the classroom teachers (7/14), compared to PE teachers who could only identify 36% (5/14). In addition, Junaid (1998) also reported an average convergent validity of 51%. With reference to the revised MABC-C, Schoemaker et al. (2012) found the highest convergent validity (80%), in marked contrast to the current study. However, Shoemaker et al. (2012) also reported that low rates for either sensitivity or specificity are a common finding in population-based samples, irrespective of which questionnaire measuring functional motor impairment is used and irrespective of whether teachers or parents are asked to rate motor performance.

Reasons for the low convergent validity in South Africa might be that some of the items on the MABC-C were inappropriate for this population due to the lack of facilitations and apparatus including playgrounds. With regard to classroom activities some of the children used a scissors for the first time when they entered school. In addition, some schools do not have balls, bats or bicycles for recreational activities, nor climbing apparatus for children to develop their gross motor abilities. Furthermore, not all schools provide opportunities for sport activities because children have to go home immediately after school for transport reasons.

It can be concluded that, using the MABC-C, teachers are better at identifying children who do not have DCD, than those who do have in Grade 1-learners. It might be due to the fact that one fifth of the teachers in South Africa are presently not appropriately qualified for the classes they are responsible for (Pienaar, 2004). Furthermore, the norms of the MABC-C might have to be adapted in order to make provision for the diversity in cultures amongst various countries (Pienaar (2004). From the results of this study it cannot be recommended that the MABC-C is used by teachers to identify learners with DCD. This finding contributes to the dialogue regarding the fact that children are not identified in a timely manner so that earlier intervention can be initiated in order to help these learners overcome their motor difficulties. Further research should be conducted to explore the value of other DCD screening questionnaires in an attempt to identify those whereby children with motor difficulties would be easier identified by the teachers.

CONCLUSION

To our knowledge, this is the second study in South Africa to assess the competency of teachers to use the MABC-C to correctly identify children with motor difficulties. This study showed only an 11% convergent validity between the MABC-2 Test and the MABC-C as completed by the teachers. Therefore the ability of teachers in the Bloemfontein area, Free State province, South Africa to use the MABC-C to correctly identify children with motor difficulties was found to be low. Thus, the MABC-C is useful to screen children without DCD, although the purpose of a screening tool is to identify children with a specific condition.

Wilson et al. (2009) state that the degree of accuracy in identifying children with possible DCD (sensitivity) must be compared to the accuracy in correctly identifying children who do not have the condition (specificity). This “trade-off” is common to all diagnostic tests, because when one of these predictive values increases, the other decreases. The current study demonstrates the need for further research in identifying efficient and effective assessment screening tools for teachers to help professionals in the early identification of motor difficulties. It is clear from the research that a screening tool alone will rarely identify all children with DCD and that the MABC-C may not be the best screening tool for identifying DCD in primary school children in South Africa.

LIMITATIONS OF STUDY

This study had some limitations. The teachers who took part in the current study were not formally trained to observe and rate motor development according to the MABC-C criteria. The large number of teachers may have affected the reliability of the scores according to the MABC-C. Furthermore, since this was a population-based sample, criterion B of the diagnostic criteria for DCD, which states that the academic performance of the children should also be considered (American Psychiatric Association, 2013), was not used. It should also be recognized that the current study recruited children from the Bloemfontein metropolitan area only. One should note that two different groups of people were used with two different measuring instruments. Furthermore, the Kinderkineticists and teachers are all from different backgrounds and experiences. This can influence the results due to the fact that some of the teachers have years of experience with regard to developing children. It is recommended that the Kinderkineticist should have done the testing with the MABC-2 Tests well as the MABC-C, in order to have the same background and experience to determine if the results would have been different. Hence, a replication of this study in different provinces and regions in South Africa is recommended to provide more generalized and robust results.

RECOMMENDATIONS FOR FUTURE RESEARCH

As indicated in the current study, the MABC-C demonstrated a low sensitivity and is therefore not a valid screening tool in a South African sample. The multifactorial nature of motor capacity required the measurement of a large number of skills to assess a heterogeneous condition such as DCD. We therefore conclude that caution should be taken when the MABC-C is used as a single indicator of DCD in young learners. Results with regard to sensitivity differ between various authors, thus the independent use of screening tools will not aid professionals in the early identification of motor difficulties in young children. It is therefore recommended that more research should be conducted on this topic. In addition, we propose that the norms of the MABC-C might be adapted in order to address each country's specific needs.

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CHAPTER 6

Article 4:

The prevalence and effect of developmental coordination disorder on learning related skills in grade 1 children in South Africa

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The prevalence and effect of developmental coordination disorder on learning related skills in grade 1 children in South Africa

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ABSTRACT

Physically awkward children face a host of difficulties, but rarely receive attention. It is therefore important to identify developmental coordination disorder (DCD) early in a child's life to allow for proper and timely intervention and support, reducing the negative secondary consequences associated with this condition. The objective of the study was to determine the prevalence of DCD and examine the effect of the degree of motor difficulties on learning-related skills. This comparative study made use of quantitative data. The Movement Assessment Battery for Children-2 (MABC-2 Test) was used to identify DCD. In addition, each participant was evaluated with the Aptitude Test for School Beginners (ASB), conducted and interpreted by qualified teachers. Learning-related skills of children with DCD were compared to those of children without DCD. The prevalence of DCD (severe motor difficulties) amongst grade 1 learners was 6% and the at risk group constituted another 6%. Of the children tested, 88% had no motor difficulties. Motor difficulties had a significant effect on five of the eight learning-related subtypes, namely reasoning, numerical skills, gestalt, coordination and memory. The degrees of motor difficulties (at risk/severe motor difficulties) have significant effects on the learning skills of grade 1 children.

Keywords: Developmental coordination disorder (DCD); Movement Assessment Battery for Children-2 (MABC-2 Test); Learning-Related skills; Aptitude Test for School Beginners (ASB) questionnaire.

The Prevalence and Effect of Developmental Coordination Disorder on Learning-Related Skills in Grade 1 Children in South Africa, Bloemfontein

INTRODUCTION

Children with DCD experience considerable difficulties in motor learning as well as in the performance of functional motor tasks that are critical for success in the school environment (American Psychiatric Association [APA]; 2013). These children demonstrate poor motor performance that is not accounted for by their age, intellect or neurological disorders, and the impact can be found in both their daily living activities and academic performance (APA, 2013).

Research indicates that DCD affects 5%–6% of school-age children (APA, 2013; Gaines & Missiuna, 2007). According to Hamilton, (2002) as well as Wilmut et al. (2007) the prevalence of DCD might be even higher (5%–15%) and the research indicates that a large percentage of school-aged children have coordination difficulties serious enough to interfere with social integration as well as academic performance. In South-Africa (Bloemfontein province) the results indicated that 15% of children have moderate to severe motor difficulties (De Milander et al. 2014). Alarmingly, different studies reported significantly higher prevalences of DCD in the North West province of South Africa of 61.2% (Pienaar, 2004) and 52% (Wessels et al. 2008) respectively. This clearly indicates that South African children appear to have more motor difficulties than children in other parts of the world. Pienaar (2004) concluded that the norms of the Movement Assessment Battery for Children should be adjusted for South African children. Furthermore, the real prevalence of DCD among children might even be higher, since medical as well as educational systems frequently fail to identify this disorder in young children (Hamilton, 2002; Missiuna, 2003; Miyahara et al. 2008).

A gender difference also occurs with regard to DCD. The literature indicates that boys experience more problems than girls with a boy:girl ratio of 2:1 (Wright &

Sugden, 1996). According to Rivard et al. (2007) it has been estimated that the gender difference could even be as high as 3–4:1. These findings are supported by Hoare and Larkin (1991) who stated that more boys than girls are attending remedial programs (9:1). South African researchers have found boy:girl ratios of 2–3:1 (Wessels et al. 2008) as well as 1.6:1 (De Milander et al. 2014).

Major concerns relating to DCD according to Schoemaker et al. (2003) as well as Sugden and Wright (2005) are the considerable harmful effects associated with this disorder. Developmental coordination disorder influences children's daily activities at home (self-care tasks), normal play (running, riding a bike, swimming and ball games) and school activities (writing and cutting activities). A problem found amongst children with DCD is that they are often not formally diagnosed, but rather described by their teachers as lazy or awkward (Zwicker et al. 2012). These children are not diagnosed due to the lack of awareness of the disorder (Wilmut et al. 2007; Zwicker et al. 2012).

Children with DCD share a common feature, namely experiencing difficulty in executing motor skills necessary for progress in the formal and informal learning in a school environment (Sugden and Chambers, 2003). The impaired ability to control functional movements often continues throughout the school years, with evidence showing that children do not outgrow this disorder (Henderson and Henderson, 2002; Sugden and Chambers, 2003). Thus, without early identification and intervention, the difficulties experienced in the school environment will persist into later life (Losse et al. 1991).

Secondary problems associated with DCD are physical health issues such as obesity and lower aerobic capacity due to lower activity levels (Cantell et al., 2003; Tsiotra et al. 2009), social problems, along with emotional problems, due to withdrawal or exclusion from peers, as well as academic problems related to aspects such as tracing, writing and learning difficulties (Piek and Edwards, 1997;

Hamilton, 2002; Cantell et al. 2003). Other co-occurring problems linked to DCD are speech and language disorders (Missiuna, 2003; Wilmut, 2007), visual-motor deficits (Hamilton, 2002) and attention deficit hyperactivity disorder (ADHD) (Watemberg et al. 2007; Wessels et al. 2008). It is clear from the literature that the DCD child experiences countless problems associated with the learning process.

Limited research findings were available with reference to the relationship between DCD and learning-related skills amongst children in South Africa (Wessels et al. 2008), thus the purpose of this study was to determine the prevalence of DCD as well as the relationship between DCD and learning-related skills amongst grade 1 children in the Bloemfontein area, Free State province, South Africa.

METHODOLOGY

Participants

Initially 13 mainstream schools in the Bloemfontein area, Free State province, South Africa were targeted to take part in the research project, but only seven schools eventually agreed to participate. All of these schools are classified as quintile 5 schools, indicating a high socio economic status. From these seven schools, only four made use of the Aptitude Test for School Beginners (ASB). Scores on the Movement Assessment Battery for Children-2 (MABC-2 Test) and the ASB were obtained for a total of three hundred and forty seven (N = 347) grade 1 children. The children who took part in this study were between the ages of five and eight years. There were n = 190 girls and n = 157 boys. The mean age of the children was six years and seven months with a standard deviation of 0.4. The minimum age was five years and eight months and the maximum age was eight years. All children in the participating primary schools were considered for inclusion in the study. Exclusion criteria included a child in the age group outside the expected range of five to eight years, parental permission not obtained or the informed consent not completed fully, or parents indicating that they would be relocating during the study. Additionally the Diagnostic and Statistical Manual of

Mental Disorders, fifth edition, (DSM-5) (APA, 2013) was used to exclude children who had associated symptoms according to the criteria for DCD as stated in the DSM-5. Children with motor difficulties should meet criterion C (disturbance is not due to a general medical condition, for example, cerebral palsy, hemiplegia, or muscular dystrophy, and does not meet criteria for a pervasive developmental disorder). or criterion D (if mental retardation is present, the motor difficulties are in excess of those usually associated with it). None of the children met the criteria and therefore all of them were included for further data analysis.

Ethical consideration

The Department of Education of the Free State province as well as the principals of each school gave permission for the research to be conducted on the school premises during the Life Orientation periods. Approval had been obtained from the Ethics Committee of the Faculty of Health Sciences, University of the Free State (ECUFS57/2012). The participants were treated in accordance with the ethical guidelines outlined by the Ethics Committee of the Faculty of Health Sciences. The parents of the participants completed an informed consent form for each child participating in this study. In addition, the children signed an assent form. Recruitment was targeted at children with and without DCD via the four participating schools.

Measuring instruments

Movement Assessment Battery for Children-2 (MABC-2 Test). The MABC-2 Test requires children to perform a series of motor tasks in a specified manner (Henderson and Sugden, 2007). In addition to age-related norms, the test also provides qualitative information on how children should approach and perform the tasks. The MABC-2 Test is used to assess the subject's motor proficiency levels and to diagnose DCD in children. The first assessment component of this test battery contains 24 items organized into three sets of eight tasks. Each set is designed for use with children of a different age band. For the current study age band 1 and age band 2 were used. The eight tasks are grouped under three headings, namely manual dexterity (MD), balance (B) as well as aiming and catching (AC). Age-adjusted standard scores and percentiles are provided, as well as a total test score for each of the three components of the test. The total test score can be interpreted in terms of a “traffic light” system. The green zone indicates performance in a normal range (> 15th percentile), while the amber zone indicates that a child is at risk and needs to be carefully monitored (5th–15th percentile). The red zone is an indication of definite motor impairment (≤ 5th percentile). Thus, high standard scores on the MABC-2 Test represent good performance. The MABC-2 Test is a valid and reliable tool to use with a reliability coefficient for the total test scores of 0.80 (Henderson and Sugden, 2007).

The Aptitude Test for School Beginners (ASB). The ASB was administered by qualified teachers to all participating children in the first two months of the school year. A requirement of the ASB is that it must be presented and completed in a child’s mother tongue. The ASB is a norm-based instrument and consists of eight sub-items, which include perception, spatial skills, reasoning, numerical skills, gestalt, coordination, memory and verbal comprehension (Olivier and Swart, 1996; Van Zyl, 2004). Each sub-item is evaluated by means of a standard score out of five. An evaluation score of 1 is regarded as below average and an evaluation score of 5 as above average. The aim of the ASB is to obtain a differentiated picture of certain aptitudes of grade 1 children. The ASB is a valid and reliable tool to use with a reliability coefficient for the total test of 0.80 (Olivier and Swart, 1996).

Procedure

This comparative study made use of quantitative data. The study involved one testing procedure by means of the MABC-2 Test in order to identify DCD among grade 1 children. The participants were tested at their schools during the Life Orientation periods by Kinderkineticists-in-training who were trained in the use of the measuring instrument. Each Kinderkineticst-in-training was responsible for one subtest in order to have consistency across the study. In addition, each participant was evaluated with the ASB, conducted and interpreted by qualified teachers. Learning-related skills (determined with the ASB) of children with DCD (as identified by the MABC-2 Test) were compared to the learning-related skills of children without DCD.

Statistical analysis of data

Data from the MABC-2 Test as well as the ASB were captured electronically by the principle researcher using Microsoft Excel. Data analysis was performed by a statistician using the Statistical Package for the Social Sciences (SPSS) for Windows (SPSS version 16.0, SPSS Inc., Chicago, IL). Descriptive statistics, namely frequencies and percentages, were calculated for categorical data. Medians and percentiles were calculated for numerical data. Median differences were tested by calculating p-values using the signed-rank test. The chi-squared statistics were used to test for proportion differences. A probability level of 0.05 or less was taken to indicate statistical significance.

RESULTS

The distribution of the children in terms of the traffic light system (degree of motor difficulty) according to the MABC-2 Test is illustrated in Figure 6.1.

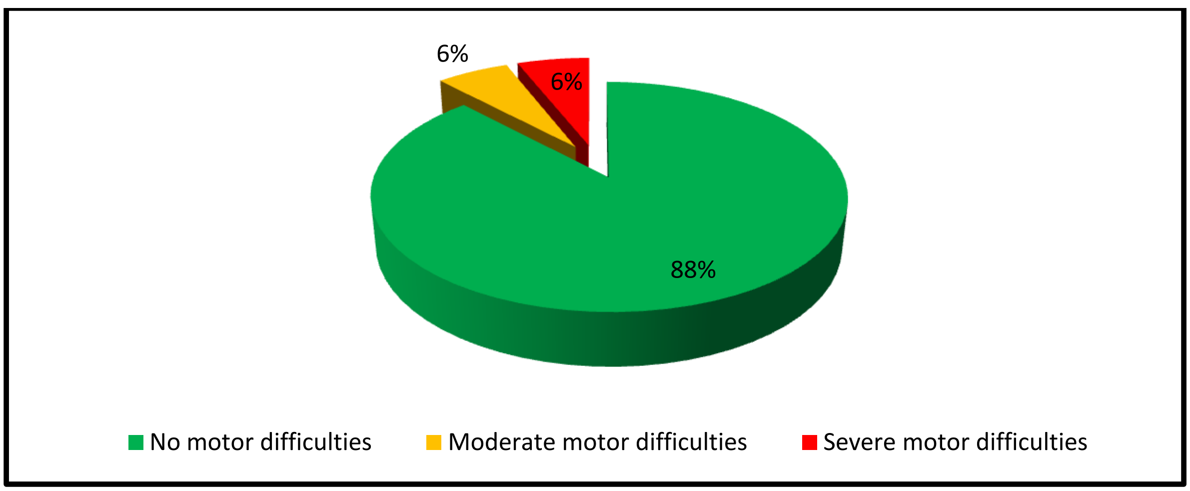

Figure 6.1: Prevalence of DCD in Grade 1 Children

Figure 6.1 presents the percentages in terms of the traffic light system (degree of motor difficulty). Green indicates no motor difficulties (88%), amber indicates moderate motor difficulties (6%) and the red zone indicates severe motor difficulties or DCD (6%) amongst children in Bloemfontein, Free State province, South Africa. It is interesting to note that more children are experiencing motor difficulties than previously indicated in the literature.

The distribution of the girls and boys in terms of the traffic light system (degree of motor difficulty) according to the MABC-2 test is shown in Figures 6.2 and 6.3.

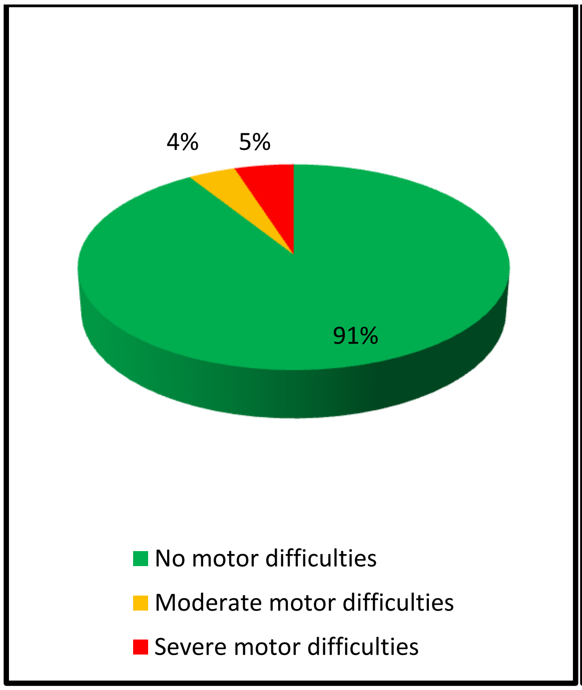

Figure 6.2: Traffic Light Categories for Girls.

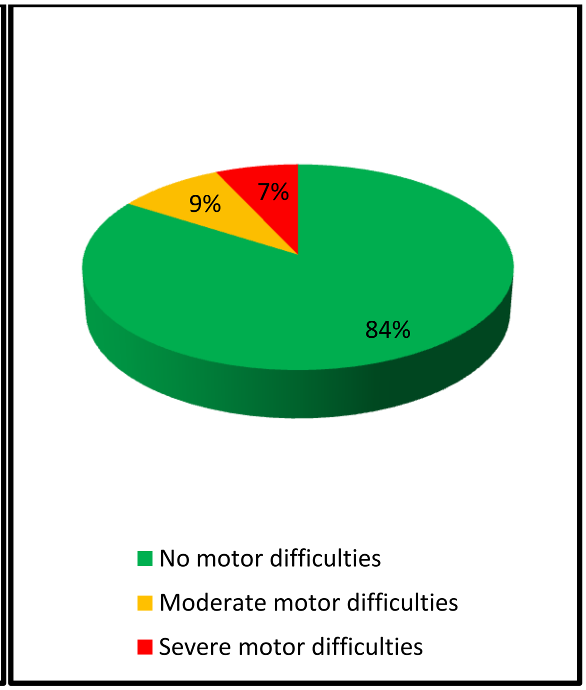

Figure 6.3: Traffic Light Categories for Boys.

As expected, Figures 6.2 and 6.3 indicate that 91% of the girls fell in the green zone compared to 84% of the boys. With reference to the amber zone, 4% of the girls had moderate motor difficulties in contrast to 9% of the boys. The red zone indicates that 5% of the girls had severe motor difficulties compared to 7% of the boys. However, there was no significant difference ($p = 0.1150$) between the genders.

Figure 6.4: Learning-Related Skill Scores of the ASB Expressed as a Percentage by Degree of Motor Difficulty

Abbreviations: NMD – no motor difficulties; AR – at risk; SMD – severe motor difficulties; Score 1 & 2 = below average; Score 3 = average; Score 4 & 5 = above average.

Figure 6.4 indicates the results of the various learning-related skills according to the ASB in the different categories of degree of motor difficulty (at risk and severe) and no motor difficulties. From Figure 4 it can be observed that for three of the eight learning-related skills, namely perception (p = 0.1408), spatial skills (p = 0.3930) as well as comprehension (p = 0.0741), there was no significant difference. Furthermore, Figure 4 illustrates that, of the remaining learning-related skills, significant differences were indicated for reasoning (p = 0.0040) and memory (p = 0.024). It is interesting to note that there were highly significant differences between the children with different degrees of motor difficulty and those with no motor difficulties for numerical skills (p = 0.0001), gestalt (p = 0.0001) and coordination (p = 0.0001).

In summary, it would appear that children at risk for motor difficulties as well as those with severe motor difficulties may struggle more with the domains of reasoning, numerical skills, gestalt, coordination and memory, as illustrated by the sub-tests of the ASB.

DISCUSSION

The research set out to determine the prevalence of DCD in Bloemfontein, Free State province, South Africa. In addition, the study aimed to provide possible answers regarding the effect of DCD on specific learning-related skills amongst children aged five to eight years.

Literature clearly indicates that DCD affects children all over the world, but the prevalence differs considerably between various countries (Lingam et al. 2009; Prado et al. 2009). The results of the current study indicated that at least 12% of the sample had moderate to severe motor difficulties. These results are in contrast to various findings reported in the literature where the researchers state that DCD affects more or less 5%–6% of school-age children (APA, 2013; Prado et al. 2009). Researchers on the prevalence of DCD in the United Kingdom estimate that 4%–5% of children struggle with motor difficulties (Lingam et al. 2009), which is much lower than the 12% found in the present study. The findings of research conducted on Canadian children correlate the best with the findings of the current study. These researchers found approximately 8%–15% of Canadian children to have some form of coordination problems (Junaid et al. 2000). Studies in America and Europe found an even higher prevalence of DCD, estimated at 5%–19% (Miller et al. 2001).

The current study found that boys did not exhibit significantly ($p = 0.1150$) more moderate to severe motor difficulties than girls, with a boy:girl ratio of 1.6:1. However, this ratio is smaller than the ratio found in other research. The literature indicates that boys experience more problems than girls, with reported boy:girl ratios of 2–3: (Wessels et al. 2008) and 3–4:1 (Wright and Sugden; 1996). Although gender differences do occur, researchers need to take into consideration that gender differences are a normal phenomenon in the attainment of motor skills among children. Literature indicates that girls perform better in fine motor skills, whilst boys are better at gross motor skills (Gallahue and Ozmun, 2006). Furthermore, research reported that girls outperformed the boys with regard to the manual dexterity items of the MABC and the boys were superior with regard to the ball skills items (Junaid et al. 2006). No differences were established between the boys' and girls' balancing skills and the researchers argue that these differences are due to the disparity in the acquisition of motor skills between boys and girls (Junaid et al. 2006).

Limited research reported on the effect of DCD on specific learning-related skills such as reasoning, numerical skills, gestalt, coordination, memory perception, spatial skills and comprehension amongst children. The results of the current study indicate that the different degrees of motor difficulty do have a significant differential negative effect on the subtypes of specific learning-related skills such as reasoning, numerical skills, gestalt, coordination and memory. This may be due to the fact that children who are at risk as well as children with severe motor difficulties could have deficits due to their diagnosis that may influence these different domains negatively.

Children with DCD struggle to organize tasks, since the DCD child need to plan the movement over and over. This could influence their gestalt and reasoning abilities. The findings of the current study correlate with a number of other studies indicating that children with DCD struggle with academic skills such as writing and tracing, which forms part of gestalt, numerical and coordination abilities (Hamilton, 2002; Missiuna, 2003; Tsiotra et al. 2009). Since children with DCD struggle with coordination activities in general, it is obvious that they will experience significant difficulties with regard to the coordination domain of the ASB. This result correlates with a previous study done in Potchefstroom, North West province, South Africa, where the researchers established that boys with DCD struggled more with the coordination domain of the ASB (Wessels et al. 2008). In contrast to the current study, the same researchers did not find any significant correlation between learning-related skills and DCD with regard to the remaining 7 domains in 52 children with DCD (Wessels et al. 2008).

There were no significant differences between the different categories of motor difficulties for the domains of perception, spatial skills and verbal comprehension. The results of this study indicated that being at risk for or having severe motor difficulties did have an effect on learning-related skills. Similar to the results of this study, the majority of research reported that there is a strong correlation between DCD and learning-related skills and that many children with DCD experience difficulties with learning and academic performance (Hamilton, 2002; Henderson and Henderson, 2002; Rivard et al. 2007; Wilmut et al. 2007; Tsiotra et al. 2009).

The research done showed that children who are at risk for or who have severe motor difficulties are potentially at risk of struggling more with specific learning-related skills. These findings of this research can be used to evaluate, manage and possibly improve the specific domains of weakness for the degrees of motor difficulty in order to improve these children's prognosis for their learning-related skills.

CONCLUSIONS

The results of this study are important for teachers who work with young children, as children who start formal school with a motor deficit may also have problems with a variety of learning-related skills necessary for school success. Thus, the teachers can take these limitations in consideration and address these problems by means of new preventative strategies. It would also be necessary to present motor programs by professionals who are familiar with motor development, to attend to the motor difficulties experienced by children with DCD. It is important to view development in a holistic manner,[24] thus motor difficulties as well as difficulties with learning-related skills should be addressed in order to minimize problems associated with academic performance.

LIMITATIONS

This study had some limitations. It should be recognized that the current study only recruited children from the Bloemfontein metropolitan area, while excluding children from the rural regions. Furthermore, since this was a population-based sample, criterion B of the diagnostic criteria for DCD, which states that the academic performance of the children should also be considered (APA, 2013), was not used. Hence, a replication of this study in different provinces and regions in South Africa is recommended to provide more generalized and robust results.

IMPLICATIONS FOR SCHOOL HEALTH

As indicated in the current study, children with DCD in a Bloemfontein, Free State province, South African sample struggle more with learning-related skills than children without motor difficulties. The researchers therefore conclude that it is critical that early identification of DCD should take place by means of parent and teacher questionnaires, since these children do not outgrow their motor difficulties. Appropriate interventions by professionals at an early age are crucial. Results with regard to the learning-related skills can give teachers a better understanding of difficulties experienced by children with DCD. Thus, the researchers propose that teachers should take these difficulties in consideration in order to help children excel in their academic performance.

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CHAPTER 7

ARTICLE 5:

Perceptual-motor intervention for developmental coordination disorder in grade 1 children

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Perceptual-motor intervention for developmental coordination disorder in grade 1 children

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ABSTRACT

Although different approaches, such as the bottom-up and the top-down approach have been used as interventions to treat developmental coordination disorder (DCD), there is controversy about the effectiveness of these approaches as interventions for improving the motor skills of children with DCD. Thus, the purpose of this study was to determine if a perceptual-motor intervention would improve the symptoms associated with DCD. Seventy-six children with DCD between the ages of five and eight years participated in this study The study had a pre-test/post-test experimental design (n = 36) with a control group (n = 40). The Movement Assessment Battery for Children-2 was used to assess the motor proficiency levels of the children. The intervention comprised a 10-week programme of two 30-minute sessions per week. The dependent variables were all measurable on an interval scale with the Mann-Whitney U-test was used. No significant differences (p ≥ 0.05) occurred between the two groups prior to the intervention. After the intervention one subtest, balance, showed a significant difference (p = 0.050), while manual dexterity (p = 0.797) and aiming and catching (p = 0.252) showed no significant differences. These three components contributed to the total test score, which revealed no significant difference (p = 0.068) in the overall motor proficiency levels of the experimental group and the control group. It is concluded that a perceptual-motor intervention only improved balance. However, participation in physical education classes presented by teachers also proved to be beneficial.

Keywords: Perceptual-motor; Motor proficiency; Developmental coordination disorder; Intervention; Movement Assessment Battery for Children-2

Perceptual-motor intervention for developmental coordination disorder in grade 1 children

INTRODUCTION

Developmental coordination disorder (DCD) is recognised as one of the most common developmental dysfunctions during childhood (Ellinoudis et al., 2009) and a large number of children are identified with DCD between five and eleven years of age (APA, 2013). Literature indicates wide debate with regard to the prevalence of DCD (Giagazoglou et al., 2011) and varies according to the diagnostic criteria that are used (Carslaw, 2011). According to Gaines and Missiuna (2007), as well as Prado et al. (2009), DCD affects 5%-6% of school-age children, while Wilmut et al. (2007) indicated the prevalence of DCD to be between 5%-10%. However, it is estimated that 5%-19% of children in America and Europe are struggling with DCD (Miller et al., 2001; Henderson & Henderson, 2002). In South-Africa (Bloemfontein, Free State province) the prevalence was also high, with 15% of children having moderate to severe motor difficulties (De Milander et al., 2014).

According to Henderson and Henderson (2002), children will not outgrow this disorder, as was previously believed; however, children can be assisted by means of the five-step assessment process (Barnett, 2008). This process entails firstly the use of questionnaires for screening and identification of children with motor difficulties. The second step is the use of norm-referenced tests for measuring the child’s motor performance. These tests are administered by professionals. The third step of this motor assessment process entails making a formal diagnosis of DCD. This is done by measuring the qualitative and quantitative performance in motor tasks. The fourth step focuses on understanding the nature of the condition. Finally, the fifth step is the planning of an intervention programme.

It follows that intervention programmes are a vital element of the assessment process for improving DCD. Sugden and Chambers (1998) proposed that most interventions are successful with a good number of children diagnosed with DCD. Researchers conventionally made use of a process-orientated approach by means of sensory integration and perceptual motor training in children with DCD (Bernie & Rodger, 2004; Sugden et al., 2008). The process-orientated approach is also known as the bottom-up or developmental approach. The aim of this approach is to improve the underlying process which is not developed fully for the child's age. This includes sensory functions, attention and planning, considered prerequisite for the attainment of motor skills. This approach can therefore be considered to eliminate motor deficiencies (Sugden & Chambers, 2003; Bernie & Rodger, 2004). According to Auxter et al. (2005), the underlying principle of this approach is to ensure that the supporting building blocks and integration processes are functioning optimally in order to facilitate skill development. This approach aimed to improve children's processing abilities or performance components and are still being practiced as an intervention by many therapists (Missiuna et al., 2006; Sugden et al., 2008). According to Hamilton (2002), the most frequently used interventions were sensory-integration therapy, kinesthetic training as well as perceptual-motor therapy, and all of these produced positive results more often than not.

Johnstone and Ramon (2011) state that perceptual-motor skills permit sensory information to be successfully obtained and understood with appropriate reaction. Thus, "perceptual" refers to obtaining information and "motor" deals with the outcome of the movement (Gallahue & Ozmun, 2006). According to Gallahue and Ozmun (2006), perceptual-motor activities require children to use cognitive functions (memory, attention and awareness) and the body together in order to accomplish tasks. Johnstone and Ramon (2011) also state that meeting children's gross motor needs will improve their academic readiness, as well as their overall behaviour. Neural pathways are built by means of physical activity. This process refers to the connections by which information travels through the brain. A child with more neural pathways will be able to learn more easily, thus early intervention is very important in order to develop perceptual-motor skills.

A perceptual-motor intervention targets components such as laterality (unilateral, bilateral and cross-lateral activities), balance, body image, tracking, spatial relations (body, spatial, directional and temporal awareness), locomotor as well as manipulative skills (Gallahue & Ozmun, 2006; Johnstone & Ramon (2011). Taking part in perceptual-motor activities enables children to develop greater levels of body control and encourages greater effort in all areas of the school curriculum. Children with sufficient perceptual-motor skills enjoy better coordination, greater body awareness, stronger intellectual skills and a more positive self-image (Johnstone & Ramon, 2011).

Due to a lack of support for the bottom-up approach, new approaches emerged known as the cognitive or top-down approach (Bernie & Rodger; 2004). More researchers are in favour of this approach (Sugden et al., 2008). These new approaches were based on theoretical concepts of motor learning and cognition. Motor learning is based on a conscious understanding of the processes involved when a motor problem needs to be solved. Thus, the interaction between the task and environment, as well as the child needs to be taken into consideration (Perry, 1998). Cognitive approaches use direct skill teaching, but differ in the sense of the unique problem-solving framework, attempting to help children generalise from the learning of one skill to the next (Missiuna et al., 2006).

According to Missiuna et al. (2006) and Sugden et al. (2008), although the task-specific approach aims at increasing various participations for children, it is preferable to consider how children can perform a specific task in a variety of real-life situations, rather than in one specific setting. Consequently, one should consider how to modify the task or to adapt the environment in order for children to participate and improve their learning capabilities.

It is clear that controversies exist between these different approaches and there is still not enough evidence to substantiate that one specific intervention approach is superior to another (Miller et al., 2001; Miyahara et al., 2008). It is thus proposed that these two approaches (bottom-up and top-down) should be merged in order to care for children with DCD (Peters & Wright, 1999; Davidson & Williams, 2000).

The aim of study was to determine the efficacy of a perceptual-motor intervention for improving the motor proficiency levels of children classified with DCD.

METHODOLOGY

Study design

A pre-test/post-test quasi-experimental design with a control group was applied as an empirical study which made use of quantitative and qualitative data. The study involved one testing procedure by means of the Movement Assessment Battery for Children-2 (MABC-2 Test) in order to identify DCD among grade 1 children. The participants were tested at their schools during the physical education periods by Kinderkineticists-in-training who were trained in the use of the instrument. Each Kinderkineticst-in-training was responsible for one subtest in order to have consistency across the study. The cut-off scores used in this study were based on the recommendations of Henderson et al. (2007), which are as follows: performance at or below the 5th percentile is classified as severe motor difficulties, performance from the 5th to the 15th percentile is classified as moderate motor difficulties and performance above the 15th percentile is classified as no motor difficulties. All the children took part in some form of intervention for 30 minutes two times a week over a period of 10 weeks. The control group followed a school programme (Physical Education classes) presented by personnel from the school. The personnel made use of the Curriculum Assessment Policy Statements (CAPS) according to the Department of Basic Education. The CAPS document with regard to Physical Education states that they should develop children's gross- and fine motor skills in addition to perceptual development (Department of Basic Education, 2011). The personnel focused on perceptual activities which include aspects such as locomotor, rhythm, balance and laterality. The experimental group followed a specific perceptual-motor intervention implemented by a Kinderkineticist familiar with the motor development of young children. The perceptual-motor intervention was divided into four categories namely unilateral-, bilateral-, contralateral- and combined activities. These categories consisted of a variety of aspects such as spatial awareness; eye-hand- as well as eye-foot coordination; body awareness; gross motor coordination; motor planning; directionality and dynamic balance in order to improve DCD. It can be concluded that both interventions include activities for perceptual-motor development, thus both groups followed a bottom-up approach. A post-test using the same procedure as the pre-test took place after the intervention process in order to observe any improvement.

Participants

Initially 13 schools in the Bloemfontein area were targeted to take part in the research project, but only seven schools eventually agreed to participate. The Department of Education of the Free State province as well as the principal of each school gave permission for the research to be conducted on the school premises during the Physical Education periods. Approval had been obtained from the Ethics Committee of the Faculty of Health Sciences, University of the Free State (ECUFS57/2012). The participants were treated in accordance with the ethical guidelines outlined by the Ethics Committee of the Faculty of Health Sciences. The parents/legal guardians of the participants completed an informed consent form for each child participating in this study. In addition, the children signed an assent form. Recruitment was targeted at children with DCD via the 7 participating schools who had permission to take part in the study (inclusion criteria). Exclusion criteria included a child in the age group outside the expected range (younger than five and older than eight), parental permission not obtained, the informed consent form not fully completed, or parents indicating that they would be relocating during the study. Children who were absent during the testing procedure were also excluded due to incomplete testing. Additionally, the Diagnostic and Statistical Manual of Mental Disorders, fifth edition, (DSM-5) (APA, 2013) was used to exclude children if they had associated symptoms according to the criteria for DCD as stated in the DSM-5. Children with motor difficulties should not meet criterion C (disturbance is not due to a general medical condition, for example, cerebral palsy, hemiplegia, or muscular dystrophy and does not meet criteria for a pervasive developmental disorder) or criterion D (if mental retardation is present, the motor difficulties are in excess of those usually associated with it). None of the children met the criteria and therefore all of them were included for further data analysis.

Measuring instruments

According to Henderson et al. (2007), the Movement Assessment Battery for Children-2 (MABC-2 Test) requires children to perform a series of motor tasks in a specified manner. In addition to age-related norms, the test also provides qualitative information on how children should approach and perform the tasks. The MABC-2 Test is used to assess the subject's motor proficiency levels and to diagnose DCD in children. The first assessment component of this test battery contains 24 items organised into three sets of eight tasks. Each set is designed to use with children of a different age band. For the current study age band 1 and age band 2 were used. The eight tasks are grouped under three headings, namely manual dexterity (MD), balance (B) and aiming and catching (AC) (Henderson et al., 2007). Age-adjusted standard scores and percentiles are provided, as well as a total test score for each of the three components of the test. The total test score can be interpreted in terms of a "traffic light" system. The green zone indicates performance in a normal range (> 15th percentile), while the amber zone indicates that a child is at risk and needs to be carefully monitored (5th-15th percentile). The red zone is an indication of definite motor impairment (≤ 5th percentile). Thus, high standard scores on the MABC-2 Test represent good performance. The MABC-2 Test is a valid and reliable tool to use with a reliability coefficient for the total test scores of 0.80 (Henderson et al., 2007).

Statistical analysis of data

The principal researcher used Microsoft Excel to electronically capture data from the MABC-2 Test. Data analysis was performed by a statistician using the Statistical Package for the Social Sciences (SPSS) for Windows (SPSS version 16.0, SPSS Inc., Chicago, IL). Regarding the size of the subgroups (see Table 7.2), a non-parametric statistical technique was used to explore the objective stated. This was due to the small sample size used, which could cause doubt regarding the assumptions of normality and homogeneity of variances. A bigger sample size could, however, not be obtained in order for the central limit-setting to be implemented.

The dependent variables are all measurable on an interval scale and therefore the Mann

Whitney U-test (Howell, 2012) – which is a counterpart of the t-test for independent variables – has been considered. The two groups' pre-recordings on the four dependent variables with the use of the Mann-Whitney U-test to compare, where after it has been recorded for the post-recordings. A probability level of 0.05 or less was taken to indicate statistical significance.

RESULTS

Table 7.1 shows that the group of 76 children was made up of more boys (55.3%) than girls (42.1%). With regard to race, there were more Black children (57.9%) than Caucasian children (42.1%).

TABLE 7.1: **FREQUENCY DISTRIBUTION FOR THE PARTICIPANTS ACCORDING TO GENDER AND RACE**

Gender	Race		Total
	Caucasian	Black	
Boys	18 (56.3%)	24 (54.6%)	42 (55.3%)
Girls	14 (43.7%)	20 (45.4%)	34 (44.7%)
Total	32 (42.1%)	44 (57.9%)	76 (100%)

As indicated in Table 7.2, the group consisted of 76 children, 36 of whom formed the experimental group and the remaining 40 the control group. With regard to gender, the control group consisted of 14 girls (18.4%) and 26 boys (34.2%) compared to the 20 girls (26.3%) and 16 boys (21.1%) in the experimental group.

TABLE 7.2: **FREQUENCY DISTRIBUTION FOR THE PARTICIPANTS ACCORDING TO GENDER AND RACE FOR THE EXPERIMENTAL AND CONTROL GROUPS**

Group	Caucasian boys	Caucasian girls	Black boys	Black girls	Total
Experimental	6 (33.3%)	10 (71.4%)	10 (41.7%)	10 (50%)	36 (47.4%)
Control	12 (66.7%)	4 (28.6%)	14 (58.3%)	10 (50%)	40 (52.6%)
Total	18 (23.7%)	14 (18.4%)	24 (31.6%)	20 (26.3%)	76 (100%)

It is clear from Table 7.3 that there was no significant difference between the control group and the experimental group for the pre-test, done before the intervention commenced, with regard to the various subtests, namely manual dexterity ($p = 0.737$), aiming and catching ($p = 0.527$), and balance ($p = 0.582$), as well as the total test score ($p = 0.372$).

Manual dexterity involves the coordinated use of the hands, guided by the visual system, within time limits (Henderson et al., 2007). For this subtest the post-test average scores for the experimental group as well as the control group improved in the total group, Caucasian children and Black children, as well as for the girls and boys. As can be seen in Table 7.3, the results for the total group indicate that, although there was no significant difference ($p = 0.068$) between the two groups after the intervention, the average scores for both groups did increase. The increase was found with regard to the total group and for boys, girls, Caucasian children and Black children independently. Furthermore, although both groups improved on their average scores, the improvement was found to be greater in the experimental group than in the control group.

Aiming and catching entails coordinating body movements when receiving moving objects, as well as performing throwing tasks accurately (Henderson et al., 2007). Similar to the results of the subtest for manual dexterity, the post-test average scores for this subtest increased in both the control and the experimental group. The increase was also obtained in all the categories researched and again the improvement was found to be greater in the experimental group. It is interesting to note that the boys had a higher average pre-test score

($\overline{X}$ = 9.31) than their female counterparts ($\overline{X}$ = 8.45). These results emphasise the fact that boys have better ball skills than girls.

The balance subtest involves static and dynamic balance, where the child has to keep the body upright against gravity while standing on one leg and performing hopping and jumping movements (Henderson et al., 2007). Balance is the only subtest indicating a significant difference between the pre-test (p = 0.582) and the post-test (p = 0.050) for the total group. From Table 7.3 it is clear that the experimental group ($\overline{X}$ = 8.86) had a significantly higher average score than the control group ($\overline{X}$ = 7.80) in the post-test. Similar findings were obtained for the Caucasian children, the experimental group ($\overline{X}$ = 9.31) achieving a significantly higher average score than the control group ($\overline{X}$ = 7.31), indicating that their balancing skills improved significantly (p = 0.035). In addition, the girls also improved on their average score, the experimental group ($\overline{X}$ = 9.15) performing better than the control group ($\overline{X}$ = 7.29), resulting in a significant difference (p = 0.043) between the two groups. This indicates that the perceptual-motor intervention did aid in the improvement of the balancing skills of some of the children. However, no significant differences were observed for the Black learners or the boys.

The sum of the three categories of the MABC-2 Test produced the total test score. Although the average total test score improved in all the categories, the only significant difference was found in the Caucasian children. The results in Table 7.3 indicate that the experimental group ($\overline{X}$ = 9.00) had a significantly higher total test score than the control group ($\overline{X}$ = 7.19) in the post-test. Thus a significant difference (p = 0.050) was observed. The results indicate that the perceptual-motor intervention did improve the overall motor proficiency of Caucasian children.

TABLE 7.3: **DESCRIPTIVE STATISTICS REGARDING THE PRE- AND POST-TEST SCORES FOR THE TOTAL GROUP, BOYS, GIRLS, CAUCASIAN CHILDREN AND BLACK CHILDREN IN THE EXPERIMENTAL AND CONTROL GROUPS**

			Total Group				Boys				Girls			
Variable	**Test**	**Gr.**	**M_{ss}**	**SD**	**U**	**p**	**M_{ss}**	**SD**	**U**	**p**	**M_{ss}**	**SD**	**U**	**p**
MD	**Pre**	**Exp**	4.14	1.48	688.5	0.737	3.75	1.34	196.0	0.751	4.45	1.54	121.5	0.522
		Con	3.99	1.51			3.90	1.45			4.14	1.66		
	Post	**Exp**	6.42	2.43	611.0	0.252	5.87	2.36	205.0	0.937	6.85	2.46	100.5	0.169
		Con	5.75	2.42			5.77	2.60			5.71	2.13		
AC	**Pre**	**Exp**	8.83	1.95	660.5	0.527	9.31	2.41	205.5	0.947	8.45	1.43	126.5	0.641
		Con	9.05	2.06			9.42	1.65			8.36	2.59		
	Post	**Exp**	10.64	2.49	695.5	0.797	11.25	2.79	187.0	0.581	10.15	2.16	132.0	0.796
		Con	10.33	2.79			10.54	2.98			9.93	2.43		
B	**Pre**	**Exp**	7.25	1.34	668.0	0.582	7.13	1.36	186.5	0.570	7.35	1.35	135.0	0.877
		Con	7.17	1.88			6.96	1.68			7.57	2.21		
	Post	**Exp**	8.86	2.73	**533.0**	0.050	8.50	2.78	177.0	0.416	9.15	2.72	82.0*	0.043
		Con	7.80	2.97			8.08	3.12			7.29	2.70		
TTS	**Pre**	**Exp**	5.42	0.77	642.0	0.372	5.25	0.93	203.5	0.899	5.55	0.61	117.0	0.436
		Con	5.25	0.84			5.27	0.78			5.21	0.98		
	Post	**Exp**	7.97	2.72	546.0	0.068	7.69	2.36	172.0	0.348	8.20	3.02	89.5	0.077
		Con	6.82	2.71			7.00	3.01			6.50	2.14		

			Total Group				Caucasian children				Black children			
Variable	**Test**	**Gr.**	**M_{ss}**	**SD**	**U**	**p**	**M_{ss}**	**SD**	**U**	**p**	**M_{ss}**	**SD**	**U**	**p**
MD	**Pre**	**Exp**	4.14	1.48	688.5	0.737	5.06	1.53	107.0	0.445	3.40	0.94	223.5	0.685
		Con	3.99	1.51			4.44	1.50			3.69	1.47		
	Post	**Exp**	6.42	2.43	611.0	0.252	7.63	1.78	99.5	0.287	5.45	2.48	234.5	0.896
		Con	5.75	2.42			6.75	2.52			5.09	2.16		
AC	**Pre**	**Exp**	8.83	1.95	660.5	0.527	8.56	2.39	95.5	0.224	9.05	1.54	225.0	0.716
		Con	9.05	2.06			9.38	2.19			8.83	1.99		
	Post	**Exp**	10.64	2.49	695.5	0.797	10.94	2.57	125.5	0.926	10.40	2.46	234.0	0.886
		Con	10.33	2.79			10.69	2.55			10.08	2.96		
B	**Pre**	**Exp**	7.25	1.34	668.0	0.582	6.81	1.38	87.0	0.128	7.60	1.23	219.5	0.622
		Con	7.17	1.88			6.06	1.18			7.92	1.91		
	Post	**Exp**	8.86	2.73	**533.0**	0.050	9.31	2.92	**72.0**	0.035	8.50	2.58	215.0	0.552
		Con	7.80	2.97			7.31	2.41			8.13	3.30		
TTS	**Pre**	**Exp**	5.42	0.77	642.0	0.372	5.63	0.50	81.0	0.080	5.25	0.91	223.5	0.668
		Con	5.25	0.84			5.06	0.85			5.38	0.82		
	Post	**Exp**	7.97	2.72	546.0	0.068	9.00	2.78	**76.5**	0.050	7.15	2.43	206.0	0.419
		Con	6.82	2.71			7.19	2.37			6.58	2.94		

Gr= Group; Mss= Mean standard score; SD= Standard deviation; $p \leq 0.05$; Exp=Experimental Gr.; Con= Control Gr.MD= Manual dexterity; AC= Aiming and catching; B= Balance; TTS= Total test score

The distribution of the children according to the traffic light system (degree of motor difficulty) before and after the perceptual-motor intervention is shown in Figures 7.1 and 7.2. Note that only children classified as borderline or with severe motor impairment took part in the intervention.

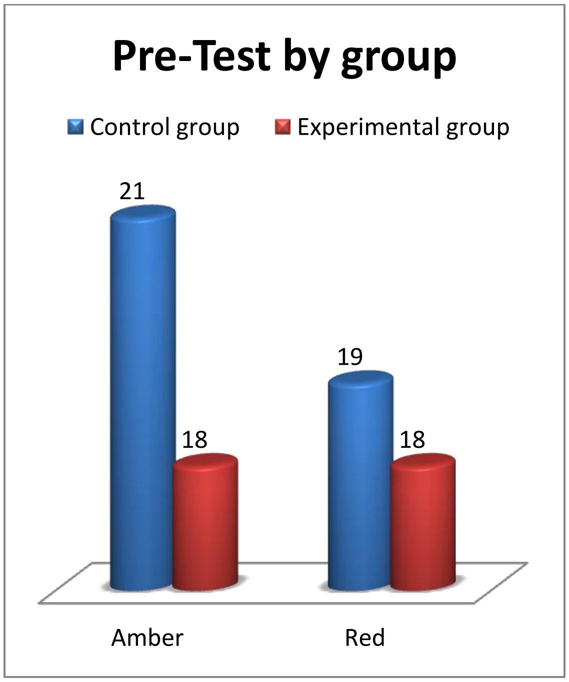

FIGURE 7.1: **Pre-Test placements using the traffic light system by group**

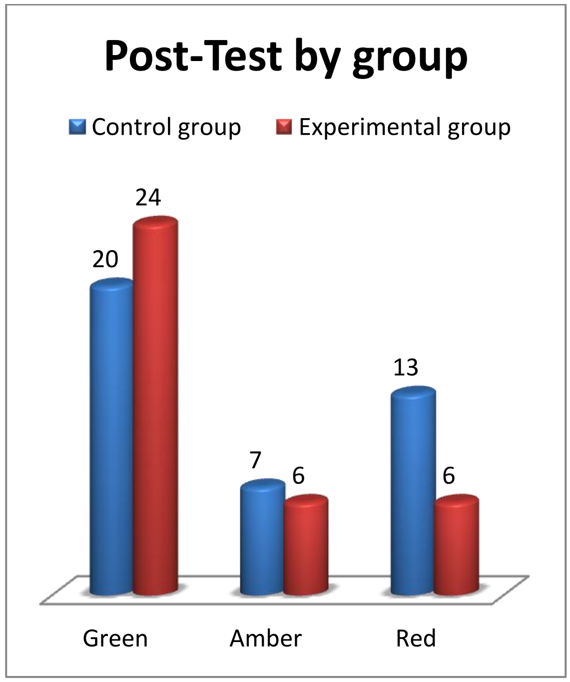

FIGURE 7.2: **Post-Test placement using the traffic light system by group**

As stated previously, the total test score is derived from the three subtests and can be interpreted in terms of a traffic light system. The green zone indicates performance in a normal range, the amber zone indicates a child as being at risk and the red zone is an indication of definite motor impairment. After the pre- and post-tests, the total test scores of the 76 children were interpreted and placed according to the traffic light system.

Figure 7.1 indicates the placement in terms of the traffic light system prior to the intervention. The results clearly indicate that all the participants had some form of motor problems prior to the intervention. Of the control group, 21 children fell in the amber zone and 19 children in the red zone. Of the experimental group, 18 children fell in the amber zone and another 18 in the red zone.

In addition, Figure 7.2 indicates that, subsequent to the intervention, the experimental group performed better than the control group. The distribution according to the traffic light system was as follows: the majority of the children in the control group improved, with 20 children placed in the green zone (no motor difficulties). Similar results can be observed for the experimental group, in which 24 children improved after the intervention and were placed in the category for no motor difficulty. Furthermore, the results show that seven children from the control group and six of the experimental group remained in the amber zone. Finally, of the 19 children in the control group who were initially in the red zone, 13 remained after the intervention. This confirms that children will not outgrow their motor problems. Of the intervention group, only 6 children remained in the red zone. The findings of this study indicate that the motor proficiency levels of children with DCD improved not only due to their participation in a perceptual-motor intervention, but also by taking part in physical education classes presented by their teachers.

DISCUSSION

There has been an abundance of published research concerning various interventions for children with DCD. According to Smits-Engelsman et al. (2013), interventions in general have proved to be beneficial for children with DCD, implying that any intervention is better than no intervention at all. It must be mentioned that literature available with regard to the bottom-up approach has become somewhat outdated. This might be due to the criticism towards this approach (Bernie & Rodger, 2004), since more researchers are in favour of the top-down approach (Sugden et al., 2008). A combined systematic review and meta-analysis was conducted by Smits-Engelsman et al. (2013), reviewing studies published between 1995 and 2011 on various interventions for children with DCD. The researchers concluded their study indicating that the comparison between various interventions showed strong effects for the task-oriented intervention (dw = 0.89), in addition to physical and occupational therapies (dw = 0.83), whereas the process-oriented intervention was weak (dw = 0.12).

The results with regard to manual dexterity indicated no significant difference (p = 0.252) between the two groups after the intervention was completed. This is similar to a study conducted by Pienaar and Lennox (2006), who determined that the fine motor skills of children between five and eight years from two farm schools did improve, but not significantly. Furthermore, Peens et al., (2008) also found no improvement after a motor intervention. In the current study, the perceptual-motor intervention did not focus on fine motor development; however, both groups did improve. This might be due to the exposure in the classroom, where children take part in writing and cutting activities as well as beading.

With reference to aiming and catching, it is interesting to note that the control group had a higher average score during the pre-test, although the difference was not significant (p = 0.527). Both groups improved with regard to aiming and catching. Although the intervention group improved more based on the average score, the results do not indicate a significant difference (p = 0.797) between the pre- and post-tests of the two groups. The findings of Pienaar and Lennox (2006) were of a similar nature. In contrast, Peens et al. (2008) used a motor-based intervention and found a significant improvement. Another reason for improvement in both groups might be the fact that these children participate in a variety of object manipulative skills at school and in sports.

The results for balance indicate a significant difference (p = 0.050) between the two groups after the intervention was completed. The improvement of the intervention group correlates with the findings of Pienaar and Lennox (2006) as well as Peens et al. (2008), who found that a motor intervention improved the balance sub-test of the Movement Assessment Battery for Children. The results of this study indicate that the perceptual-motor intervention contributed to the improvement of balance.

Although there was an improvement in the average score of the total test score, there was no significant difference (p = 0.068) between the groups after the intervention. It was also apparent that the participants of the current study were a heterogeneous group and it is necessary to address the individual needs of each child; this statement is also confirmed by Missiuna et al. (2006). Based on the current study, a perceptual-motor intervention did not lead to a significant improvement with regard to overall motor proficiency. This correlates with Pienaar and Lennox (2006), who also found no significant difference in motor performance after conducting a motor intervention with 32 children between five and eight years of age. In contrast, Peens et al. (2008) found that a motor-based intervention did improve the total test score of 20 children between seven and nine years.

The results of the current study show that the children who followed the perceptual-motor intervention, conducted by a Kinderkineticist-in-training familiar with the development of children, had a 67% improvement (24/36). Furthermore, the results indicate that the physical education classes conducted by the teachers also improved the motor proficiency of the children in the control group by 50% (20/40). This indicates that a majority of the children in both groups achieved scores above the 15th percentile during the post-test. The improvement illustrates that interventions conducted by other people, such as teachers, can also be helpful.

This statement is supported by findings from Sugden and Chambers (2003), observing that interventions done by parents and teachers can also be successful. The researchers found that a seven-week intervention (task-orientated approach) conducted by parents and teachers helped a majority of children to obtain scores above the 15th percentile. Miyahara et al. (2008) made use of university students in a clinical setting to apply a task-orientated approach and found that 40% of the participants improved beyond the cut-off scores. Intervention by means of a combination of the bottom-up and top-down approaches through intense physical activity, conducted by Watemberg et al. (2007), concluded that 50% of the participants with DCD scored above the cut-off scores (> 15 percentile) after a four-week intervention.

The implications of the results indicate that although both groups improved in general with regard to the average scores, the experimental group improved more compared to the control group. Therefore, the results indicate that a perceptual-motor intervention can be used as an appropriate intervention for children identified with DCD.

CONCLUSIONS

When children are identified with DCD, it is important to implement intervention programmes. Intervention programmes have proven to enhance the motor proficiency of these children (Peens et al., 2008). The results suggest that a perceptual-motor intervention did not improve the motor proficiency levels of children with DCD. From the point of view of a therapist, no two children are the same, especially children identified with DCD, since they are not a homogeneous group.

LIMITATIONS

One of the major limitations was the fact that the control group was exposed to physical education classes. This could have contributed to the improvement of their motor proficiency levels and influenced the results. Since this was a population-based sample, criterion B of the diagnostic criteria for DCD, which states that the academic performance of the children should also be considered (APA, 2013), was not used. It should also be recognized that the current study recruited children from the Bloemfontein metropolitan area only. Hence, a replication of this study in different provinces and regions in South Africa is recommended to provide more generalized and robust results. Another limitation of the study was the fact that the children were tested on age band 1 (age six) during the pre-test. The majority of the children turned seven during the intervention, and therefore had to be tested on age band 2, implying that they had to perform more difficult activities than for age band 1.

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CHAPTER 8

ARTICLE 6:

Sport stacking intervention programme for children with developmental coordination disorder

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Sport stacking intervention programmefor children with developmental coordination disorder

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ABSTRACT

The purpose of this study was to explore sport stacking as an alternative intervention approach with typically developing children and in addition to improve DCD. Sport stacking consists of participants stacking and unstacking 12 specially designed plastic cups in predetermined sequences in as little time as possible. Eighteen children (6 girls and 12 boys) classified with DCD, between the ages of 6 and 7 years, participated. A pre-test/post-test quasi-experimental design with a control group was applied. The Movement Assessment Battery for Children-2 (MABC-2) was used to assess the motor proficiency levels of the children and to classify DCD. The sport stacking intervention consisted of an 8-week programme of 3 sessions per week, 30 minutes per session. During the intervention the children learned the various sport stacking sequences, as well as how to apply them to a variety of physical activities. The results indicate that prior to the intervention no significant differences occurred between the 2 groups. After the intervention, manual dexterity and balance showed a significant difference, while aiming and catching, showed no significant difference. The total test score revealed a significant difference in the overall motor proficiency levels of the experimental group. The results suggest that sport stacking can be used as an effective intervention programme for children with DCD.

Key words: Sport stacking; Motor proficiency; Developmental coordination disorder; Intervention; Movement Assessment Battery for Children-2.

Sport Stacking Motor Intervention Programme for Children with Developmental Coordination Disorder

INTRODUCTION

Developmental coordination disorder (DCD) is a neuro-developmental disorder, causing marked impairment in the maturation of motor coordination (Polatajko & Cantin, 2006). According to Missiuna et al. (2006), children with DCD experience significant difficulties in motor learning and in the execution of functional motor tasks that are pivotal for success in their everyday lives. A large number of school-aged children have been identified with motor proficiency problems. These problems have substantial negative effects on their ability to participate fully in daily activities at home, school and in normal play (Polatajko & Cantin, 2006).

Even though children will not outgrow this disorder as previously believed (Henderson & Henderson, 2002), children can be facilitated by means of Barnett’s V-step assessment process for the identification of children with motor problems (Barnett, 2008). The first step focus on the use of questionnaires for the screening and identification of children with motor problems. The second entails the use of norm-referenced tests for measuring the motor performance of the child. The third step of this motor assessment process entails the making of a formal diagnosis of DCD. This is served by measuring the qualitative and quantitative performance in motor tasks. The fourth step focus on understanding the nature of the condition. Finally, the fifth step is the planning of an intervention programme.

It follows that intervention programmes are a vital element of the assessment process in order to improve DCD. Researchers conventionally made use of bottom-up approaches by means of sensory integration and perceptual motor training in children with DCD (Bernie & Rodger, 2004; Sugden et al., 2008). These approaches aim to improve children’s processing abilities or performance components and are still being practised as an intervention by many therapists (Missiuna et al., 2006; Sugden et al., 2008). According to Hamilton (2002), the most frequently used approaches are perceptual-motor therapy, sensory-integration therapy and kinesthetic training. All of these more often produced positive results than not.

Due to a lack of support for the bottom-up approach, new approaches emerged known as the cognitive or top-down approach (Bernie & Rodger; 2004). More researchers are in favour of this approach (Sugden et al., 2008). These new approaches were based on theoretical concepts of motor learning and cognition. Motor learning is based on a conscious understanding of the processes involved when a motor problem needs to be solved. Thus, the interaction between the task and environment, as well as the child needs to be taken into consideration (Perry, 1998). Cognitive approaches use direct skill teaching, but differ in the sense of the unique problem-solving framework, attempting to help children generalise from the learning of one skill to the next (Missiuna et al., 2006).

According to Missiuna et al. (2006) and Sugden et al. (2008), although the task-specific approach aims at increasing various participations for children, it is preferable to consider how children can perform a specific task in a variety of real-life situations, rather than in one specific setting. Consequently, one should consider how to modify the task or to adapt the environment in order for children to participate and improve their learning capabilities.

Sugden and Chambers (1998) proposed that most interventions are successful with a good number of children diagnosed with DCD. This statement was supported by findings from the same authors (Sugden & Chambers, 2003), observing that interventions done by parents and teachers can also be successful. The researchers found that a 7-week intervention (task-orientated approach), conducted by parents and teachers helped the majority of children to obtain scores above the 15th percentile. Miyahara et al. (2008) made use of university students in a clinical setting to apply a task-orientated approach and found that 40% of the participants improved beyond the cut-off scores. Intervention by means of a combination of the bottom-up and top-down approaches through intense physical activity conducted by Watemberg et al. (2007), concluded that 50% of the participants with DCD scored above the cut-off scores (>15th percentile) after a 4-week intervention.

It is clear that controversies exist between these different approaches and there is still not enough evidence to substantiate that one specific intervention approach is superior to another (Miller et al., 2001; Miyahara et al., 2008). It is thus proposed that these two approaches (bottom-up and top-down) should be merged in order to care for children with DCD (Peters & Wright, 1999; Davidson & Williams, 2000).

Sport stacking was launched in a South African setting in January 2009. Sport stacking is already recognised as a sport by more than 18 nations, including Australia and Germany in addition to South Africa (Krog, 2008). According to the World Sport Stacking Association (2009), sport stacking is defined as a sport where 12 specialised cups are used to build formations. A participant is called a stacker. Stackers must stack cups in predetermined sequences, competing against the clock or another player (Gibbons et al., 2007). Sport stacking can, therefore, be used as an innovative and exciting way of improving motor proficiency, such as hand-eye coordination, ambidexterity, speed and concentration while having fun (Udermann et al., 2004; Krog, 2008).

RESEARCH PROBLEM

The aim of this study was to explore the effectiveness of sport stacking as an alternative intervention approach for typically developing children and in addition to improve DCD in children.

According to Aparo (2009:ii): "Sport stacking seems to improve, in a fun and challenging way, several rudimentary fine motor skills, such as hand-eye coordination, which is assessed in this study, and others such as bimanual coordination, ambidexterity, reaction time, concentration and quickness".

This study explores the efficacy of a cup stacking intervention for children classified with DCD in order to improve their motor proficiency levels.

MATERIAL AND METHODS

Study design

A pre-test/post-test quasi-experimental design with a control group was applied as an empirical study, which made use of quantitative data. The study involved a pre-test in order to identify the children with motor difficulties, in other words DCD. The children were tested at their school by Kinderkineticists in-training who were familiar with the testing procedures of the relevant instrument. Each Kinderkineticist in-training was responsible for one subtest in order to have consistency across the study.

The children classified with DCD were divided into 2 groups. The experimental group took part in an 8-week intervention programme (sport stacking) comprising 30-minute group sessions 3 times a week. The reason for the 8-week intervention instead of the prescribed 12-week intervention is due to the fact that a school term consists of only 10 consecutive weeks. The Kinderkineticists were trained by professionals from a Speed Stacking company in order to execute the intervention programme accordingly. The speed stacking intervention was combined with various fundamental movements, such as locomotor-, manipulation-, as well as stability skills. A post-test, using the same procedure as the pre-test, took place after the intervention process in order to observe any improvement.

Participants

The participants were selected from a primary school in Bloemfontein, Free State province, South Africa, and therefore, constitute a convenient sample. Eighteen children between the ages of 6 and 7 years took part in this study. The group consisted of girls (n=6) and boys (n=12) classified with DCD.

Ethical considerations

The Department of Education, as well as the principal of the school granted permission for the research to be conducted on the school premises during the Life Orientation class periods. Approval had been obtained from the Ethics Committee of the Faculty of Health Sciences (ECUFS57/2012) of the University of the Free State. The parents of the participants completed an informed consent form for each child participating in this study. All children in the identified classes were considered for inclusion in the study. Exclusion criteria included a child in the age group outside the expected range of 6 to 7 years, where parental permission was not obtained or the informed consent form had not been completed fully or where parents had indicated that they would be relocating during the study.

Measuring instrument

The Movement Assessment Battery for Children-2 (Movement ABC-2) is a standardised test and requires children to perform a series of motor tasks in a specified manner. In addition to age-related norms, the test also provides qualitative information on how children approach and perform the tasks. The Movement ABC-2 assesses the subject's motor proficiency levels and classifies children with DCD. The first assessment component of this test battery contains a total of 24 items organised into 3 sets of 8 tasks. Each set is designed for use with children of a different age band. The 8 tasks are grouped under 3 categories, namely manual dexterity (MD), balance (B) and aiming and catching (AC) (Henderson et al., 2007). Age-adjusted standard scores and percentiles are provided, as well as a total score based on each of the 3 components of the test. The total test score can be interpreted in terms of a 'traffic light' system. The green zone indicates performance in a normal range (>15th percentile), while the amber zone indicates a child as being at risk and needing to be carefully monitored (5th to 15th percentile). The red zone is an indication of definite motor impairment (≤5th percentile).

Analysis of data

Analysis of the data was completed by a Bio-statistician using Statistical Analysis Software Version 9.1.3. Descriptive statistics, namely frequencies and percentages, were calculated for categorical data. Medians and percentiles were calculated for numerical data. Median differences were tested by calculating p-values using the signed-rank test. The chi-square was used to test for proportional differences. A significance level of 0.05 was accepted for all aspects of the study.

RESULTS

The sample consisted of 18 children, of which 8 formed the control group and 10 the intervention group. With regard to gender the control group consisted of 2 girls (25%) and 6 boys (75%) and the intervention group consisted of 4 girls (40%) and 6 (60%) boys. There was no significant difference, ($p=0.6380$) between the 2 groups at the start. Table 8.1 presents the numerical data to compare the 2 groups regarding the pre-test median results of the various subtests of the Movement ABC-2

***TABLE 8.1.*Median results of two groups: comparison of pre- and post-test**

Variables		**Control group**		**Experimental group**		**p-Value**	
	n	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
MD	18	1.5	1.0	1.5	5.0	0.7832	0.0191
AC	18	25.0	50.0	25.0	69.0	0.6732	0.0734
B	18	20.5	7.0	37.0	20.5	0.2595	0.0472
TTS	18	5.0	2.0	9.0	12.5	0.1784	0.0018

Abbreviations: MD= Manual Dexterity, AC= Aiming and Catching, B= Balance, TTS= Total Test Score

It is clear from median results for the pre-test of the control and intervention groups that there was no significant difference between the 2 groups before the intervention commenced with regard to the various subtests, namely manual dexterity (p=0.7832), aiming and catching (p=0.6732), balance (p=0.2595) and the total test score (p=0.1784).

Manual dexterity involves the coordinated use of the hands, guided by the visual system, within time limits (Henderson et al., 2007). The pre-test median for the control group was 1.5 and the post-test showed a slight decrease to 1.0. For the intervention group, the pre-test was 1.5 and increased to 5.0. A significant difference (p=0.0191) was found between the 2 groups after the intervention was completed.

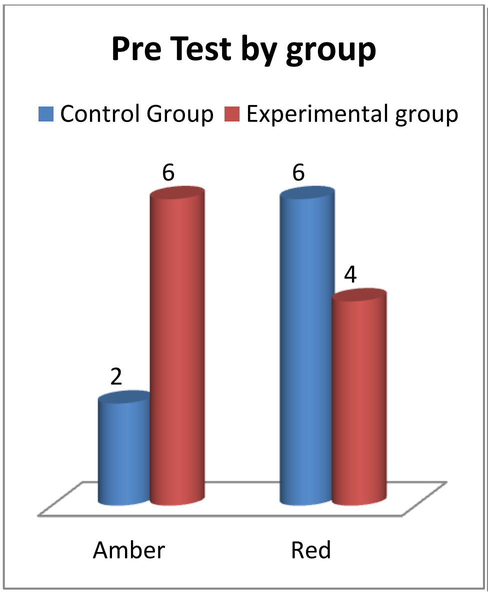
Aiming and catching entails coordinating body movements when receiving moving objects, as well as performing throwing tasks accurately (Henderson et al., 2007). The pre-test median score for the control group was 25.0 and this improved to 50.0 in the post-test. With regard to the intervention group, the median score was also 25.0 and increased to 69.0. Both groups improved in this category and there was no significant difference ($p<0.0734$) between the pre- and post-test median scores of the 2 groups in respect of aiming and catching.

The balance subtest involves static and dynamic balance where the child has to keep the body upright against gravity while standing on 1 leg and performing hopping and jumping movements (Henderson et al., 2007). The median value of the pre-test for the control group was 20.5 and for the post-test the median score decreased to 7.0. The intervention group scores for balance resulted in a median score of 37.0, which decreased to 20.5 at the post-test. While there was a decrease in performance for both groups between pre- and post-test scores, there was a significant difference ($p<0.0472$) with reference to balance between the 2 groups.

The 3 categories of the MABC-2 produced the total test score. At the pre-test, the median score for the control group was 5.0 and in the post-test it decreased to 2.0. The pre-test median score for the intervention group was 9.0 and increased to 12.5 in the post-test. These results indicate a significant difference ($p=0.0018$) between the 2 groups in respect of the total test score.

The results indicate that the control group performed poorer in the post-test with regard to manual dexterity, balance and the total test score compared to the intervention group. It is interesting to note that both groups scored poorer in the post-test with reference to the balance subtest. After the intervention period there was a significant difference between the 2 groups with regard to manual dexterity ($p=0.0191$), balance ($p=0.0472$) and the total test score ($p=0.0018$).

The distribution of the children, according to the traffic light system (degree of motor difficulty) before and after the intervention programme is shown in Figures 8.1 and 8.2. Note that only the children classified as borderline or severe motor proficiency impairment took part in the intervention.



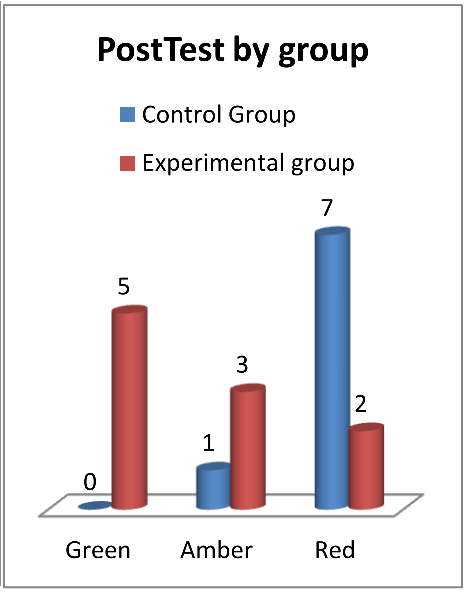


FIGURE 8.1. Pre-test placements using the traffic light system by group

FIGURE 8.2. Post-test placement using the traffic light system by group

As stated previously, the total test score is derived from the 3 subtests and can be interpreted in terms of a ‘traffic light’ system. The green zone indicates performance in a normal range, the amber zone indicates a child as being at risk and the red zone is an indication of definite motor impairment. After the pre- and post-tests the total test scores of the 18 children were interpreted and placed according to the traffic light system.

Figure 8.1 indicates the placement with regard to the traffic light system prior to the intervention. The results clearly indicate that all the participants had some form of motor proficiency problems prior to the intervention. With reference to the control group, 2 children fell in the amber zone and 6 children in the red zone. With regard to the intervention group, 6 children fell in the amber zone while 4 children were in the red zone.

In addition, Figure 8.2 indicates that subsequent to the intervention, the intervention group performed better in contrast to the control group. The distribution according to the traffic light system was as follows: observing the control group none of the children improved and, therefore, no children were in the green zone (no motor difficulties). In contrast, 5 children from the intervention group improved after the intervention and landed in the no motor difficulty category. Furthermore, the results shows that only 1 child from the control group remained in the amber zone, in contrast to 3 of the intervention group. Finally, 7 children of the control group were in the red zone whereas there were 6 initially. This confirms that children will not outgrow their motor problems. With regard to the intervention group, only 2 children remained in the red zone. The findings of this study indicate that the motor proficiency levels of children with DCD improved to a great extent due to their participation in a sport stacking intervention.

DISCUSSION OF RESULTS

With regard to manual dexterity, the results indicate a significant difference ($p=0.0191$) between the 2 groups after the intervention was completed. This is similar to a study conducted by Aparo (2009) who determined the influence of a sport stacking intervention on hand-eye coordination in children. According to the Saskatchewan Physical Education Association (2008), children using both sides of their bodies should improve their bilateral abilities. These statements support the finding of the current study. The children had ample opportunity to use both hands in a coordinated fashion during the speed stacking intervention; therefore, their manual dexterity (ability to use the 2 hands together) did improve significantly compared to the control group.

With reference to aiming and catching, it is interesting to note that both groups had a median score of 25.0, indicating a good standard of aiming and catching ability. Both groups improved with regard to aiming and catching. Although the intervention group improved more based on the median score, the results do not indicate a significant difference ($p<0.0734$) between the pre- and post-test median scores of the 2 groups. The improvement of the intervention group correlates with the findings of Udermann et al. (2004), who found that sport stacking intervention improves hand-eye coordination and reaction time, which are both important components when executing aiming and catching skills successfully. The findings of Aparo (2009) were of a similar nature. The improvement in both groups can be attributed to the fact that they had good skills prior to the intervention, thus it is harder to improve on these skills. Another reason for improvement in both groups might be due to the fact that these children participate in a variety of manipulative skills at school.

Even though both groups decreased in performance with reference to the balance subtest there was a significant difference (p<0.0472) between the 2 groups after the intervention. The decline in performance could be due to the fact that the majority of the children had to be tested on age band 2 during the post-test, indicating that the balancing activities were more difficult to execute. This may also indicate the need for the intervention to include more balancing activities.

With reference to the total test score, a significant difference (p=0.0018) was observed between the groups after the intervention. The results, therefore, suggest that children would not outgrow their motor difficulties without appropriate interventions (Henderson & Henderson, 2002; Sugden & Chambers, 2003). It was also apparent that the participants of the current study were a heterogeneous group and it is necessary to address the individual needs of each child. Based on the current study, speed stacking led to a significant improvement with regard to overall motor proficiency. This correlates with Aparo (2009), who also found a significant increase in motor performance after using a speed stacks intervention programme with 20 children between 7 and 11 years of age.

LIMITATIONS

Although the aim of this study was to determine if a sport stacking intervention might improve the motor proficiency levels of children with DCD, the population sample used in this study was obtained from a single institution and province and can, therefore, not be generalised to the larger population of 6 and 7 year old children. It is recommended that the effect of a Sport stacking intervention on children with DCD should be explored further by means of larger samples. In addition, the long-term effects of a sport stacking intervention should be researched. Another limitation to the study was that the children were tested on age band 1 (age 6) during the pre-test. A majority of the children turned 7 during the intervention, and therefore, had to be tested on age band 2, indicating that they had to perform more difficult activities compared to age band 1.

CONCLUSION

The aim of this study was to determine if a sport stacking intervention resulted in an improvement of motor proficiency levels of children with DCD. When children are diagnosed with DCD, it is important to implement motor intervention programmes. Intervention programmes have proven to enhance the motor proficiency of these children (Peens et al., 2008). The results suggest that a sport stacking intervention improved the motor proficiency levels of children with DCD. From the point of view of a therapist, no two children are the same, especially children identified with DCD, since they are not a homogeneous group. The findings of this research contribute to the field of study by providing an alternative intervention approach, namely sport stacking, for Kinderkineticists to utilise with the purpose of improving the motor proficiency levels of children with DCD.

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CHAPTER 9

Summary, conclusions and recommendations

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9.1 Summary

The research questions addressed in this study were the following: Firstly, to determine the prevalence of developmental coordination disorder (DCD) amongst Grade 1-learnersin Bloemfontein. Secondly, to determine if parents have the competency to identify DCD in Grade 1-learnersat home. Thirdly, to determine if teachers have the competency to identify DCD in Grade 1-learnersin the classroom. Fourthly, to determine if DCD influence the learning related skills of Grade 1 children. In addition, determine if the application of a perceptual-motor intervention programme (research question 5) as well as the application of a sport stacking intervention programme (research question 6) will improve the status of Grade 1-learnersclassified with DCD.

Chapter 1 provided a brief introduction and outline of the problem statement that underlies the research questions and aims that form the basis of this study. The thesis is submitted in article format, as approved by the senate of the University of the Free State (Bloemfontein Campus), and therefore includes a literature review (Chapter 2) and six research articles (Chapter 3,4,5,6,7, and 8 respectively) which all have been presented to accredited peer reviewed journals.

In order to answer the aims of this study, the current literature on DCD was investigated in Chapter 2. Firstly the definition and terminologies used for DCD were discussed, together with the prevalence of DCD as well as the characteristics of comorbidity. Furthermore, the etiology of DCD was discussed and an overview on the basic principles of neurophysiology was provided as well as the major psychomotor problems related to the nervous system. The importance of diagnoses and various assessments required to identify children with DCD were discussed in detail and included the psychometric properties, reliability, validity, sensitivity and specificity of each assessment used in this study. The assessments included the Developmental Coordination Disorder Questionnaire ’07 (DCDQ’07), Movement Assessment Battery for children-2 Checklist (MABC-2 C), as well as the Movement Assessment Battery for children-2 Performance Test (MABC-2 Test). Interventions for children with DCD were also discussed in Chapter 2, with emphasis on the process orientated approach, specifically for perceptual-motor skills. The reason for using a process orientated approach is because the current study made use of a perceptual-motor intervention in addition to speed stacking.

In conclusion, the reviewed literature indicated that the prevalence of DCD differs between various countries and was found to be as low as 5% in the United Kingdom and as high as 15% in Europe. Furthermore, the literature states that the prevalence might even be higher since medical as well as educational systems frequently fail to identify DCD in young children. Thus, it is important to use screening tools, for parents and teachers, to identify children with possible motor delays due to DCD in order to be tested by professionals on the Movement ABC-2 Test. After assessments, interventions should follow. The literature clearly indicates that a variety of intervention approaches are available for therapists to utilize in order to improve the symptoms associated with DCD, since children will not outgrow this disorder. However, controversies exist between these different approaches and there is still not enough evidence to prove that one specific intervention approach is superior to another. It is therefore recommended that these two approaches (bottom-up and top-down) should be combined in order to treat children with DCD.

In Chapter 3, the research article entitled “Developmental Coordination Disorder in grade 1 learners” by De Milander, M., Coetzee, F.F. and Venter, A. was accepted for publication in the African Journal for Physical, Health Education, Recreation and Dance (AJPHERD) Volume 20(3:1), September 2014, pp. 1075-1085. The purpose of the study was; to determine the prevalence of DCD amongst Grade 1 learners, to establish the boy-girl ratio regarding DCD and the prevalence of DCD amongst various ethnic groups. Five-hundred and fifty nine learners between the ages of 6 and 8 years took part in this study. There were n=321 girls (57%) and n=238 boys (43%) of various ethnical groups, which consisted of 57.4% Caucasian, 39.7% Black, 2.50% Mixed-race, 0.3% Hispanic and 0.1% Indian children. The Movement ABC-2 was used to determine DCD. Analysis of the data was done using Statistical Analysis Software Version 9.1.3. Descriptive statistics, namely frequencies and percentages, were calculated for categorical data. Medians and percentiles were calculated for numerical data. Median differences were tested by calculating p-values using the signed-rank test. The Chi-square statistics were used to test for proportion differences. Probability level of 0.05 or less was taken to indicate statistical significance. The results indicated that 85% participants had no motor difficulties (green zone), 8% of children in the group were identified with moderate motor difficulties (amber zone), while 7% were identified with severe motor difficulties (red zone). With regard to the boy-girl ratio, 9% of boys had moderate difficulties and 10% severe difficulties in contrast to 7% moderate difficulties and 5% severe difficulties amongst the girls. With reference to ethnical groups, 5.3% of Caucasian learners fell in the amber zone and 5.3% in the red zone, 10.6% of Black learners fell in the amber zone and 9.7% in the red zone, 14.2% Mixed-race learners fell in the amber zone and 21.4% in the red zone. The conclusions drawn from the results suggest that the prevalence of DCD amongst Grade 1 learners in Bloemfontein is estimated to be 15%. The results also indicate that boys have a significantly higher ($p=0.0507$) prevalence of DCD, although marginally when compared to their female counterparts.

In Chapter 4, the second research article entitled "The competency of parents to identify Grade 1-learnerswith Developmental Coordination Disorder at home" by De Milander, M., Coetzee, F.F. and Venter, A. was presented for publication in the South African Journal for Research in Sport, Physical Education and Recreation and accepted for publication, 2015, 37(3): in press. The corresponding author is still waiting for the results. The aim of the study was to examine the convergent validity of the classification of motor difficulties by Kinderkineticists-in-training using the MABC-2 Test and the classification of motor difficulties by the parents of the participants using the DCDQ'07, in order to determine if parents possess the competency to identify Grade 1-learnerswith DCD at home. Four hundred and ten (N = 410) Grade 1-learnersbetween the ages of five and eight years took part in this study. There were n = 226 girls (55%) and n = 184 boys (45%). The ethnic groups that took part consisted of 67% Caucasian and 33% Black children. Data analysis was performed using the Statistical Package for the Social Sciences (SPSS) for Windows (SPSS version 16.0, SPSS Inc., Chicago, IL). In order to determine the convergent validity of the classification of motor problems (no motor difficulties or motor difficulties) using the MABC-2 Test and the classification of motor difficulties (no motor difficulties or motor difficulties) by the parents of the participants using the DCDQ'07, the kappa (k-) coefficient was used. This coefficient supplies information with regard to the convergent validity between the two measuring instruments. The results indicated 91% specificity for the DCDQ'07. In contrast, the sensitivity was only 23%. The kappa coefficient of 0.151 indicated a 15% convergent validity between the two assessment tools. Therefore, it can be argued that parents using the DCDQ'07 could not identify children with DCD at home.

Article 3 in Chapter 5 is entitled "The ability of South African teachers in identifying Grade 1 learners with developmental coordination disorder in the classroom" by De Milander, M., Coetzee, F.F. and Venter, A. was presented for publication in the Adapted Physical Activity Quarterly (MS APAQ.2014-0209.R1.). The corresponding author is still waiting for the results. The aim of the study was to examine the convergent validity of the classification of motor difficulties by trained Kinderkineticists using the MABC-2 Test and the classification of motor difficulties by the teachers of the participants using the MABC-C, in order to determine if teachers possess the competency to identify Grade 1-learnerswith DCD in the classroom. Five hundred and six (n = 506) Grade 1-learnersin South Africa between the ages of five and eight years took part in this study. There were n = 289 girls and n = 217 boys. The ethnic groups that took part consisted of 313 Caucasian and 193 Black learners. Data analysis was performed using the Statistical Package for the Social Sciences (SPSS) for Windows (SPSS version 16.0, SPSS Inc., Chicago, IL). In order to achieve the aim of this study, namely to examine the convergent validity of the classification of motor problems (no motor difficulties/motor difficulties) using the MABC-2 Test and the classification of motor difficulties (no motor difficulties/motor difficulties) by the teachers of the participants using the MABC-C, the kappa (k-) coefficient was used. This coefficient supplies information with regard to the convergent validity between the two measuring instruments. The higher the coefficient (whether it is a negative or a positive value), the greater the convergent validity between the two measuring instruments. The practical importance of the results was also investigated. As standard of practical significance, the effect size was calculated. The following guideline values need to be used when the effect size is interpreted (Steyn, 1999): r = 0.1: small effect; r = 0.3: medium effect and r = 0.5: large effect. A probability level of 0.05 or less was taken to indicate statistical significance. The MABC-C demonstrated a specificity of 70.3% and a sensitivity of 46.5%. The convergent validity between the two assessment tools when completed by teachers indicated a kappa coefficient of 0.110 (11%), and thus had a small effect size (r = 0.125). Therefore, it can be argued that teachers using the MABC-C could not identify children with DCD in the classroom.

In Chapter 6, the fourth research article entitled "The Prevalence and Effect of Developmental Coordination Disorder on Learning Related Skills in Grade 1-learnersin South Africa" by De Milander, M., Coetzee, F.F. and Venter, A. was presented for publication in the South African Journal for Research in Sport, Physical Education and Recreation (MS1115). The corresponding author is still waiting for the results. The objective of the study was to determine the prevalence of DCD additionally to examine the effect of the degree of motor difficulties on learning related skills. This comparative study made use of quantitative data. The study involved one testing procedure by means of the MABC-2 Test in order to identify DCD. In addition, each participant was evaluated on the Aptitude Test for School Beginners (ASB) conducted and interpreted by qualified teachers. Learning related skills of children who were identified by the MABC-2 Test with DCD was compared to children without DCD. Data analysis was performed by a Statistician using the Statistical Package for the Social Sciences (SPSS) for Windows (SPSS version 16.0, SPSS Inc., Chicago, IL. Descriptive statistics, namely frequencies and percentages, were calculated for categorical data. Medians and percentiles were calculated for numerical data. Median differences were tested by calculating p-values using the signed-rank test. The chi-square statistics were used to test for proportion differences. Probability level of 0.05 or less was taken to indicate statistical significance. The prevalence of DCD amongst Grade 1 learners was 6% for at risk for motor difficulties as well as severe motor difficulties. Eighty eight percent (88%) of the children had no motor difficulties. The degrees of motor difficulties had a significant effect on five of the eight specific learning related subtypes namely; reasoning, numerical, gestalt, coordination and memory. The different degrees of motor difficulties, namely at risk and severe motor difficulties have significant different effects on learning of Grade 1 children.

Article 5 in Chapter 7 is entitled "Perceptual-motor intervention for developmental coordination disorder in grade 1 children" by De Milander, M., Coetzee, F.F. and Venter,

A. was presented for publication in the South African Journal for Research in Sport, Physical Education and Recreation and accepted for publication, 2015, 37(2): in press. The corresponding author is still waiting for the results. The purpose of this study was to determine if a perceptual-motor intervention will improve the symptoms associated with DCD. Seventy six children between the ages of 5 and 8 years took part in this study. The group consisted of girls (n=34) and boys (n=42) classified with DCD. The study had a pre-test/post-test experimental design (n=36) with a control group (n=40). The Movement Assessment Battery for Children-2 (MABC-2 Test) was used to assess the motor proficiency levels of the children and to classify DCD. The perceptual-motor intervention consisted of a 10-week programme of 2 sessions per week, 30 minutes per session. The dependent variables were all measurable on an interval scale and therefore the Mann-Whitney-U test was used. The results indicate that prior to the intervention, no significant differences ($p \geq 0.05$) existed between the two groups. However, after the intervention one subtest, namely balance showed a significant difference, ($p=0.050$) whiles the remaining components, manual dexterity ($p=0.797$) as well as aiming and catching ($p=0.252$), showed no significant difference. The three components contribute to the total test score, which revealed no significant difference ($p=0.068$) in the overall motor proficiency levels of the experimental group compared to the control group. The conclusion drawn from the results suggests that a perceptual-motor intervention only improved balance. However, children taking part in physical education classes presented by the teachers also proved to be beneficial.

In Chapter 8, the sixth research article entitled "The Prevalence and Effect of Developmental Coordination Disorder on Learning Related Skills in Grade 1-learnersin South Africa" by De Milander, M., Du Plessis, J. and Du Randt, A. was accepted for publication in the South African Journal for Research in Sport, Physical Education and Recreation, 2014, 36(3): 51-60, ISBN: 0379-9069. The purpose of this study was to explore sport stacking as an alternative intervention approach with typically developing children and in addition to improve DCD. Sport stacking consists of participants stacking and un-stacking 12 specially designed plastic cups in predetermined sequences in as little time as possible. Eighteen children (6 girls and 12 boys) classified with DCD, between the ages of 6 and 7 years, participated. A pre-test/post-test quasi-experimental design with a control group was applied. The MABC-2 was used to assess the motor proficiency levels of the children and to classify DCD. The sport stacking intervention consisted of an 8-week programme of 3 sessions per week, 30 minutes per session. During the intervention the children learned the various sport stacking sequences, as well as how to apply them to a variety of physical activities. Analysis of the data was done using Statistical Analysis Software Version 9.1.3. Descriptive statistics, namely frequencies and percentages, were calculated for categorical data. Medians and percentiles were calculated for numerical data. Median differences were tested by calculating p-values using the signed-rank test. The chi-square was used to test for proportional differences. A significance level of 0.05 was accepted for all aspects of the study. The results indicated that prior to the intervention no significant differences occurred between the 2 groups. After the intervention, manual dexterity and balance showed a significant difference, while aiming and catching, showed no significant difference. The total test score revealed a significant difference in the overall motor proficiency levels of the experimental group. The results suggest that sport stacking can be used as an effective intervention programme for children with DCD.

9.2 Conclusions

The conclusions that are drawn from this research are presented in accordance with the research questions set in Chapter 1, (p. 5-6).

Research question 1:
What is the prevalence of developmental coordination disorder amongst Grade 1 learners in Bloemfontein?

The conclusions drawn from the results suggest that the prevalence of DCD amongst Grade 1 learners in Bloemfontein is estimated to be 15%. The results also indicate that boys have a higher prevalence of DCD when compared to their female counterparts. Although there was a statistically significant difference, it was only marginal. The research indicated a trend towards a higher prevalence in black learners with a suggestion of even a higher prevalence in learners of mixed race.

Research question 2:

Do parents have the competency to identify developmental coordination disorder in Grade 1-learnersat home?

The results indicated that parents could identify 324 out of the 356 Grade 1 learners without motor difficulties indicating a 91% specificity by means of the DCDQ'07. In contrast the parents were able to identify 12 children with motor difficulties only, compared to 52 children identified by the MABC-2 Test, indicating a sensitivity of 23%. The *(k)-coefficient* of 0.151 indicated a 15.1% agreement between the two assessment tools after correcting for chance and show that the agreement of the two assessments is not high when completed by parents. The results suggest that parents possess the ability to identify children without motor difficulties, but not those where motor difficulties exist.

Research question 3:

Do teachers have the competency to identify developmental coordination disorder in Grade 1-learnersin the classroom?

The results indicated that the teachers had 70.3% (306/435) specificity by means of the MABC-C. In contrast the teachers were only able to achieve a 46.5% (33/71) sensitivity for the total group. The calculated (*k)*-coefficient of 0.110 was on the 1%-level and provides a small effect size which means that the findings are of insignificant practical importance. The (*k)*-coefficient of 0.110 indicates that there was only a 11.0% agreement between the two measuring instruments after correcting for chance, which implies that the agreement of the two assessments was not high when questionnaires were completed by the teachers. Thus, the results suggest that the teachers could not accurately identify the learners with motor difficulties in the classroom.

Research question 4:
Does developmental coordination disorder influence the learning related skills of Grade 1 learners?

The results indicated that the prevalence of DCD amongst children was 88% for those with no motor difficulties and 6% were at risk for motor difficulties as well as severe motor difficulties. The degree of motor difficulties had an effect on five of the eight specific learning related subtypes that were assessed namely; reasoning, numerical, gestalt, coordination and memory. The conclusion can be drawn that the different degrees of motor difficulties, namely at risk and severe motor difficulties, have significant different effects on learning of Grade 1 children.

Research question 5:
Will the application of a perceptual-motor intervention programme improve the status of Grade 1 learners diagnosed with developmental coordination disorder?

The results indicate that prior to the intervention, no significant differences occurred between the two groups. However, after the intervention one subtest, namely balance showed a significant difference, while the remaining components, manual dexterity as well as aiming and catching, showed no significant differences. The three components contribute to the total test score, which revealed no significant difference in the overall motor proficiency levels of the experimental group compared to the control group. The conclusion drawn from the results suggests that a perceptual-motor intervention did not improve the motor proficiency levels of children with DCD significantly. However, the children who followed the perceptual-motor intervention had a 67% improvement (24/36), and the children who followed the Physical Education classes also improved by 50% (20/40). This indicates that a majority of children in both groups achieved scores above the 15^{th} percentile during the post-test.

Research question 6:

Will the application of a sport stacking intervention programme improve the status of Grade 1 learners classified with DCD?

The results indicate that prior to the intervention, no significant differences existed between the two groups. However, after the intervention two subtests, namely manual dexterity and balance each showed a significant difference, while the remaining component, aiming and catching, showed no significant difference. The three components contribute to the total test score, which revealed a significant difference in the overall motor proficiency levels of the experimental group compared to the control group. The conclusion drawn from the results suggests that sport stacking can be used as an effective intervention programme for children with DCD.

9.3 Recommendations and Limitations

The results and recommendations made in this thesis will be disseminated to health professionals through publications in peer-reviewed research journals as indicated earlier in this chapter and presentations of papers at the following national conferences during 2014:

- Life Through Movement Conference (LTM), Developmental Coordination Disorder in grade 1 learners, Stellenbosch, September 2014.
- South African Sport and Recreation Conference (SASReCon), The competency of parents to identify Grade 1-learnerswith Developmental Coordination Disorder at home, Potchefstroom, November 2014.

The following recommendations are proposed for each article presented in this study:

The results of this thesis indicated that the prevalence of DCD amongst Grade 1 learners in Bloemfontein is estimated to be 15%. The results also indicate that boys have a significantly higher (p=0.0507) prevalence, although marginally, of DCD when compared to their female counterparts. In addition there was a statistically significant difference (p=0.0192) in DCD between the various ethnic groups. It is clear that the prevalence of DCD is higher in South-Africa compared to other parts of the world. It is therefore recommended that specific norms should be established for South African children. Additionally, establish a measuring instrument specifically for the South African population. It would also be necessary to present intervention programs by professionals who are familiar with motor development, to attend to the motor difficulties experienced by children with DCD.

The results of this thesis with regard to the competency of parents to identify Grade 1-learnerswith DCD at home indicated a 15% convergent validity between the DCDQ'07 and the MABC-2 Test. In addition, to determine the ability of South African teachers in identifying Grade 1-learnerswith DCD in the classroom. The convergent validity between the two assessment tools was 11%, Therefore, it can be argued that parents using the DCDQ'07 at home as well as teachers using the MABC-C in the classroom could not identify children with DCD. Therefore the researchers recommend that caution should be taken when the DCDQ'07 and the MABC-C is used as a single indicator of DCD in young children. Results with regard to sensitivity differ between various authors, thus the independent use of screening tools will not aid professionals in the early identification of motor difficulties in young children. It is therefore recommended that more research should be conducted on this topic. In addition, the researchers propose that the norms of the MABC-C might be adapted in order to address each country's specific needs. Furthermore, adapt the DCDQ'07 to the South African context, since the use of Canadian norms and Canadian item development, includes specific sports, which may not be applicable to South African children.

With reference to the results for the Prevalence and effect of DCD on learning-related skills in Grade 1-learnersin South Africa, the prevalence of DCD (severe motor difficulties) amongst grade 1 learners was 6% and the at risk group constituted another 6%. Of the children tested, 88% had no motor difficulties. Motor difficulties had a significant effect on five of the eight learning-related subtypes, namely reasoning, numerical skills, gestalt, coordination and memory. It is recommended that the knowledge generated from this article should be used to inform teachers in order to address these problems by means of new preventative strategies. Thus, the researchers propose that teachers should take these difficulties in consideration in order to help children excel in their academic performance. It would also be necessary to present motor programs by professionals who are familiar with motor development, to attend to the motor difficulties experienced by children with DCD.

With regard to the final two articles focusing on interventions for children with DCD the results were as follows. With regard to the perceptual-motor intervention for DCD in grade 1 children, the results indicated that only the balance sub-test improved. Interesting to note that the children taking part in Physical Education classes presented by the teachers also prove to be beneficial. In contrast, the sport stacking motor intervention programme for children with DCD showed an improvement in manual dexterity, balance as well as the total tests score. From the point of view of a therapist, no two children are the same, especially children identified with DCD, since they are not a homogeneous group. It is therefore recommended that individualized programmes should be established to address the specific need(s) for each child. The findings of this research contribute to the field of study by providing evidence that the bottom-up approach and the top-down approach should be combined with the purpose of improving the motor proficiency levels of children with DCD.

The study demonstrated several limitations on various areas, which could be overcome in future research. The limitations include the following:

- The results of the study were based on data obtained from the Bloemfontein metropolitan only; therefore the results cannot be generalized to the larger population in the country, as certain discrepancies may occur. It is recommended that future studies should be conducted to incorporate all the provinces of South Africa including urban- and rural areas.

- A comparison between the DCDQ'07 and the MABC-2 Checklist, which can also be completed by the parents, could have been conducted to determine which screening questionnaire yielded the best results.
- Furthermore, the parents who took part in the current study were not specifically taught how to complete the DCDQ'07. Furthermore the teachers who took part in the current study were also not formally trained to observe and rate motor development according to the MABC-C criteria. The large number of parents and teachers may have affected the reliability of the scores according to the DCDQ'07 and the MABC-C.
- Additionally, since this was a population-based sample, criterion B of the diagnostic criteria for DCD, which states that the academic performance of the children should also be considered (APA, 2013), was not used.
- One of the major limitations with regard to the perceptual-motor intervention article was the fact that the control group was exposed to Physical Education classes. Thus, this could have contributed to the improvement of their motor proficiency levels and influenced the results.
- Another limitation to the study with regard to both interventions was that the children were tested on age band 1 (age 6) during the pre-test. A majority of the children turned 7 during the intervention, and therefore, had to be tested on age band 2, indicating that they had to perform more difficult activities compared to age band 1.
- Furthermore, the long-term effects/benefits of the perceptual-motor intervention as well as the sport stacking intervention should be researched.

9.4 References

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APPENDIX A

Premission from Department of Education

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16 April 2012

MR. R.S. MALOPE
Head of Department of Education
Department of Education
BLOEMFONTEIN
9301

Dear Mr. R.S. Malope

RESEARCH TITLE: DEVELOPMENTAL COORDINATION DISORDER IN PRIMARY SCHOOL CHILDREN AGED 6-7 YEARS

Hereby I (Monique de Milander) would like permission to conduct research at seven primary schools in Bloemfontein. The purpose of the research project will be to determine how many children in Bloemfontein suffer from Developmental Coordination Disorder. Furthermore, the impact of this disorders on children's school performance will be investigated as well as the ability of parents and teachers in the early identification of possible coordination problems. Finally, recommendations are made regarding intervention to improve this deviation. No research indicates whether South African parents and teachers have the ability in the early identification of possible coordination problems could be found.

Data will be collected through the help of parents, teachers and Kinderkineticists. Parents will complete two questionnaires. The first questionnaire is the DCDQ-07 as well as the Movement Assessment Battery for Children-2 Checklist (Movement ABC-2) about parents' perceptions of their child's motor abilities. Teachers will also complete the Movement ABC-2 Checklist, one month after school commenced. Questionnaires will take parents and teachers approximately 20 minutes to complete.

In addition, Kinderkineticists will determine children's motor abilities using a standardized measuring instrument. All the learners participating in the research project will receive an intervention programme to improve potential developmental delays and to prevent future problems from occurring.

The study will be executed over an eight week period. Three schools will form the control group with one intervention session per week. The other four schools will form the experimental group with three intervention sessions per week. The intervention will take place during the Life-Orientation period. Feedback will be provided to parents regarding their children's motor skills and school readiness. There is no cost associated with testing and feedback of results.

The principals of each school in Bloemfontein, granted permission for the participation of their learners in this project and will receive a parental informed consent form to be completed by their legal guardians and each learner will receive a minor’s consent form to be completed.

There are no risks involved in participation in this study.

I trust that my application will meet your approval.

………………………….	………………………….
MONIQUE DE MILANDER	**DR. F.F. COETZEE**
(RESEARCHER)	**(PROMOTOR)**

APPENDIX B
Feedback from the Department of Education

Enquiries: BE Qwelane
Tel : 051 404 8756/8758
E-mail: qwelaneb@edu.fs.gov.za

education
Department of Education
FREE STATE PROVINCE

Dear Monique de Milander (Researcher)

cc: Dr. F.F Coetzee (Promoter)

RESEARCH TITLE: DEVELOPMENTAL COORDINATION DISORDER IN PRIMARY SCHOOL CHILDREN AGED 6-7 YEARS

You are hereby given the permission to conduct your research on the mentioned topic

During your research proceedings teaching and learning time should always be respected except where prior arrangements have been made with the Life Orientation Educator with the Principal's approval.

Your interest in researching some of the factors that we view as barriers to learning, early identification thereof and an intervention program is highly commendable and we are looking forward in engaging with your findings.

Your research findings should be shared with the relevant section and Ms. Qwelane at 051 404 8756/082 771 1185 can be contacted to arrange the session with Inclusive and Special Education personnel.

Good luck with your research.

Kind regards,

RM Malope

Mr. RS Malope
Head of Department

25/04/2012
Date

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APPENDIX C
Informed consent form

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9 January 2012

INFORMATION DOCUMENT

DEVELOPMENTAL COORDINATION DISORDER IN PRIMARY SCHOOL CHILDREN AGED 6-7 YEARS

Studies in America and Europe have shown that 5-6% of children encounter motor difficulties with a boy to girl ratio of 2:1. Developmental Co-ordination Disorder (DCD) affects children's performance of functional motor tasks necessary for success in children's daily lives, in activities at home, free play and school. Children do not out grow this disorder, and to take preventive and rehabilitative action, specialized intervention programs are implemented.

Negative influences associated with this disorder are, for example, physical health problems such as obesity, leading to the withdrawal from activities, which further leads to social, emotional and academic problems. Other contributing problems associated with DCD are Attention Deficit Hyperactivity Disorder (ADHD), speech and language impairments, and visual-motor problems.

The purpose of the research project will be to determine how many children in Bloemfontein suffer from DCD. Furthermore, the impact of these disorders on children's school performance will be investigated as well as the role that parents and teachers may play in the early identification of possible coordination problems. Finally, recommendations are made regarding intervention to improve this deviation. No research showing whether South African parents and teachers have a role to play in the early identification of possible coordination problems could be found.

Data will be collected through the help of parents, teachers and Kinderkineticists. Parents will complete two questionnaires. The first questionnaire is the DCDQ-07 as well as the Movement Assessment Battery for Children-2

Checklist (Movement ABC-2) about parents' perceptions of their child's motor abilities. Teachers will also complete the Movement ABC-2 Checklist, one month after school commenced. Questionnaires will take parents and teachers approximately 20 minutes to complete. In addition, Kinderkineticists will determine children's motor abilities using a standardized measuring instrument. All the learners participating in the research project will receive an intervention programme to improve potential developmental delays and to prevent future problems from occurring.

The study will be executed over an eight week period. Three schools will form the control group with one intervention session per week. The other four schools will form the experimental group with three intervention sessions per week. The intervention will take place during the Life-Orientation period. Feedback will be provided to parents regarding their children's motor skills and school readiness. There is no cost associated with testing and feedback of results.

This information is vital in order to determine whether parents and teachers have a role to play in the early identification of coordination problems. Kinderkineticists involved in the development of the young child will be able to evaluate the results to help make the correct recommendations regarding intervention and the awareness of this disorder among parents and teachers.

Your participation in this research project is greatly appreciated, but remains voluntary. The researcher undertakes to keep all personal information confidential. The results of this research study will be used for presentations at national and international conferences and for publication of articles in medical journals.

Contact details of the researcher:

....

Monique de Milander

051 401 9342

CONSENT FORM TO PARTICIPATE IN RESEARCH PROJECT

Please return all relevant forms back to school no later than Monday 22 of January 2012, whether completed or not.

DEVELOPMENTAL COORDINATION DISORDER IN PRIMARY SCHOOL CHILDREN AGED 6-7 YEARS

I, ____, parent / guardian of ____ (child's full name and surname) ________________________ (date of birth), give permission that he / she may participate in the research project. I am aware that the information supplied by completing the questionnaires, will be analysed to determine parents' perceptions of their child's motor skills and the ability of parents' in the early identification of motor problems.

The researcher will take precautions to ensure that the identities of participants remain anonymous and that all information is kept confidential.

________________________ ________________________

Parent / Guardian **Date**

________________________ ________________________

Researcher's Signature **Date**

APPENDIX D
Child Assent Form

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS·UV
HUMANITIES
GEESTESWETENSKAPPE

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www.ufs.ac.za

9 January 2012

CHILD ASSENT FORM

You are being asked to take part in a research study being done by the University of the Free State. In this study, we are interested to know more about your motor proficiency. We have asked your parent or caregiver whether it is OK for you to participate, but now we want to see if it is OK with you.

If you decide to take part in this study, you will be asked to perform a variety of physical activities such as catching a ball, jumping and throwing activities. This will take about 30 minutes to do. Also, we would like to ask your parents about your motor abilities. All the information we collect will be kept secret. We will not use your name so everything will remain private.

By signing this you are showing that you understand what is going to be happening and have asked any questions you may have about the research. You can also ask questions later if you cannot think of them now. Signing this form does not mean that you have to finish the study- you can pull out from the study at any time without explaining why.

______________________________ ______________

Child's signature Date Time

APPENDIX E
Summary of intervention programmes

PERCEPTUAL-MOTOR INTERVENTION				
Week 1: Unilateral activities				
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Laterality; motor-planning; gross motor coordination.	One tumbling mat; four cones; active learning cards (colors and shapes).	Place cones in a straight line 0.6 meter apart on the mat.	Do a unilateral crawl from cone to cone by using your right hand and right leg at the same time and then your left hand and left leg at the same time. As you pass each cone, say what is shown on the card for that cone. Once you reach the last cone, do a backward unilateral crawl to your original starting point by using your left hand and left leg at the same time and then your right hand and right leg at the same time.	The child should raise his or her torso so that the weight is supported by the hands and knees without the stomach touching the floor; movement should be continual; the relevant hand and knee should move forward simultaneously.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Laterality; locomotor skills; spatial awareness; motor planning.	Hopscotch mat; active learning cards (colors and shapes).		Hop through the mat using only your left foot. With each hop, say what is shown on the card for the square you are landing in. Repeat the activity using only your right foot. Continue in this way-hopping	The student should hop on only one foot in each square, thus isolating that side of the body. Make sure that the student uses proper hopping form: Swing your non-weight-bearing leg like a

			through the mat on your left foot, then hopping through on your right foot, then back to the left, and so on.	pendulum to produce power; on landing, keep the foot of your non-weight-bearing leg behind your body; bend arms and swing forward to produce power.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Spatial awareness; eye-hand coordination; body awareness; gross motor coordination.	One hoop for each student; one 22-centimeter playground ball for each student.		Crawl around the outside of the hoop while rolling the ball around inside the hoop with the fingertips of one hand; repeat the activity using the elbow; reverse the direction of the crawl, using the other side.	Make sure the student uses proper crawling form: Raise your torso so that your weight is supported by your hands and knees without your stomach touching the floor; movement should be continual; right side of the body and left side should move forward simultaneously.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Laterality; locomotor skills, motor planning.	Agility rings (round ring), active learning cards (uppercase letters with pictures).	Place the rings on the floor so that they are touching one another. Place an active learning card in each ring.	Hop forward three rings, saying the letter shown on the card for each ring as you land in it. Then hop to the next ring and say what is shown in the picture on the card. Continue on to the next letter-picture sequence.	Make sure the student uses proper hopping form: Swing your non-weight-bearing leg like a pendulum to produce power; on landing, keep the foot of your non-weight-bearing leg behind your body; bend arms and swing forward

				to produce power.
Week 2: Bilateral activities				
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Locomotor skills; motor planning, spatial awareness.	Ten cones with clear sleeves; active learning cards (numbers 1-10).	Scatter the cones 1.2 meters apart.	Frog-jump randomly from cone to cone. When you get to each cone, touch it and say the color and number shown on its card.	Remind student to slow down and focus on using the correct form for a frog jump: start in a squat position; place your hand on the floor between your legs; move your hands to a position on the floor a short distance in front of your body; keeping your feet together and your hands on the floor, jump and let your feet land near your hands.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Locomotor skills; motor planning, spatial awareness.	Foo-Foo wands (two per child).		Touch your body parts with your wands and name the different parts.	Make sure the child uses the wands properly, should be to identify body parts.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Laterality, motor planning, gross motor coordination.	One stomp board for each child; one beanbag for each child.		Stop on the stomp board with feet at once to project the beanbag into the air. Catch the beanbag with two hands and say the color of the beanbag. Try five times. Repeat the activity, clap	Make sure that the student uses both feet while stomping. Remind the student to slow down and focus on using the correct form for a bird's nest catch (two-hand catch with

			once and catch the beanbag with two hands. Try five times.	palms up): prepare by extending your hands in front of your body with your elbows bent; reach for the beanbag with your palms up as the beanbag approaches; catch the beanbag with your hands only; keep eyes on the beanbag while catching.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Spatial awareness, gross motor coordination.	Eight hoops, the color of the hoop should match that of the active learning card; one 22-centimeter playground ball for each child; active learning cards (shapes).	Place hoop in a circle (about 1 meter) apart. Put an active learning card inside each hoop.	Starting at the first hoop, say the shape and color shown on the card in the hoop. Then use a two-handed dribble to dribble the ball in the hoop five times, counting from 1 to 5 as you dribble. Move to the next hoop and repeat.	The ball should contact the surface in front of the student; keep your eyes up; use your finger pads – not your fingertips; for good control, dribble at waist level or lower; student should maintain control of the ball for at least four consecutive bounces.
Week 3: Cross-lateral activities				
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Locomotor skills, motor planning, spatial awareness.	Six cones; active learning cards (numbers).	Place six cones 1 meter apart in a straight line.	Crawl from cone to cone. Along the way touch each cone and say the number shown on the card for that cone.	Make sure child use proper crawling form: raise your torso and support your weight on your hands and knees with your stomach off

				the floor; move without stopping; your right hand and left knee should move forward simultaneously; make sure child correctly identifies the numbers on the cards
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Cross-laterality, directionality, balance, eye-hand coordination; midline crossing.	22-centimeter playground ball; floor tape.	Use the floor tape to mark an 2.4 meter line.	Hold the ball and walk forward on the line using a crossover step: On each step with your right foot, step to the left of the line; do the same with the opposite foot; continue this pattern to the end of the line. After each step, bounce the ball with either hand.	Make sure that the child uses proper form for dribbling: keep your eyes up; use your finger pads – not your fingertips; for good control, dribble at waist level or lower. Make sure that child use proper form for the crossover step: midline crossing.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Eye-hand coordination, gross motor development.	One stomp board for each child; one beanbag for each child.		Stop on the stomp board with right foot to project the beanbag into the air. Catch the beanbag with the left hand and count. Try ten times. Repeat the activity, with the opposite foot. Progression, clap once	Make sure that the student uses proper form for cross-lateral stomping: face the board with feet slightly apart and adjacent to each other; step quickly on the stomp board with minimum force; if stomping with right foot

			and catch the beanbag. Try ten times; repeat the opposite side.	catch with left hand and opposite. Make sure child uses proper form for catching: prepare by extending your hands in front of your body with your elbows bent; reach for the beanbag with your palms up as the beanbag approaches; catch the beanbag with your left or right hand only; keep eyes on the beanbag while catching.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Dynamic balance, spatial awareness.	Floor beam; hoop with stand; two cones with hurdle.		Walk forward on the beam from one end to the other. Along the way, step over the hurdle and through the hoop.	Watch for balance problems and provide support when needed, if child have trouble let them walk on floor; make sure that the child uses dynamic balance to maintain equilibrium while in motion; child should do the task smoothly, without falling or having to hold on to an object.
Week 4: Combined activities				
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Laterality; locomotor skills; motor planning.	Jump box (30-centimeter high); one	Place the hurdle 30-centimeter in front of the	Step onto the box; jump from the box over the	Make sure only one child is on the course at

	foam hurdle (made from pool noodle on two cones); three hoops (two on the ground, on in a stand).	jump box. Place the first hoop 30-centimeter in front of the hurdle and the second hoop 30-centimeters in front of the first hoop. Set up the third hoop in the stand and place it 1 meter in front of the second hoop.	hurdle and into hoop one; from one to two and step through the last hoop.	a time; make sure the child prepare to jump with movement that includes bending both of their knees and extending their arms behind the body.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Locomotor skills, motor planning, eye-hand coordination.	Mini trampoline; scooter board; 2 meter jumping rope; hoop; 22-centimeter ball.	Place the scooter board 1.2 meter in front of the mini trampoline. Place the jump rope 1.5 meters in front of the scooter board and the hoop and ball 1.2 meter in front of the jump rope.	Jump on the mini trampoline for five times; lie facing forward on our tummy on the scooter board and use both arms together to propel yourself forward to the rope; jump over the rope from front to back and then back to front five times; walk to the hoop and bounce the ball in the hoop five times with both hands together.	Emphasize safety: on the scooter board, trampoline etc. Remind the child to slow down and focus on using the correct form for a standing long jump; bend both knees with your arms extended behind your body before take-off; when jumping, thrust your arms forcefully forward and upward (above your head); take off and land with both feet; move arms downward on landing; child should use both hands to push the ball to the ground.

Skills developed	Equipment	Setup	Activity	Skill check
Cross-lateral awareness; dynamic balance; eye-hand coordination.	Ladder mat; three hoops; stomp board; one beanbag.	Place the hoops in a row 1.2 meters away from the ladder mat with 30-centimeters in between each one. The stomp board should be placed 1.2 meters away from the last hoop.	Walk on the rungs of the ladder; leap into and then out of each hoop; stomp on the board with your right foot to launch the beanbag, the catch it with your left hand; opposite side as well.	Make sure that the child uses proper form for leaping: move continuously without hesitation before the leap; take off on one-foot and land on the other; use a long stride in which both feet are off the ground during each leap; for each leap reach in front of your body with the opposite arm.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Cross-lateral awareness; dynamic balance; eye-hand coordination.	Scooter board; 3 meter tunnel; three cones; two noodles or long jump ropes (4 meters).		Lie on your tummy on the scooter board; use alternating hands to propel yourself forward through the tunnel; kneel on the scooter board and use alternate hands to weave through the cones; sit on the scooter board and use alternating feet to propel yourself backward through the space between the noodles or ropes.	Stress scooter board safety; make sure that the student uses only one hand at a time in propelling the scooter board.

Week 5: Unilateral activities				
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Laterality; locomotor skills; motor planning; spatial awareness.	Hopscotch mat; active learning cards (lower case with pictures).		Hop sideways through the mat using only your left foot. With each hop, say what is shown on the card for the square you are landing in. Repeat with right foot.	Child should hop only on one foot in each squared; make sure child uses proper hopping form: swing non-weight-bearing leg like a pendulum to produce power; on landing, keep the foot of your non-weight-bearing leg behind your body; bend your arms and swing them forward to produce power.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Laterality; motor planning; gross motor coordination.	One scooter board for each child; jump rope of 3 meters long; volleyball.	Attach the rope to the base of the volleyball and extend in on the floor; position the scooter at the free end of the rope.	Lie on your torso on the scooter board and use the rope to pull yourself forward with only your right hand; repeat using left hand; sit on the scooter board and pull with right and then left hand.	Safety is important; make sure child isolates one side of the body by using only one hand to pull.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Laterality; eye-foot coordination.	Five white and black foam bricks.	Arrange to rows of bricks-the right one containing whit bricks and the left one black bricks; in each row, the	Walk between the two rows of bricks, kicking the black ones over with your left foot and kicking the white ones over with	Make sure that the student kicks each brick with proper foot.

		bricks should be 0.6 meters apart; stagger the spacing go the rows.	your right foot.	
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Laterality; motor planning; coordination.	One hula hoop for each child; Frisbee; floor tape.	Place the hoops on the floor against a wall; the hoops should be in a row about 1 meter apart from each other; use the floor tape to mark a line approximately 1.5 meters away from the hoops.	Toss the disc into the target using your right hand and stepping with your right foot, do the same with your left hand and foot.	Make sure child isolates one side of the body; make sure that the child use proper form for tossing the disc: turn your throwing hand so the palms faces up; hold the Frisbee with your index finger on the outside rim, your other three fingers on the bottom side, and your thumb on the top side; keep your palm up and the elbow of your throwing arm in toward your body; face the target and step toward it with the foot on the same side as throwing hand, then toss; snap wrist and fingers on the follow-through; keep palm up throughout the throw.

Week 6: Bilateral activities				
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Laterality; locomotor skills; motor planning.	Leap; hop and jump mat; active learning cards (uppercase letters).		Start at the pointed end of the mat; jump across this first section of the mat with both feet and say the number shown on the card for that sections; move to the next section to the right and jump across every remaining sections until you reach the end. Don't need to make the distance.	Encourage child to speak loudly when saying the numbers as he/she jumps; remind child to slow shown and focus on correct form for standing long jump; bend both knees with your arms extended behind your body before take-off; when jumping, thrust your arms forcefully forward and upward above head; take off and land with both feet; move arms downward on landing.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Motor planning; gross motor coordination; locomotor skills.	Ten giant shapes (circles).	Scatter the giant shapes on the floor; 30-centimeters apart.	Do frog jumps from one shape to another; after each jump and starting with A, work your way through the alphabet, start again if you get to the end; repeat by jumping sideways.	During sideways jumping, make sure that the child jumps with feet facing forward; remind child of proper form for frog jump: start in a squat position; place your hand on the floor between your legs; move your hands to a position on the floor a short distance in front of

				your body; keeping your feet together and your hands on the floor, jump and let your feet land near your hands.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Eye-hand coordination; tracking skills.	One 22-centimeter playground ball for each child.	Use floor tape to mark out a line parallel to a wall at a distance of 2 meters.	Sit facing the and roll the ball to the wall with two hands, after each roll, say the alphabet, roll as many times as possible in the allotted time; stand on line and toss the ball with two hand against the wall, let it bounce one time after hitting the wall, catch with two hand, repeat the toss but catch without the bounce.	Make sure child performs activity with both hands.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Locomotor skills; motor planning; spatial awareness.	Floor tape.	Use tape to mark four lines, approximately 3 meter long and 3 meters apart on the floor for each station.	Jump over the line on the floor with both feet; with hand on your hips, jump over the line slowly for five times and the quickly; jump across the line high, then turn around and jump across the line, repeat and	Remind the student to slow down and focus on using the correct form for a standing long jump: bend both knees with your arms extended behind your body before take-off; when jumping, thrust your arms

			jump low; repeat the activities and recite the alphabet while jumping.	forcefully forward and upward (above your head); take off and land with both feet; move arms downward on landing.
Week 7: Cross-lateral activities				
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Cross-lateral awareness.	22-centimeter playground ball; foam brick; two cones; floor tape.	Position two cones 1.5 meters apart; use the floor tape to mark a line 3 meters from where child will be kicking the ball.	Taking a 3-meter approach, run up to the ball without slowing and use your right foot to kick the ball at the brick between the cones; when kicking with your right foot, extend your left arm forward; repeat with your left foot and right arms; repeat five times.	Make sure the child uses proper kicking form: a fast and nonstop approach to the ball; just prior to kicking the ball, take a long stride; place your non-kicking foot even with or slightly behind the ball; kick the ball with instep or toe of preferred foot; follow through by landing on your kicking foot.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Laterality; motor planning; gross motor coordination.	One scooter board for each child; four cones; active learning cards (lowercase letters).	Position the cones a half meter apart in a straight line.	Lie on your tummy on the scooter board and push yourself from cone to cone, alternate side in pushing, as you pass each cone, say what is shown on the card; repeat the activity by sitting on the scoot board.	Safety first; watch for cross-laterality; make sure child says aloud what is shown on the card.

Skills developed	Equipment	Setup	Activity	Skill check
Laterality; motor planning; gross motor coordination.	Four buckets and four beanbags in primary colors.		Crawl from beanbag t beanbag, putting each one in the bucket with the matching color; when picking up a beanbag from the floor, use whichever hand is closest to it and use that same hand to put the beanbag in the bucket.	Make sure child does not switch hands; make sure child uses correct crawling form: the child should raise his or her torso so that the weight is supported by the hands and knees without the stomach touching the floor; movement should be continual; the relevant hand and knee should move forward simultaneously.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Cross-lateral awareness; dynamic balance.	Leap; hop and jump mat; floor tape; active learning cards (lower case).		Start at a line 3 meters from the mat and leap across the mat; start at the narrow end and work your way to the wide end; emphasize using good leaping form; on landing say what is shown on the card for the section.	Make sure child uses proper form for leaping: move continuously without hesitation before the leap; take off on one foot and land on the other; use a long stride in which both feet are off the ground during each leap; for each leap, reach in front of your body with the arm on the opposite side from your landing foot.

Week 8: Combination activities				
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Eye-hand coordination; unilateral awareness.	Giant shapes; 22-centimeter playground ball.	Place the shapes 1.2 meters apart to allow space for child to hop to the next shape.	Hop from shape to shape, at each shape bounce the ball in the shape five times with your right hand and then the left hand; while bouncing the ball say the shape and color.	Make sure child use one hand to bounce; make sure child uses proper form for dribbling: keep your eyes up; use your finger pads – not your fingertips; for good control, dribble at waist level or lower. Make sure that child use proper form for the crossover step: midline crossing; make sure child use proper hooping form: Swing your non-weight-bearing leg like a pendulum to produce power; on landing, keep the foot of your non-weight-bearing leg behind your body; bend arms and swing forward to produce power.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Eye-hand coordination; motor planning; dynamic balance.	Eight hula hoop; floor beam; 22-centimeter playground ball.	Set each hoop close enough to the floor beam so the students can bounce the ball in the hoop as the slide	Hop five times in each hoop; get on the beam and slide sideways to the right to the end of the beam, as you go	If child have trouble walking on the beam, walk on the floor; make sure child uses proper hopping form (as

		down the beam.	bounce ball once in each hoop with right hand, repeat with the left hand.	indicated previously); proper sliding form; turn body sideways with your leading foot, the slide your trailing foot to meet it; move with a rhythmic continual motion; make use of proper dribbling (as indicated previously).
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Bilateral awareness; eye-hand coordination; motor planning.	Three hoops; scooter board; beanbag; floor tape.	Place the hoops in a line so that they are touching each other; use the floor tape to mark an X about half a meter away from the hoops and place the scooter board there; place the beanbag 2 meters away from the scooter board.	Jumping from hoop to hoop by taking off and landing with both feet simultaneously; lie on your tummy on the board and use both hand at the same time to propel yourself forward to the beanbag; toss and catch the beanbag five times with both hands.	Remind child to use proper form for standing long jump and catching (as indicated previously); as well as tossing: use both hands together to make the toss; make your tosses equally high; keep your eyes focused at the peak of the toss; keep your elbows close to your body; stand straight without leaning.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Cross-lateral awareness; motor planning.	Incline mat; step box 30-centimeters high; hoop on stand; hurdle on two cones.	Place one hoop on the floor 30-centimeters in front of the incline mat, the vertical hoop should be set up 1.2 meters away from the hoop on	Crawl up the incline mat onto the step box; jump off the box into the hoop on the floor; step through the vertical hoop and say “through”;	Make sure child uses proper crawling: raise your torso so that your weight is supported by your hands and knees without your stomach

		the floor; place the hurdle 1.2 meters away from the vertical hoop.	crawl under the hurdle and say "under".	touching the floor; movement should be continual; right side of the body and left side should move forward simultaneously. and standing long jump (as indicated previously).
Week 9: Unilateral activities				
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Locomotor skills; motor planning.	Six cones; six cone collars; active learning cards (uppercase letters with pictures).	Place six cones 1.2 meter apart in a straight line, place matching letter and picture cards in the cones, alternating with each cone example, letter A, apple, letter B, ball picture.	Hop from cone to cone, at each cone, say the letter or picture shown on the card for that c one. Repeat activity using your other foot.	Make sure child uses proper hopping form: Swing your non-weight-bearing leg like a pendulum to produce power; on landing, keep the foot of your non-weight-bearing leg behind your body; bend arms and swing forward to produce power.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Spatial awareness; gross otor coordination.	65-centimeter exercise ball; active learning cards (uppercase with pictures); floor tape.	Post a letter card and a picture card side by side on the wall against which students will roll the ball, the name of whatever is shown on the picture card should start with the letter shown on the letter card. Use the floor tape	Roll the ball to the wall with your dominant hand; be sure you step forward with the same foot as the hand you used to roll the ball, while it rebounds off the wall, say the letter shown on the card posted on the wall,	Make sure child uses proper form for unilateral rolling: face your target; step toward the target with the foot on the same side as your rolling arm; use a pendulum motion with your arm to roll the ball (as in bowling); bend

		to mark a line 2 meters from the wall so that the child will know where to stand to roll the ball.	catch the ball on the rebound, repeat with non-dominant hand.	your knees to lower your body and release the ball close to the ground; follow through with your rolling hand toward the sky.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Laterality; eye-hand coordination.	Juggling scarves.		Toss the scarf up into the air with your right hand, then catch it with your right hand using the lion's claw catch; as you toss the scarf, say "toss up" and catch "catch down"; repeat with the left hand until music stops.	Make sure child toss and catch with the same hand; make sure child uses proper form for lion's claw hand: prepare by extending your hand in front of your body with your elbows bent; palms facing outward; reach for the scarf with your palms downward with palm facing down; catch the scarf with your hand only; keep eyes on the scarf while catching.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Balance.	22-centimeter playground ball		Put your belly on the ball and try to balance yourself without touching the floor; with belly on ball, lift right arm and right leg and try to balance, repeat with	Child should try to achieve static balance, encourage to make no movement if possible.

			left side.	
Week 10: Bilateral activities				
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Laterality; locomotor skills; motor planning.	Five hoops.	Place five hoops in a straight line 15-centimeters apart.	Jump forward from hoop to hoop while saying one letter in alphabetical order after each jump; repeat activity backwards.	Remind child to slow down and focus on correct form for standing long jump: bend both knees with your arms extended behind your body before take-off; when jumping, thrust your arms forcefully forward and upward (above your head); take off and land with both feet; move arms downward on landing.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Laterality, dynamic balance.	Floor beam – best if 2 meters long and no more than 15-centimeters off the floor; long noodle 1 meter long.		Hold a noodle horizontal in both hands with palms up at chest level and walk forward for the length of the beam; carry a noodle over your head with both hands and walk forward for the length of the beam.	Make sure child uses proper form for walking: stand tall by keeping your body erect; you should be able to draw a straight line from ear to shoulders; align your hips, knees and ankles; you head should be level and looking forward, and your chin should be parallel to the ground; shoulders should be relaxed and

				arms bent; walk heel to toe; should do task smoothly, without falling or holding on to an object; if they experience difficulty let them walk on the floor.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Eye-hand coordination; spatial awareness; coordination.	Four cones; active learning cards (lowercase letters and spelling words); floor tape; 22-centimeter playground ball.	Use floor tape to mark a 2 meter line away from each cone.	While standing, place the ball on the floor between your legs and roll it (with both hand together) at a cone, say the letter on the cone, retrieve the ball and repeat until you have rolled the ball five times; turn and face away from the cone, roll the ball backward between your legs at the cone.	Make sure child performs each activity with both hands.
Skills developed	**Equipment**	**Setup**	**Activity**	**Skill check**
Directionality; locomotor skills	Jump box; incline mat; hoop.		Activity may be done without the incline mat, use a mat to crawl up to the jump box; get on the jump box and assume proper jumping position, with knees bent and your arms extended behind your body, jump into the hoop, making a	Make sure child lands on two feet and thrusts his or her arms downward on landing; remind to slow down and focus on correct form for a standing long jump: bend both knees with your arms extended behind your body before

			quarter-turn to the right, repeat it to the left.	take-off; when jumping, thrust your arms forcefully forward and upward; take off and land with both feet; move arms downward on landing.

Adapted from Johnstone and Ramon (2011)

SPORT STACKING INTERVENTION

During week 1 and week 10 the children underwent the pre-test and post-test. During week 2 to week 5 the children took part in the intervention that was repeated in order to complete an 8 week intervention period.

Week 2: Programme 1

Equipment: Speed-Stacks; four trampolines; four beacons; twelve beanbags; twelve ropes; 30 hula hoops.

Activity 1	Build-up and break down the 3 tower
Activity 2	Run and jump 20 jumps on the trampoline Then jump double legs and build the 3 tower Run back
Activity 3	Walk on a line Balancing a beanbag on your head Build and break down the 3 tower
Activity 4	Jump from hula to hula (hula's in a snake shape) each 3rd hula build and break down the 3 tower

Week 2: Programme 2

Equipment: Speed-Stacks; different colour shapes; big beacons; small beacons; wooden planks; all the hula's; 12 Hockey beacons.

Activity 1	Build-up and Break down the 3 Tower
Activity 2	Robot Game Each child stands on a shape Jump on left/right leg Build the colour you are standing on (3 tower)
Activity 3	Obstacle course 2 Teams 4 beacons with planks on (going over and under) Build and break down 3 tower

	Run back running backwards
Activity 4	Hula snake
	Climbing through each hula as fast as you can
	Build and break down the 3 tower
Week 2: Programme 3	
Equipment:	Speed-Stacks; 12 beanbags; 12 Stump-boards; 12 Hula's; 12 Hockey beacons.
Activity 1	Build-up and Break down the 3 Tower
Activity 2	Race
	2 Children in a team
	Throw and catch beanbag (5 times without falling; both hands)
	Run to the middle
	Build and break down 3 stacks of the 3 tower
	Run back and sit down (first team to sit wins)
Activity 3	Individual race
	Stump-board, catch 5 times (both hands/left/right)
	Run and build 3 stacks of 3 tower
	Run back (first one to sit wins)
Activity 4	3 Teams- Race
	Each team stands in the corner of the hall in a colour hoola-hoop
	Jump on one leg (left/right)
	Collecting your colour speed-stacks(one by one)
	Build your 3 tower and sit (first team sitting down wins)
Week 3: Programme 4	
Equipment:	Speed-Stacks; 12 hockey beacons; 12 hula's; beads and laces; bouncey ear balls.
Activity 1	Build-up and Break down the 6 Tower
Activity 2	Race
	Hop on right leg

	Build and break down 6 Tower
	Hop back on left leg
Activity 3	Start at the beacon
	Run to the Hula
	Thread all the beads
	Run to the speed-stacks
	Build a 6 tower and run back (tag your friend to go next)
Activity 4	Bouncing Race
	Bounce on the Ear Ball
	Build and break down the 6 tower
	Bounce back (tag your friend to go next)

Week 3: Programme 5

Equipment: Speed-Stacks; purple worms; 12 hockey beacons; 12 elephant feet; 12 shapes.

Activity 1	Build-up and Break down the 6 tower
Activity 2	Crawl through purple worm
	Jump hop-scotch on shapes
	Build and break down 6 tower
Activity 3	Race on elephant feet
	Build and break down 6 tower
	Race back on elephant feet
Activity 4	2 teams! Competition
	Building the BIGGEST and HIGHEST tower

Week 3: Programme 6

Equipment: Speed-Stacks;12 hula hoops; 12 blue balance boards; 15 hockey. beacons

Activity 1	Build-up and break down the 6 tower
Activity 2	Building circle
	Standing in a circle each child gets a number to remember

	When your number is called run to the middle
	Build and break down 6 tower and run back (you call the next number)
Activity 3	Clock-building Speed-Stacks
	Building your Speed-Stacks – CLOCK-WISE
	Breaking down your Speed-Stacks – CLOCK-WISE
Activity 4	Balancing on blue balance boards
	When whistle blow run and build a 6 tower
	Run back and start balancing
	When whistle blow run and break down a 6 tower
Week 4: Programme 7	
Equipment:	Speed-Stacks; 12 big picture balls.
Activity 1	Build-up and break down the 10 tower
Activity 2	Bounce and catch the ball
	After 10 bounces build a 10 tower and break down
Activity 3	Competition TIME!
	Building and breaking down 10 tower competition!
Week 4: Programme 7	
Equipment:	Speed-Stacks; 12 big picture balls.
Activity 1	Build-up and break down the 10 tower
Activity 2	Bounce and catch the ball
	After 10 bounces build a 10 tower and break down
Activity 3	Competition TIME!
	Building and breaking down 10 tower competition!
Week 4: Programme 8	
Equipment:	Speed-Stacks; 12 hula hoops; 12 beanbags; beads and lace; 12 hockey beacons.
Activity 1	Build-up and break down the 10 tower

Activity 2	Stand at the beacon
	Aim for a hula-hoop throw your beanbag into a hula
	Run and build a 10 tower
Activity 3	Animal walk RACE
	(crab, frog ,baboon)
	Build and break down a 10 tower
Activity 4	Start at the beacon
	Run to the Hula
	Thread all the beads
	Run to the speed-stacks
	Build a 10 tower and run back (tag your friend to go next)
Week 4: Programme 9	
Equipment: Speed-Stacks; 12 hula hoops; ladders (speed and agility); 12 hockey beacons; 12 big picture balls; 12 small hand balls.	
Activity 1	Build-up and Break down the 10 Tower
Activity 2	RACE (speeds-stacks spread out all over)
	Run and fetch 10 cups
	Only one cup at a time (picking the cups up with your left hand only)
	Build a 10 tower and sit down (first one to sit wins)
Activity 3	Ladder Race (Speed and Agility)
	Build and break down a 10 tower
Activity 4	Teams (2 Children in a team)
	Bounce / throw / roll (10 times)
	Run and build a 10 tower
Week 5: Programme 10	
Equipment:	Speed-Stacks; 12 hockey beacons; purple worms.
Activity 1	Build-up and break down the 3 and 6 tower
Activity 2	Build-up and break down 10 tower
Activity 3	RACE

	Build 3 ,6,10 tower
	Break down 10,6,3 tower
Activity 4	Build and break down 3 tower
	Crawl through purple worm
	Build and break down 6 tower
	Run back and tag a friend

Week 5: Programme 11

Equipment: Speed-Stacks; 12 hockey beacons; 4 trampolines; 4 small hand balls; 1 bib.

Activity 1	Build-up and Break down the 3,6,10 tower
Activity 2	SQUARE Building and breaking down each other's towers
	Moving forward in square formation
	Building and breaking down 3,6,10 towers
Activity 3	Jump on trampoline 10 times
	Hold ball under your chin
	Stop and build a 6 tower stop and build a 10 tower
	Run back and tag a friend
Activity 4	Build-touchers
	One is the "tagger"
	When tagged run to speed-stacks and start stacking

Week 5: Programme 12

Equipment: Speed-Stacks; 12 hockey beacons; 12 beanbags; 12 balloons.

Activity 1	Build-up and break down the 3, 6,10 tower
Activity 2	Teams (2 in a team)
	Beanbag race- (holding beanbag with hands/backs/heads/bums)
	Then build a 6 tower
Activity 3	Obstacle course
	Walk with beanbag between knees
	Wheel-barrow race

	Both build a 10 tower
	Wheel-barrow race back (first team to sit wins)
Activity 4	balloon game
	Keeping your balloon in the air (both hands/right/left)
	When whistle blow, run and build a 6 tower
	Run back and start keeping your balloon in the air again.

Created by du Plessis and du Randt (2013)

APPENDIX F Guidelines for authors: The African Journal for Physical, Health Education, Recreation and Dance

GUIDELINES FOR AUTHORS

The African Journal for Physical, Health Education, Recreation and Dance (AJPHERD) is a peer-reviewed journal established to:

i) provide a forum for physical educators, health educators, specialists in human movement studies and dance, as well as other sport-related professionals in Africa, the opportunity to report their research findings based on African settings and experiences, and also to exchange ideas among themselves.

ii) afford the professionals and other interested individuals in these disciplines the opportunity to learn more about the practice of the disciplines in different parts of the continent.

iii) create an awareness in the rest of the world about the professional practice in the disciplines in Africa.

GENERAL POLICY

AJPHERD publishes research papers that contribute to knowledge and practice, and also develops theory either as new information, reviews, confirmation of previous findings, application of new teaching/coaching techniques and research notes. Letters to the editor relating to the materials previously published in AJPHERD could be submitted within 3 months after publication of the article in question. Such letter will be referred to the corresponding author and both the letter and response will be published concurrently in a subsequent issue of the journal.

Manuscripts are considered for publication in AJPHERD based on the understanding that they have not been published or submitted for publication in any other journal. In submitting papers for publication, corresponding authors should make such declarations. Where part of a paper has been published or presented at congresses, seminars or symposia, reference to that publication should be made in the acknowledgement section of the manuscript.

AJPHERD is published quarterly, i.e. in March, June, September and December. Supplements/Special editions are also published periodically.

SUBMISSION OF MANUSCRIPT

Three copies of original manuscript and all correspondence should be addressed to the Editor-In-Chief:

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Centre for Biokinetics, Recreation Fax: +27 15 9628076/9628035
and Sport Science, University of Venda for E-mail: amusalbw@yahoo.com
Science and Technology, P. Bag X5050,
Thohoyandou 0950
Republic of South Africa

Articles can also be submitted electronically, i.e. via e-mail attachment. However, the corresponding author should ensure that such articles are virus free. AJPHERD reviewing process normally takes 4-6 weeks and authors will be advised about the decision on submitted manuscripts within 60 days. In order to ensure anonymity during the reviewing process authors are requested to avoid self-referencing or keep it to the barest minimum.

PREPARATION OF MANUSCRIPT

Manuscripts should be type written in fluent English (using 12-point Times New Roman font and 1½ line-spacing) on one side of whiteA4-sized paper justified fully with 3cm margin on all sides. *Guidelines for Authors* 317

In preparing manuscripts, MS-Word, Office 98 or Office 2000 for Windows should be used. Length of manuscripts should not normally exceed 12 printed pages (including tables, figures, references, etc.). For articles exceeding 10 typed pages US$ 10.0 is charged per every extra page. Longer manuscripts may be accepted for publication as supplements or special research reviews. Authors will be requested to pay a publication charge of US$ 350.0 to defray the very high cost of publication. The pages of manuscripts must be numbered sequentially beginning with the title page. The presentation format should be consistent with the guidelines in the publication format of the American Psychological Association (APA) (4th edition).

Title page:

The title page of the manuscript should contain the following information:

Concise and informative title.

Author(s') name(s) with first and middle initials. Authors' highest qualifications and main area of research specialisation should be provided.

Author(s') institutional addresses, including telephone and fax numbers.

Corresponding author's contact details, including e-mail address.

A short running title of not more than 6 words.

Abstract

An abstract of 200-250 words is required with up to a maximum of 5 words provided below the abstract. Abstract must be typed on a separate page using single line spacing, with the purpose of the study, methods, major results and conclusions concisely presented. Abbreviations should either be defined or excluded.

Text

Text should carry the following designated headings: Introduction, materials and methods, results, discussion, acknowledgement, references and appendices (if appropriate).

Introduction

The introduction should start on a new page and in addition to comprehensively giving the background of the study should clearly state the problem and purpose of the study. Authors should cite relevant references to support the basis of the study. A concise but informative and critical literature review is required.

Materials and Methods

This section should provide sufficient and relevant information regarding study participants, instrumentation, research design, validity and reliability estimates, data collection procedures, statistical methods and data analysis techniques used. Qualitative research techniques are also acceptable.

Results

Findings should be presented precisely and clearly. Tables and figures must be presented separately or at the end of the manuscript and their appropriate locations in the text indicated. The results section should not contain materials that are appropriate for presentation under the discussion section. Formulas, units and quantities should be expressed in the *systeme* 318 *Guidelines for Authors* *internationale (SI)* units. Colour printing of figures and tables is expensive and could be done upon request authors' expense.

Discussion

The discussion section should reflect only important aspects of the study and its major conclusions. Information presented in the results section should not be repeated under the discussion. Relevant references should be cited in order to justify the findings of the study. Overall, the discussion should be critical and tactfully written.

References

The American Psychological Association (APA) format should be used for referencing. Only references cited in the text should be alphabetically listed in the reference section at the end of the article. References should not be numbered either in the text or in the reference list.
Authors are advised to consider the following examples in referencing:

Examples of citations in body of the text:-
For one or two authors; Kruger (2003) and Travill and Lloyd (1998). These references should be cited as follows when indicated at the end of a statement: (Kruger, 2003); (Travill & Lloyd, 1998).

For three or more authors cited for the first time in the text; Monyeki, Brits, Mantsena and Toriola (2002) or when cited at the end of a statement as in the preceding example; (Monyeki, Brits, Mantsena & Toriola, 2002). For subsequent citations of the same reference it suffices to cite this particular reference as: Monyeki et al. (2002).

Multiple references when cited in the body of the text should be listed chronologically in ascending order, i.e. starting with the oldest reference. These should be separated with semi colons. For example, (Tom, 1982; McDaniels & Jooste, 1990; van Heerden, 2001; de Ridder at al., 2003).

Reference List

In compiling the reference list at the end of the text the following examples for journal references, chapter from a book, book publication and electronic citations should be considered:

Examples of journal references:

Journal references should include the surname and initials of the author(s), year of publication, title of paper, name of the journal in which the paper has been published, volume and number of journal issue and page numbers.

For one author: McDonald, A.K. (1999). Youth sports in Africa: A review of programmes in selected countries. *International Journal of Youth Sports*, 1(4), 102-117.

For two authors: Johnson, A.G. & O'Kefee, L.M. (2003). Analysis of performance factors in provincial table tennis players. *Journal of Sport Performance*, 2(3), 12-31.

For multiple authors: Kemper, G.A., McPherson, A.B., Toledo, I. & Abdullah, I.I. (1996). Kinematic analysis of forehand smash in badminton. *Science of Racket Sports*, 24(2), 99-112.

Examples of book references: *Guidelines for Authors* 319

Book references should specify the surname and initials of the author(s), year of publication of the book, title, edition, page numbers written in brackets, city where book was published and name of publishers. Chapter references should include the name(s) of the editor(s) and other specific information provided in the third example below:

For authored references: Amusa, L.O. & Toriola, A.L. (2003). *Foundations of Sport Science* (1st ed.) (pp. 39-45). Mokopane, South Africa: Dynasty Printers.

For edited references: Amusa, L.O. and Toriola, A.L. (Eds.) (2003). *Contemporary Issues in Physical Education and Sports* (2nd ed.) (pp. 20-24). Mokopane, South Africa: Dynasty Printers.

For chapter references in a book: Adams, L.L. & Neveling, I.A. (2004). Body fat characteristics of sumo wrestlers. In J.K. Manny and F.O. Boyd (Eds.), *Advances in Kinanthropometry* (pp. 21-29). Johannesburg, South Africa: The Publishers Company Ltd.

Example of electronic references:

Electronic sources should be easily accessible. Details of Internet website links should also be provided fully. Consider the following example:

Wilson, G.A. (1997). Does sport sponsorship have a direct effect on product sales? *The Cyber-Journal of Sport Marketing (online*), October, 1(4), at http://www.cad.gu.au/cjsm/wilson.html. February 1997.

PROOFREADING

Manuscript accepted for publication may be returned to the author(s) for final correction and proofreading. Corrected proofs should be returned to the Editor-In-Chief within one week of receipt. Minor editorial corrections are handled by AJPHERD.

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APPENDIX G: Guidelines for authors: South African Journal for Research in Sport, Physical Education and Recreation

INFORMATION FOR AUTHORS

The *South African Journal for Research in Sport, Physical Education and Recreation* is published by the Stellenbosch University. Contributions from the fields of Sport Science, Movement Education, Recreation/Leisure Studies, Exercise Science and Dance Studies will be considered for publication. The articles submitted will be administered by the appropriate Subject Review Editor and evaluated by two or more referees. The decision as to whether a particular article is to be published or not, rests with the Editorial Board.

SUBMISSION

Manuscripts should be typed with **one and a half spacing** in 12-point Times New Roman letter size and printed on A4-size white paper in laser quality. The original manuscript (clearly indicated) and three copies of the manuscript must be submitted. Length must not exceed 20 pages (tables, figures, references, etc. included). Original manuscripts may be submitted in English or Afrikaans and should be sent to:

The Editor
South African Journal for Research in Sport,
Physical Education and Recreation
Department of Sport Science
Private Bag X1
7602 Matieland, STELLENBOSCH
Republic of South Africa

Editorial Office
Tel: 021-808 4915 / 4724
Fax: 021-808 4817
E-mail: floris@sun.ac.za

NB. Articles can also be submitted by e-mail.

CONDITIONS

A signed declaration in respect of the originality must accompany each manuscript. On submission of the manuscript, the author shall present a written statement that the article has not been published or is not being presented for publication elsewhere. We discourage the practice of parts of one study in different journals. Authors who submit a manuscript from a study, some of these data which has been or will be published elsewhere, must provide a strong justification in an accompanying letter to the editor. The justification for not publishing all the data together in one paper or as multiple papers in a single issue of the *South African Journal for Research in Sport, Physical Education and Recreation* must also be covered in the covering letter.

Should the article be taken from a Master's thesis or Doctoral dissertation, academic ethic requires that the student will be the first author. The author should also ensure that the LANGUAGE of the manuscript has been thoroughly edited at the time of submission (in British English). The name, address and telephone number of the person who has done the language editing must be provided. On receiving a written notification from the Managing Editor that the article has been accepted, a final hard copy of the manuscript and a diskette (virus checked) should be submitted using MS WORD as a DOC-file (see figures). It can also be send per e-mail as an attached file.

PREPARATION OF MANUSCRIPT

Title page

The first page of each manuscript should indicate the *title* in English and Afrikaans (will be translated for foreign authors), the *names* (title, first name in full and other initials, surname) of the author(s), the *telephone* numbers (work & home), *facsimile* number, *e-mail* address (if available) and the *field of study*. The mailing address of the first named author and the institution where the work was conducted should be provided in full. A short title of not more than 45 characters, including the spaces, should be provided for use as a running head.

Abstract

Each manuscript must be accompanied by an abstract of approximately 150-200 words in *English* and should be set on a *separate page* as a SINGLE paragraph (one and a half spacing). A list of three to seven **key words** in *English* is required for indexing purposes and should be typed below the abstract. Articles in Afrikaans must include an *additional* extended summary (500-1000 words) in English. This summary must start on a new page (following the list of sources) providing the English title of the article at the beginning.

Text

Start the text on a new page with the title of the article (centred and *without* the names of the authors). Follow the style of the most recent issue of the journal regarding the use of headings and subheadings. Use only one space after a sentence.

Tables and figures

Tables and figures should be numbered in *Arabic* numerals (1, 2, etc.). Tables require a heading at the *top* and figures a legend *below* and separate from the figure. ***Note:*** Use the decimal POINT (not the decimal comma).

References

In the *text* the Harvard method must be adopted by providing the author's surname and the date placed in parentheses. *For example:* Daly (1970); King and Loathes (1985); (Botha & Sonn, 2002); McGuines *et al.* (1986) or (Daly, 1970: 80) when Daly is not part of the sentence. More than one reference must be arranged chronologically. Note that *et al.* is used in the body of the text when there are more than two authors, but never in the list of references.

List of references

Only the references cited in the text should be listed alphabetically according to surname (last name) of authors (capitals) after the body of text under the heading, **References** (capitals) starting on a new page. In the case of articles published in *JOURNALS,* references listed should include the surnames and initials (capitals) of all authors, the date of the publication in parentheses, the full title of the article, the full title of the journal (italics), the volume number, the serial number in parentheses (omitted only if the said journal does not use issue numbers), followed by a colon and the first and last page numbers separated by a hyphen.

Example:

VAN WYK, G.J. & AMOORE, J.N. (1995). A practical solution for calculating instantaneous values of tension in the extensor muscles of the knee joint during extension and flexion. *South African Journal for Research in Sport, Physical Education and Recreation,* 18(1): 77-97.

If the reference is a *BOOK,* the surname (last name) and initials of the author or editor (Ed.) must be given, followed by the date of publication in parentheses, the title of the book (italics) as given on the title page, the number of the edition (ed.) in parentheses, the city (and abbreviation for the state in the case of the USA) where published, followed by a colon and the name of the publisher.

Example:

JEWETT, A.E.; BAIN, L.L. & ENNIS, C.E. (1995). *The curriculum process in Physical Education* (2nd ed.). Madison, WI: WCB Brown & Benchmark.

For a CHAPTER from a book, the page numbers of the chapter cited must be provided in parentheses (not italics) after the title of the book. For further details, authors should consult the most recent publication of this Journal for other examples.

Example:

DE RIDDER, J.H. (1999). Kinanthropometry in exercise and sport. In L.O. Amusa; A.L. Toriola & I.U. Onyewadume (Eds.), *Physical Education and sport in Africa* (235-263). Ibadan (Nigeria): LAP Publications.

If the reference is a THESIS or DISSERTATION, no italics is used as it is an unpublished work.

Example:

CRAVEN, D.H. (1978). The evolution of major games. Unpublished PhD dissertation. Stellenbosch: Stellenbosch University.

For *ELECTRONIC SOURCES* all references start with the same information that would be provided for a printed source (if available). The web page information follows the reference. It will usually contain the name of the author(s) (if known), year of publication or last revision, title of complete work in inverted commas, title of web page in italics, Uniform Resource Locater (URL) or access path in text brackets (do not end the path statement with a fullstop) and date of access. See *"How to cite information from the internet and the world wide web"* at http://www.apa.org/journals/webref.html for specific examples. When citing a web site in the text, merely give the author and date (in this case: Ackermann, 1996).

Example of Web Page:

ACKERMANN, E. (1996). "Writing your own Web Pages." *Creating Web Pages*. Hyperlink [http://www.mwc.edu/ernie/writeweb/writeweb.html]. Retrieved 22 October 1999.

ADMINISTRATION

If authors honour the rules and specifications for the submission of manuscripts, unnecessary delays will be avoided. A manuscript that does not meet the requirements as set out above, will be returned to the author without being evaluated. Requesting copying rights concerning figures or photographs is the responsibility of the authors. The corresponding author will receive a complimentary copy of the journal and five reprints of the article. The original manuscripts and illustrations will be discarded one month after publication unless a request is received to return the original to the first-named author. Page charges of **R80** per page are payable on receipt of an account issued by the editor.

APPENDIX H: Guidelines for authors: Adapted Physical Activity Quarterly

Submission Guidelines for APAQ

Manuscript Type

As outlined in the *Adapted Physical Activity Quarterly* (*APAQ*) Editorial Mission page, the journal accepts four major types of papers: Viewpoint, Literature Review, Empirical Research and Application. APAQ will publish well informed viewpoints relevant to the field and excellent literature reviews integrating the body of knowledge in a relevant area. Potential contributors of empirical papers must carefully consider both the assumptions and theoretical foundations of their work, as well as its methodology. Indicate relevance of your work by referring to theories, paradigms, or conceptual frameworks and by briefly reviewing the existing knowledge base. All empirical papers must be based on research methods and designs appropriate to the question(s) addressed, conforming to whatever standards of excellence are expected with the approach(es) adopted. Bearing in mind this condition, qualitative and quantitative methods are thus equally welcome. APAQ also welcomes knowledge translation studies, or the presentation of new and promising intervention, in its application section.

Manuscript Submission

Submit manuscripts electronically to Manuscript Central: **mc.manuscriptcentral.com/hk_apaq**. Do not submit the manuscript to another journal at the same time. Authors are advised to check the typing of the final copy, particularly the accuracy of references, and to retain a duplicate copy to guard against loss. Authors of manuscripts accepted for publication must transfer copyright to Human Kinetics, Inc. Please direct general correspondence to the editorial assistant (Christina Johnson) at **ChristinaJ@hkusa.com**.

Preparing Manuscripts

Style. In preparing manuscripts for publication in APAQ, authors should adhere to the guidelines in the Publication Manual of the American Psychological Association (PMAPA, 6th edition, 2010, 3rd printing or later). Copies of PMAPA are available in most university libraries or obtained through the American Psychological Association (APA) Order Department, P.O. Box 92984, Washington, DC 20090-2984 (www.apa.org/books). Tel: 800-374-2721. Contributors from U.K., Europe, Africa, and the Middle East may obtain copies from APA, 3 Henrietta Street, Covent Garden, London, WC2E 8LU England.

Using the PMAPA as a guide, pay attention to all the facets related to manuscript preparation. Format papers with a 1-in. (2.5 cm) margin, 12-point font, and double spacing, including quotes. Papers should not exceed 30 pages including tables and figures. Check format against APA sample paper (pp. 41-59). Note that Method is singular, and the heading, Participants, is preferred over Subjects. Insert line numbers 1-27 in the left margin of each page, beginning with the abstract page. This facilitates providing line-by-line feedback. All manuscripts must include a single paragraph abstract of 100-150 words and three to five keywords chosen from terms not used in the title.

Language. Use person-first, non-sexist language in your writing, according to PMAPA standards (pp. 70-76). Pay particular attention to section 3.15. Refer to disabled citizens as individuals with disabilities. Avoid using characteristic and attribute. Instead, use demographic data, diagnostic criteria met, behaviors, or indicators. Do not assume commonalities; base language on individual assessment.

Ethics approval. For studies involving humans, the participants section must include a statement certifying that the study received institutional approval and that the participants' informed consent was obtained.

Preparation of figures and tables. In figures, use black and white only, no shading or color. Resolution of digital images should be 300 dpi at full size for photos and 600 dpi for line art; color images cannot be accepted. Figures or photos should be in .jpeg or .tif files. Tables must be formatted using Microsoft Word's table-building functions, and not by using tab keystrokes and line breaks.

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*Uniform requirements for manuscripts submitted to biomedical journals. *New England Journal of Medicine,* 1991, 324, 424–428.

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APPENDIX I: Proof of Language Editing